



Mississippi Department of Education

Tom Burnham, Ed.D., State Superintendent of Education

Lynn J. House, Ph.D., Deputy State Superintendent • Instructional Enhancement and Internal Operations

Office of Career Education and Workforce Development

Jean Massey • Associate State Superintendent • 601-359-3465 • Fax: 601-359-6619

TO: District Superintendents and Secondary Vocational Directors/Contact Persons

FROM: Jean Massey, Associate State Superintendent
Office of Vocational Education and Workforce Development

DATE: May 23, 2011

RE: Revised Secondary Curriculum Framework

The State Board of Education, on May 23, 2011, approved the Office of Vocational Education and Workforce Development to begin the Administrative Procedures Act Process for the following item:

To revise the Mississippi Secondary Curriculum Frameworks for the following secondary programs:

1. Welding
2. Teacher Academy
3. Metal Fabrication
4. Marketing
5. Industrial Maintenance
6. Heating Ventilation and Air Conditioning (HVAC)
7. Digital Media Technology
8. Culinary Arts
9. Collision Repair Technician
10. Automotive Service Technician

A copy of the secondary curriculum can be downloaded from the following site:

<http://www.mde.k12.ms.us/vocational/OVTE/>

If additional information is needed, please contact Jean Massey, Associate State Superintendent of Career and Technical Education at 601-359-3465.

JM:cb

MEMORANDUM#11.032

"Quality Education for Every Child"

Central High School Building • 359 North West Street • P.O. Box 771 • Jackson, MS 39205-0771

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Welding Technology Executive Summary	6
Course Outlines.....	9
Welding Technology Competencies and Objectives	12
Welding Technology Competency Profile.....	17
Appendix A: 21st Century Skills Standards	19
Appendix B: MS Academic Standards	21
Appendix C: ACT College Readiness Standards.....	51
Appendix D: Pathway Content Standards.....	65
Appendix E: National Educational Technology Standards for Students	75

Welding Technology Executive Summary

Program Description

Welding is an instructional program that prepares students for employment or continued education in the occupations of the welding field. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **Contren Learning Series**. When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi Construction Technology instructors will be required to successfully complete the **Instructor Certification Training Program**. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi **NCCER Accredited Training and Education Facilities (ATEF)**. In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
10. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Articulation

The following articulation plans are in place for the Installation and Service Pathway:

High School Program	Community College Program	Community College Course
Welding Theory and Applications	Welding and Cutting Tech Industrial Maintenance Trades	WLV 1116 - Shielded Metal Arc Welding I (effective 2006) IMM 1734 - Maintenance Welding and Metals

Assessment

Students will be assessed using the Welding MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the Construction and Manufacturing instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Welding program, the following student prerequisites are in place:

1. C or higher in English (the previous year)
 2. C or higher in Math (last course taken or the instructor can specify the math)
- or**
3. Instructor Approval and TABE Reading Score (eighth grade or higher)
- or**
4. Instructor Approval

Proposed Applied Academic Credit

Applied Math content from the curriculum was aligned to the 2007 Mississippi Math Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Math credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A (975) educator license is required to teach the Welding program. Requirements for the (975) endorsements are listed below:

1. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education.
2. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught. Applicant with a bachelor's or higher degree must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.

3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the *Redesign* Education Program (REP).
4. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must earn a passing score on **Welding** assessment from National Craft Assessment and Certification Program.
6. Applicant must successfully complete the Contren Instructor Certification.
7. Applicant must successfully complete an MDE-approved computer literacy certification exam.
8. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
9. Applicant must successfully complete the **Welding** certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a (975) endorsement—a 5-year license. If the applicant does not meet **all** requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows options for local school districts to implement based on student needs and scheduling demands. This curriculum offers a four-Carnegie-unit program.

Option 1

Upon completion of this option, the student will be trained to take the **NCCER Level 1 Core Certification and the Welding Level 1 Certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

Welding I (Course Code: 993300)
 Welding II (Course Code: 993301)

Course Description: Welding I is a course in which students learn about welding technology including Math, Introduction to Blueprints, Hand and Power Tools, Orientation to the Trade, Introduction to Welding, and Shielding Metal Arc Welding. This is a two-Carnegie-unit course.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.

Course Description: Welding II is a continuation of Welding I with the emphasis on Gas Metal Arc Welding, Flux Core Arc Welding, Gas Tungsten Arc Welding, and applications of production welding processes. The course should be taken after the student has successfully passed Welding I. This is a two-Carnegie-unit course.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete welding courses with a score of 80/C or higher in class work to advance to the next level.

Welding I (Course Code: 993300)

Unit	Title	Hours
1	Orientation, Leadership, and Safety	15
2	Welding Math	15
3	Introduction to Blueprints, Hand and Power Tools, and Basic Rigging	50
4	Base Metal Preparation and Weld Quality, Oxy-fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting	65
5	Shielded Metal Arc Welding (SMAW)	135
		280

Welding II (Course Code: 993301)

Unit	Title	Hours
6	Orientation and Safety (Review and Reinforcement of Unit 1)	10
7	Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)	270
		280

Welding III – COOP Option (Course Code: 993305)

Unit	Title	Hours
6	Orientation and Safety (Review and Reinforcement of Unit 1)	10
8	Production Welding Processes	270
	COOP	???
		280

Option 2

Upon completion of this option, the student will be trained to take the **NCCER Level 1 Core Certification and the Welding Level 1 Certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

- Orientation and Cutting (Course Code: 993302)
- Shielded Metal Arc Welding (SMAW) (Course Code: 993303)
- Gas Metal, Flux Core, and Gas Tungsten Welding (GMAW, FCAW, and GTAW) (Course Code: 993304)
- Production Welding Processes (Course Code: 993305)

Course Description: Orientation and Cutting (Course Code: 993302) includes an introduction to the field as well as Fundamentals of Safety, Math, Blueprint Reading, Hand and Power Tools, and Oxy-fuel and Plasma Cutting Devices. This is a one-Carnegie-unit course.

Course Description: Shielded Metal Arc Welding (Course Code: 993303) emphasizes an overview of safety and shielded metal arc welding processes and equipment. This course gives students real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting.

Course Description: Gas Metal, Flux Core, and Gas Tungsten Welding (Course Code: 993304) includes an in-depth study of the gas metal arc welding, flux core arc welding, and gas tungsten arc welding processes and equipment. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting.

Course Description: Production Welding Processes (Course Code: 993305) includes an overview of Resistance Welding, Robotic Welding, Frictional Stir Welding, and Induction

Welding. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting and Gas Metal, Flux Core, and Gas Tungsten Welding.

- Safety will be reinforced and tested at the beginning of each course.
- Students must complete previous welding courses with a score of 80/C or higher in class work to advance to the next level.

Orientation and Cutting (Course Code: 993302)

Unit	Title	Hours
1	Orientation, Leadership, and Safety	10
2	Welding Math	15
3	Introduction to Blueprints, Hand and Power Tools, and Basic Rigging	50
4	Base Metal Preparation and Weld Quality, Oxy-fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting	65
		140

Shielded Metal Arc Welding [SMAW] (Course Code: 993303)

Unit	Title	Hours
6	Orientation and Safety (Review and Reinforcement of Unit 1)	5
5	Shielded Metal Arc Welding (SMAW)	135
		140

Gas Metal, Flux Core, and Gas Tungsten Welding [GMAW, FCAW, and GTAW] (Course Code: 993304)

Unit	Title	Hours
6	Orientation and Safety (Review and Reinforcement of Unit 1)	5
7	Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)	135
		140

Production Welding Processes (Course Code: 993305)

Unit	Title	Hours
6	Orientation and Safety (Review and Reinforcement of Unit 1)	5
8	Production Welding Processes	135
		140

Welding Technology Competencies and Objectives

Unit 1: Orientation, Leadership, and Safety

1. Describe local program and vocational/career–technical center policies and procedures. (CONTREN Module: 00107-09 and 00108-09) (DOK 1)
 - a. Describe local program and vocational/career–technical center policies and procedures. (DOK 1)
2. Describe employment opportunities and responsibilities of the welder. (CONTREN Module: 00107-09, 00108-09) (DOK 1)
 - a. Describe employer expectations in the workplace. (DOK 1)
3. Explore leadership skills and personal development opportunities. (CONTREN Module: 00107-09 and 00108-09) (DOK 1)
 - a. Demonstrate effective team-building and leadership skills. (DOK 1)
 - b. Demonstrate through practice appropriate work ethics. (DOK 1)
4. Describe general safety rules for working in a shop/lab and industry. (CONTREN Module: 00101-09) (DOK 1)
 - a. Appraise safety issues and prevention associated tools, equipment, and housekeeping found in the school shop area. (DOK 1)
 - b. Implement fire safety and prevention techniques. (DOK 2)

Unit 2: Math for Welding Applications

1. Apply the four basic math skills with whole numbers, fractions, and percents. (CONTREN Module: 00102-09, 00105-09) (DOK 1)
 - a. Perform mathematic calculations relating to the welding trade. (DOK 1)
2. Perform basic mathematical calculations related to industrial maintenance shop operations. (CONTREN Module: 00102-09, 00105-09) (DOK 1)
 - a. Use the metric system in craft applications. (DOK 1)
 - b. Compute distances according to a drawn plan, and then calculate the amount of material for a given project. (DOK 2)
3. Identify and perform functions using various measuring tools and instruments (CONTREN Module: 00102-09). (DOK 2)
 - a. Read a ruler and layout lines to the nearest 1/16 in. (DOK 1)
4. Read, analyze, and design a blueprint. (CONTREN Module: 00105-09) (DOK 2)
 - a. Identify and interpret terms and symbols commonly used on blueprints. (DOK 1)
5. Demonstrate the use and maintenance of various hand and power tools found in the craft trade. (CONTREN Module: 00101-09, 00103-09, 00104-09) (DOK 2)
 - a. Identify and discuss the proper safe use of common hand and power tools. (DOK 1)
 - b. Select and demonstrate the use of tools, and explain the procedures for maintaining hand and power tools. (DOK 2)

Unit 3: Introduction to Blueprints, Hand and Power Tools, and Basic Rigging

1. Demonstrate how to read and comprehend welding blueprints. (Module 29110-09, Module 29202-09) (DOK 2)
 - a. Read a basic welding blueprint found in industry and construction. (DOK 1)
2. Identify and use tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (CONTREN: 00103-09, 00104-09) (DOK 2)
 - a. Illustrate the use of tools used in the welding craft. (DOK 1)
 - b. Identify and use common hand and power tools used in the welding trade. (DOK 1)
3. Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (CONTREN Module: 00106-09) (DOK 3)
 - a. While identifying rigging equipment, describe how to perform safety inspections and use slings and common rigging hardware. (DOK 1)
 - b. Describe basic load-handling practices and basic hitch configurations and their proper connections. (DOK 2)
 - c. Identify basic rigging procedures, and demonstrate proper use of American National Standards Institute (ANSI) hand signals. (DOK 2)

Unit 4: Base Metal Preparation and Weld Quality, Oxy-Fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting

1. Explore regulations and codes for welding, base metal cleaning, joint designs and their purpose. (CONTREN Module: 29105-09 ,26106-09, and 29110-09) (DOK 2)
 - a. Discuss codes governing welding, the causes of weld imperfections, welder qualification tests, and the importance of quality of skill. (DOK 1)
 - b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld. (DOK 2)
 - c. Explain joint fit and joint measurement while fitting plate and pipe. (DOK 2)
2. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (CONTREN Module: 29102-09 Oxy-Fuel Cutting) (DOK 2)
 - a. Identify and explain the use of oxy-fuel cutting equipment. (DOK 1)
 - b. Demonstrate how to use an oxy-fuel torch. (DOK 2)
 - c. Perform oxy-fuel cutting:
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing
 - Gouging (DOK 3)
 - d. Set up and operate a motorized, portable oxy-fuel gas cutting machine. (DOK 3)
3. Identify and describe the basic equipment, setup, use, and safety rules for proper use of equipment, and prepare base metal for plasma arc cutting. (CONTREN Module: 29103-09 Plasma Arc Cutting) (DOK 2)
 - a. Identify and understand plasma arc cutting processes. (DOK 1)
 - b. Demonstrate how to set up and perform horizontal and vertical cuts in mild plate steel, pipe, and angled steel using a plasma torch to cut hot rolled mild steel. (DOK 1)

4. Explore the selection, setup, and operation of carbon arc cutting equipment. (CONTREN Module: 29104-09 Air Carbon Arc Cutting and Gouging) (DOK 2)
 - a. Identify air carbon arc cutting processes. (DOK 1)
 - b. Demonstrate how to set up and perform washing and gouging cuts in mild plate steel, pipe, and angled steel using an air carbon arc torch to cut hot rolled mild steel. (DOK 3)

Unit 5: Welding Safety and Introduction to Shielded Metal Arc Welding (SMAW)

1. Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade. (CONTREN Module: 29101-09) (DOK 1)
 - a. Recite safety hazards in the shielded metal arc welding shop environment. (DOK 1)
 - b. Perform safety inspection of SMAW welding equipment. (DOK 1)
 - c. Properly handle welding materials. (DOK 1)
2. Identify types of shielded metal arc welding machines and their accessories. (CONTREN Module: 29107-09) (DOK 2)
 - a. Explain the differences in electrical current used in welding shielded metal arc welding applications and the type of machines needed to perform the welding project. (DOK 1)
 - b. Demonstrate setting up arc welding equipment and how to use tools associated with weld cleaning. (DOK 2)
3. Select shielded metal arc electrodes for welding applications. (CONTREN Module: 29108-09) (DOK 2)
 - a. Explain factors that affect electrode selection, types of filler material, the ASME filler metal classification system, and how to store the filler electrodes. (DOK 1)
 - b. Properly select and weld metal using filler electrodes. (DOK 3)
4. Setup and make beads and fillet welds. (CONTREN Module: 29109-09) (DOK 2)
 - a. Describe the process for striking and extinguishing an arc, arc blow, and wander while properly exhibiting the process using a SMAW machine. (DOK 2)
 - b. Demonstrate stinger, weave, and overlapping beads in the horizontal, vertical, and overhead positions. (DOK 2)
5. Set up and perform groove welds with backing and without backing. (CONTREN Module: 29111-09 and 29112-09) (DOK 2)
 - a. Demonstrate groove with backing and open root groove welding procedures using SMAW equipment in the flat, horizontal, vertical, and overhead positions. (DOK 3)

Unit 6: Orientation and Safety (Review and Reinforcement)

1. Describe local program and vocational/career–technical center policies and procedures. (CONTREN Modules: 00107-09 and 00108-09) (DOK 1)
 - a. Describe local program and vocational/career–technical center policies and procedures. (DOK 1)
2. Describe employment opportunities and responsibilities of the welder. (CONTREN Modules: 00108-09) (DOK 2)
 - a. Describe employer expectations in the workplace. (DOK 1)

3. Explore leadership skills and personal development opportunities. (CONTREN Modules: 00107-09 and 00108-09) (DOK 2)
 - a. Demonstrate team-building and leadership skills. (DOK 2)
 - b. Demonstrate through practice appropriate work ethics. (DOK 2)
4. Describe general safety rules for working in a shop/lab and industry. (CONTREN Modules: 00101-09, 29101-09) (DOK 1)
 - a. Discuss safety issues and prevention associated with the installation and service shop area. (DOK 1)
 - b. Demonstrate fire safety and prevention techniques in the workplace. (DOK 2)

Unit 7: Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)

1. Demonstrate and discuss safety procedures of, applications of, and advantages and limitations of and identify the machine controls for GMAW and FCAW. (CONTREN Module: 29205-09 and 29206-09) (DOK 2)
 - a. Perform safety inspections of types of GMAW and FCAW equipment and accessories available in the school shop while explaining the characteristics of welding current and power sources. (DOK 1)
 - b. Identify and explain the use of GMAW and FCAW equipment:
 - Spray transfer
 - Globular
 - Short circuiting
 - Pulse (DOK 1)
 - c. Demonstrate the ability to set up and perform GMAW/FCAW welding operations on plate:
 - GMAW-S (short-circuit) multiple-pass fillet welds in multiple positions, using solid or composite wire and shielding gas
 - GMAW-S (short-circuit) multiple-pass V-groove welds in multiple positions (with or without backing), using solid or composite wire
 - GMAW spray fillet and V-groove welds in multiple positions (with or without backing), using solid or composite wire and shielding gas
 - FCAW multiple-pass fillet welds in multiple positions, using flux cored wire and, if required, shielding gas
 - FCAW multiple-pass V-groove welds in multiple positions (with or without backing), using flux cored wire and , if required, shielding gas (DOK 2)
2. Demonstrate and discuss safety procedures of, applications of, and the advantages and limitations of and identify the machine controls for the GTAW welding process. (CONTREN Module: 29207-09 and 29208-09) (DOK 2).
 - a. Explain the gas tungsten arc welding safety, equipment, filler metals, and shielding gases. (DOK 1)
 - b. Set up and weld using gas tungsten arc welding equipment in multiple weld positions using carbon steel filler material in the 1F, 2F, 3F, 4F, 1G, 2G, 3G, and 4G welding positions. (DOK 2)

Unit 8: Production Welding Processes

1. Recognize and explain the use of resistance welding applications in mass manufacturing, and demonstrate spot welding techniques on ferrous metals. (DOK 3)
 - a. Design and manufacture a project using resistance welding. (DOK 3)
2. Explain the use of robotics in the welding profession, and demonstrate how to safely operate welding robot equipment. (DOK 3)
 - a. Demonstrate safety procedures used in the automated environment. (DOK 1)
 - b. Describe the various major components of all robots including axis of movement, major components, and input and output devices used with robots. (DOK 2)
 - c. Demonstrate the ability to integrate a robot into a welding process by writing programs on industrial robots to perform a weld within the confines of the robot's work envelope and improve the efficiency of the robotic process by reducing cycle time, decreasing memory usage, using advanced programming techniques, and so forth. (DOK 3)
3. Explain pipe welding, and demonstrate how to safely weld carbon steel pipe. (CONTREN Module 08101-06, 08102-06, 08103-06, 08202-06, and 08207-06) (DOK 3)
 - a. Discuss the pipefitter career opportunities and the necessity for blueprint reading skills and math requirements of the pipefitter. (DOK 2)
 - b. Perform open-root V-groove pipe welds using SMAW, GMAW, FCAW, and/or GTAW welding processes in the following positions:
 - 1G-ROTATED
 - 2G
 - 5G
 - 6G (DOK 3)
4. Explain friction stir welding in industrial and marine applications. (DOK 3)
 - a. Discuss frictional stir welding and where it is used in everyday manufacturing processes as well as developmental processes. (DOK 3)
5. Understand the basic concepts of induction welding and brazing. (DOK 3)
 - a. Discuss induction welding and where it is used in everyday manufacturing processes. (DOK 1)
 - b. Perform an induction weld. (DOK 2)

Welding Technology Competency Profile

Program CIP: 48.0508

Unit 1: Orientation, Leadership, and Safety

- _____ 1. Describe local program and vocational/career–technical center policies and procedures. (DOK 1)
- _____ 2. Describe employment opportunities and responsibilities of the welder. (DOK 1)
- _____ 3. Explore leadership skills and personal development opportunities. (DOK 1)
- _____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)

Unit 2: Math for Welding Applications

- _____ 1. Apply the four basic math skills with whole numbers, fractions, and percents. (DOK 1)
- _____ 2. Perform basic mathematical calculations related to industrial maintenance shop operations. (DOK 1)
- _____ 3. Identify and perform functions using various measuring tools and instruments. (DOK 2)
- _____ 4. Read, analyze, and design a blueprint. (DOK 2)
- _____ 5. Demonstrate the use and maintenance of various hand and power tools found in the craft trade. (DOK 2)

Unit 3: Introduction to Blueprints, Hand and Power Tools, and Basic Rigging

- _____ 1. Demonstrate how to read and comprehend welding blueprints. (DOK 2)
- _____ 2. Identify and use tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (DOK 2)
- _____ 3. Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (DOK 3)

Unit 4: Base Metal Preparation and Weld Quality, Oxy-Fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting

- _____ 1. Demonstrate how to read and comprehend welding blueprints. (DOK 2)
- _____ 2. Identify and use tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (DOK 2)
- _____ 3. Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (DOK 3)
- _____ 4. Demonstrate how to read and comprehend welding blueprints. (DOK 2)

Unit 5: Welding Safety and Introduction to Shielded Metal Arc Welding (SMAW)

- _____ 1. Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade. (DOK 1)
- _____ 2. Identify types of shielded metal arc welding machines and their accessories.

_____ (DOK 2)

_____ 3. Select shielded metal arc electrodes for welding applications. (DOK 2)

_____ 4. Set up and make beads and fillet welds. (DOK 2)

_____ 5. Set up and perform groove welds with backing and without backing. (DOK 2)

Unit 6: Orientation and Safety (Review and Reinforcement)

_____ 1. Describe local program and vocational/career–technical center policies and procedures. (DOK 1)

_____ 2. Describe employment opportunities and responsibilities of the welder. (DOK 2)

_____ 3. Explore leadership skills and personal development opportunities. (DOK 2)

_____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)

Unit 7: Gas Metal Arc Welding (GMAW), Flux Core Arc Welding (FCAW), and Gas Tungsten Arc Welding (GTAW)

_____ 1. Demonstrate and discuss safety procedures, applications, and the advantages and limitations, and identify the machine controls for GMAW and FCAW. (DOK 2)

_____ 2. Demonstrate and discuss safety procedures, applications, and the advantages and limitations, and identify the machine controls for the GTAW welding process. (DOK 2)

Unit 8: Production Welding Processes

_____ 1. Recognize and explain the use of resistance welding applications in mass manufacturing, and demonstrate spot welding techniques on ferrous metals. (DOK 3)

_____ 2. Explain the use of robotics in the welding profession, and demonstrate how to safely operate welding robot equipment. (DOK 3)

_____ 3. Explain pipe welding, and demonstrate how to safely weld carbon steel pipe. (DOK 3)

_____ 4. Explain friction stir welding in industrial and marine applications. (DOK 2)

_____ 5. Understand the basic concepts of induction welding and brazing. (DOK 2)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
4. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others

3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- a. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- b. Explain the causes and characteristics of tides. (DOK 1)
- c. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- d. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
 - e. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
 - f. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
 - Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
 - g. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
 - Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
- 3. Apply an understanding of the diverse organisms found in aquatic environments.**
- a. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
 - Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
 - b. Research, calculate, and interpret population data. (DOK 2)
 - c. Research and compare reproductive processes in aquatic organisms. (DOK 2)
 - d. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
 - e. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
 - f. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
- 4. Draw conclusions about the relationships between human activity and aquatic organisms.**
- a. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
 - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
 - b. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
 - c. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
 - Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- d. Formulate questions that can be answered through research and experimental design. (DOK 3)
- e. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- f. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- g. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- h. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- i. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- a. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
 - Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- b. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- c. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- d. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
 - Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- e. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
 - Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- f. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
 - ATP structure
 - ATP function
- g. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
 - Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- a. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
 - Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- b. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- c. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- a. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- b. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- c. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- d. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- a. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- b. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- c. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - d. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- a. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - b. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - c. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - d. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - e. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - b. Clarify research questions and design laboratory investigations. (DOK 3)
 - c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- a. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - b. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - c. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - d. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- a. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - b. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - c. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- d. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- e. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- a. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- b. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- c. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- d. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- e. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- f. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- g. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- h. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- i. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- a. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- b. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- Formulate questions that can be answered through research and experimental design. (DOK 3)
- Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

- 2. Distinguish among the characteristics of botanical organization, structure, and function.**
- Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
 - Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
 - Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
 - Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
 - Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus
- 3. Demonstrate an understanding of plant reproduction.**
- Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
 - Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
 - Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
 - Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
 - Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
 - Research and compare various methods of plant propagation. (DOK 2)
- 4. Draw conclusions about the factors that affect the adaptation and survival of plants.**
- List and assess several adaptations of plants to survive in a given biome. (DOK 2)
 - Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- c. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- d. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- a. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- b. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- c. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- d. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- a. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
 - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
 - Substances and mixtures
 - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
- b. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- c. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
 - Properties and interactions of the three fundamental particles of the atom
 - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
- d. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
 - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
 - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- e. Compare the properties of compounds according to their type of bonding. (DOK 1)
 - Covalent, ionic, and metallic bonding
 - Polar and nonpolar covalent bonding
 - Valence electrons and bonding atoms
- f. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- g. Develop a three-dimensional model of molecular structure. (DOK 2)
 - Lewis dot structures for simple molecules and ionic compounds
 - Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

- a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
 - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations

- Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- c. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
4. **Analyze the relationship between microscopic and macroscopic models of matter.**
- a. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- b. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- c. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- d. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- a. Analyze and explain acid/base reactions. (DOK 2)

- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- b. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
 - c. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

- a. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
 - Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- b. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- c. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
 - Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- d. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- e. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- f. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
 - Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- a. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
 - Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- b. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
 - Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- c. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- | | |
|----|--|
| E1 | Apply inquiry-based and problem-solving processes and skills to scientific investigations. |
| E2 | Develop an understanding of the history and evolution of the universe and earth. |
| E3 | Discuss factors that are used to explain the geological history of earth. |
| E4 | Demonstrate an understanding of earth systems relating to weather and climate. |

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- a. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- b. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- c. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- d. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
 - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- a. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
 - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
 - b. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
 - c. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
 - d. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
 - e. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
 - f. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
 - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
 - g. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
 - h. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
- 4. Demonstrate an understanding of earth systems relating to weather and climate.**
- a. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
 - Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
 - b. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
 - c. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
 - d. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - e. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- a. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
 - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- b. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- c. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
 - Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- d. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- | | |
|------|---|
| ES 1 | Apply inquiry-based and problem-solving processes and skills to scientific investigations. |
| ES 2 | Develop an understanding of the relationship of ecological factors that affect an ecosystem. |
| ES 3 | Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems. |

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)

- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

- a. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
- b. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
- c. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- d. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
- e. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- f. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- g. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

- a. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
- b. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

- c. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- a. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- b. Describe how organic components are integral to biochemical processes. (DOK 2)
- c. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
 - Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- d. Explain the significance of the discovery of nucleic acids. (DOK 1)
- e. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- f. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- g. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- a. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- b. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- c. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- d. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- e. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- f. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- g. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)

- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

- a. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- b. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- c. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- d. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- e. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- f. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- g. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- h. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- i. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
- j. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
- k. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
 - Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Identify questions that can be answered through scientific investigations. (DOK 3)
- c. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
 - Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- d. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- g. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- a. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
 - Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- b. Explain the connection between force, work, and energy. (DOK 2)
 - Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)

- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
 - c. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
 - d. Draw and assess conclusions about charges and electric current. (DOK 2)
 - Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
 - e. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- a. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
 - b. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
 - c. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
 - The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
 - d. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- a. Cite evidence to summarize the atomic theory. (DOK 1)
 - Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
 - b. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
 - c. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
 - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)

- d. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
5. **Investigate and apply principles of physical and chemical changes in matter.**
- a. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
 - b. Balance chemical equations. (DOK 2)
 - c. Classify types of chemical reactions (e.g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**
 - a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
 - b. Clarify research questions, and design laboratory investigations. (DOK 3)
 - c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Develop an understanding of concepts related to forces and motion.**

- a. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
 - Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- b. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- c. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- d. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
 - Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
 - a. Explain and apply the conservation of energy and momentum. (DOK 2)
 - Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
 - b. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
 - c. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
 - d. Investigate and summarize the principles of thermodynamics. (DOK 2)
 - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
 - e. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**
 - a. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
 - Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.

- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - b. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - c. Explain the laws of reflection and refraction, and apply Snell’s law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - d. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - e. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- a. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm’s law
 - Magnetic poles, magnetic flux and field, Ampère’s law and Faraday’s law
 - Coulomb’s law
 - b. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - c. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- a. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - b. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

- SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- a. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- b. Clarify research questions, and design laboratory investigations. (DOK 3)
- c. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

- d. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
 - e. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - f. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - g. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
- 2. Demonstrate the basic concepts of remote sensing. (E, P)**
- a. Describe the characteristics of the electromagnetic spectrum.
 - b. Using images and graphs, interpret the absorption/reflection spectrum.
 - c. Distinguish between passive vs. active sensor systems.
 - d. Analyze the effects of changes in spatial, temporal, and spectral resolution.
 - e. Analyze the effects on images due to changes in scale.
 - f. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- a. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- b. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- c. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- d. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- a. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- b. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- c. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- d. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- e. Contrast food chains and food webs. (DOK 2)
- 4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- a. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
 - Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- b. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author’s Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

Industry Standards

CONTREN CORE

SAF – Basic Safety (MODULE 00101-09)

- Explain the idea of a safety culture and its importance in the construction crafts.
- Identify causes of accidents and the impact of accident costs.
- Explain the role of OSHA in jobsite safety.
- Explain OSHA’s General Duty Clause and 1926 CFR Subpart C.
- Recognize hazard recognition and risk assessment techniques.
- Explain fall protection, ladder, stair, and scaffold procedures and requirements.
- Identify struck-by hazards, and demonstrate safe working procedures and requirements.
- Identify caught-in-between hazards, and demonstrate safe working procedures and requirements.
- Define safe work procedures to use around electrical hazards.
- Demonstrate the use and care of appropriate personal protective equipment (PPE).
- Explain the importance of hazard communications (HazCom) and material safety data sheets (MSDSs).
- Identify other construction hazards on your jobsite, including hazardous material exposures, environmental elements, welding and cutting hazards, confined spaces, and fires.

MAT – Introduction to Construction Math (MODULE 00102-09)

- Add, subtract, multiply, and divide whole numbers with and without a calculator.
- Use a standard ruler, a metric ruler, and a measuring tape to measure.
- Add, subtract, multiply, and divide fractions.
- Add, subtract, multiply, and divide decimals with and without a calculator.
- Convert decimals to percentages and percentages to decimals.
- Convert fractions to decimals and decimals to fractions.
- Explain what the metric system is and how it is important in the construction trade.
- Recognize and use metric units of length, weight, volume, and temperature.
- Recognize some of the basic shapes used in the construction industry, and apply basic geometry to measure them.

HTO – Introduction to Hand Tools (MODULE 00103-09)

- Recognize and identify some of the basic hand tools and their proper uses in the construction trade.
- Visually inspect hand tools to determine if they are safe to use.
- Safely use hand tools.

PTO – Introduction to Power Tools (MODULE 00104-09)

- Identify power tools commonly used in the construction trades.
- Use power tools safely.
- Explain how to maintain power tools properly.

BLU – Introduction to Blueprints (MODULE 00105-09)

- Recognize and identify basic blueprint terms, components, and symbols.
- Relate information on blueprints to actual locations on the print.
- Recognize different classifications of drawings.
- Interpret and use drawing dimensions.

RIG – Basic Rigging (MODULE 00106-09)

- Identify and describe the use of slings and common rigging hardware.
- Describe basic inspection techniques and rejection criteria used for slings and hardware.
- Describe basic hitch configurations and their proper connections.
- Describe basic load-handling safety practices.
- Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COM – Basic Communication Skills (MODULE 00107-09)

- Interpret information and instructions presented in both verbal and written form.
- Communicate effectively in on-the-job situations using verbal and written skills.
- Communicate effectively on the job using electronic communication devices.

EMP – Basic Employability Skills (MODULE 00108-09)

- Explain the role of an employee in the construction industry.
- Demonstrate critical thinking skills and the ability to solve problems using those skills.
- Demonstrate knowledge of computer systems, and explain common uses for computers in the construction industry.
- Define effective relationship skills.
- Recognize workplace issues such as sexual harassment, stress, and substance abuse.

IMH – Introduction to Materials Handling (MODULE 00109-09)

- Define a load.
- Establish a pre-task plan prior to moving a load.
- Use proper materials-handling techniques.
- Choose appropriate materials-handling equipment for the task.
- Recognize hazards and follow safety procedures required for materials handling.

CONTREN PIPEFITTING

LEVEL ONE

OTT – ORIENTATION TO THE TRADE

- Describe the types of work performed by pipefitters.

- Identify career opportunities available to pipefitters.
- Explain the purpose and objectives of an apprentice training program.
- Explain the responsibilities and characteristics of a good pipefitter.
- Explain the importance of safety in relation to pipefitting.

PHT – PIPEFITTING HAND TOOLS

- Describe the safety requirements that apply to the use of pipefitter hand tools.
- Explain how to care for selected pipefitter hand tools properly.
- Demonstrate how to use selected pipefitter hand tools safely and properly.
- Identify tools, and state their uses.
- Use selected hand tools.

PPT – PIPEFITTING POWER TOOLS

- State the safety procedures that must be followed when working with power tools.
- Cut pipe using a portable band saw.
- Identify and explain the uses of portable grinders.
- Explain the proper and safe operation of machines used in pipe joint preparation:
 - Pipe threaders
 - Portable power drives
 - Pipe bevelers
- Perform selected pipe joint preparation operations using power tools.

LEVEL TWO

DDS – DRAWINGS AND DETAIL SHEETS

- Identify parts of drawings.
- Identify types of drawings.
- Make field sketches.
- Interpret drawing indexes and line lists.

BWP – BUTT WELD PIPE FABRICATION

- Identify butt weld piping materials and fittings.
- Read and interpret butt weld piping drawings.
- Prepare pipe ends for fit-up.
- Determine pipe lengths between fittings.
- Select and install backing rings.
- Perform alignment procedures for various types of fittings.

CONTREN WELDING

LEVEL ONE

WSS – WELDING SAFETY (MODULE 29101-09)

- Identify some common hazards in welding.
- Explain and identify proper personal protection used in welding.
- Describe how to avoid welding fumes.
- Explain some of the causes of accidents.
- Identify and explain uses for material safety data sheets.
- Explain safety techniques for storing and handling cylinders.
- Explain how to avoid electric shock when welding.
- Describe proper material handling methods.

WOC – OXY-FUEL CUTTING (MODULE 29102-09)

- Identify and explain the use of oxyfuel cutting equipment.
- Set up oxyfuel equipment.
- Light and adjust an oxyfuel torch.
- Shut down oxyfuel cutting equipment.
- Disassemble oxyfuel equipment.
- Change cylinders.
- Perform oxyfuel cutting:
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing
 - Gouging
- Operate a motorized, portable oxy-fuel gas cutting machine.

PAC – PLASMA ARC CUTTING (MODULE 29103-03)

- Explain the plasma arc cutting processes.
- Identify plasma arc cutting equipment.
- Prepare and set up plasma arc cutting equipment.
- Use plasma arc cutting equipment to make various types of cuts.
- Properly store equipment, and clean the work area after use.

CAC – AIR CARBON ARC CUTTING AND GOUGING (MODULE 29104-09)

- Identify and explain the air carbon arc cutting (CAC-A) process and equipment.
- Select and install CAC-A electrodes.
- Prepare the work area and CAC-A equipment for safe operation.
- Use CAC-A equipment for washing and gouging activities.
- Perform storage and housekeeping activities for CAC-A equipment.
- Make minor repairs to CAC-A equipment.

BMP – BASE METAL PREP (MODULE 29105-09)

- Clean base metal for welding or cutting.
- Identify and explain joint design.
- Explain joint design considerations.

- Mechanically bevel the edge of a mild steel plate.
- Thermally bevel the end of a mild steel plate.
- Select the proper joint design based on a welding procedure specification (WPS) or instructor direction.

WQT – WELD QUALITY (MODULE 29106-09)

- Identify and explain codes governing welding.
- Identify and explain weld imperfections and their causes.
- Identify and explain nondestructive examination practices.
- Identify and explain welder qualification tests.
- Explain the importance of quality artisanship.
- Identify common destructive testing methods.
- Perform a visual inspection of fillet welds.

SWS – SMAW – EQUIPMENT AND SETUP (MODULE 29107-09)

- Identify and explain shielded metal arc welding (SMAW) safety.
- Explain welding electrical current.
- Identify welding power supplies and their characteristics.
- Explain how to set up welding power supplies.
- Set up a machine for welding.
- Identify tools used for weld cleaning.

SES – SHIELDED METAL ARC ELECTRODES (MODULE 29108-09)

- Identify factors that affect electrode selection.
- Explain the American Welding Society (AWS) and the American Society of Mechanical Engineers (ASME) filler metal classification system.
- Identify different types of filler metals.
- Explain the storage and control of filler metals.
- Explain filler metal traceability requirements and how to use applicable code requirements.
- Identify and select the proper electrode for an identified welding task.

SBF – SMAW – BEADS AND FILLET WELDS (MODULE 29109-09)

- Set up shielded metal arc welding (SMAW) equipment.
- Describe methods of striking an arc.
- Properly strike and extinguish an arc.
- Describe causes of arc blow and wander.
- Make stringer, weave, and overlapping beads.
- Make fillet welds in the following positions:
 - Horizontal (2F)
 - Vertical (3F)
 - Overhead (4F)

JFA – JOINT FIT-UP AND ALIGNMENT (MODULE 29110-09)

- Identify and explain job code specifications.
- Use fit-up gauges and measuring devices to check joint fit-up.
- Identify and explain distortion and how it is controlled.
- Fit-up joint using plate and pipe fit-up tools.
- Check for joint misalignment and poor fit-up before and after welding.

GWB – SMAW – GROOVE WELDS WITH BACKING (MODULE 29111-09)

- Identify and explain groove welds.
- Identify and explain groove welds with backing.
- Set up shielded metal arc welding (SMAW) equipment for making V-groove welds.
- Perform SMAW for V-groove welds with backing in the following positions:
 - Flat (1G)
 - Horizontal (2G)
 - Vertical (3G)
 - Overhead (4G)

OGW – SMAW – OPEN V-GROOVE WELDS (MODULE 29112-09)

- Prepare shielded metal arc welding (SMAW) equipment for open-root V-groove welds.
- Perform open-root V-groove welds in the following positions:
 - Flat (1G)
 - Horizontal (2G)
 - Vertical (3G)
 - Overhead (4G)

LEVEL TWO

WWS – WELDING SYMBOLS (MODULE 29201-09)

- Identify and explain the various parts of a welding symbol.
- Identify and explain fillet and groove weld symbols.
- Read welding symbols on drawings, specifications, and welding procedure specifications.
- Interpret welding symbols from a print.

WDD – READING WELDING DETAIL DRAWINGS (MODULE 29202-09)

- Identify and explain a welding detail drawing.
- Identify and explain lines, material fills, and sections.
- Identify and explain object views.
- Identify and explain dimensioning.
- Identify and explain notes and bill of materials.
- Interpret basic elements of a welding detail drawing.
- Sketch or draw a basic welding drawing.

PPM – PHYSICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF METALS (MODULE 29203-09)

- Identify and explain the composition and classification of base metals.
- Explain and demonstrate field identification methods for base metals.
- Identify and explain the physical characteristics and mechanical properties of metals.
- Identify and explain forms and shapes of structural metals.
- Explain metallurgical considerations for welding metals.

HTM – PREHEATING AND POSTWELD HEAT TREATMENT OF METAL (MODULE 29204-09)

- Explain and demonstrate how to preheat metals.
- Describe maintaining interpass temperature.
- Explain postweld heat treatment of metals.
- Explain the effects of welding on metal:
 - Heat-affected zone (HAZ)
 - Cracking

GFE – GMAW AND FCAW: EQUIPMENT AND FILLER METALS (MODULE 29205-09)

- Explain gas metal arc welding (GMAW) and flux cored arc welding (FCAW) safety.
- Explain the characteristics of welding current and power sources.
- Identify and explain the use of GMAW and FCAW equipment:
 - Spray transfer
 - Globular
 - Short circuiting
 - Pulse
- Identify and explain the use of GMAW and FCAW shielding gases and filler metals.
- Set up GMAW and FCAW equipment, and identify tools for weld cleaning.

GFP – GMAW AND FCAW: PLATE (MODULE 29206-09)

- Perform GMAW-S (short-circuit) multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using solid or composite wire and shielding gas.
- Perform GMAW-S (short-circuit) multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire.
- Perform GMAW spray fillet and V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using solid or composite wire and shielding gas.
- Perform FCAW multiple-pass fillet welds on carbon steel plate coupons in multiple positions, using flux cored wire and, if required, shielding gas.
- Perform FCAW multiple-pass V-groove welds on carbon steel plate coupons in multiple positions (with or without backing), using flux cored wire and, if required, shielding gas.

GTE – GTAW: EQUIPMENT AND FILLER METALS (MODULE 29207-09)

- Explain gas tungsten arc welding (GTAW) safety.

- Identify and explain the function of GTAW equipment.
- Identify and explain the function of GTAW filler metals.
- Identify and explain the function of GTAW shielding gases.
- Set up GTAW equipment.

GTP – GTAW – PLATE (MODULE 29208-09)

- Weld a pad in the flat position with stringer beads using GTAW and carbon steel filler metal.
- Make multiple-pass GTAW fillet welds on carbon steel plate coupons in the following positions, using carbon steel filler metal:
 - 1F
 - 2F
 - 3F
 - 4F
- Make multiple-pass GTAW V-groove welds on carbon steel plate coupons in the following positions, using carbon steel filler metal:
 - 1G
 - 2G
 - 3G
 - 4G
- Explain GTAW and set up equipment to weld aluminum plate.
- Explain and practice GTAW techniques for plate, including padding in the flat position with stringer beads, using aluminum filler metal.
- Make fillet welds on aluminum plate in the following positions:
 - 1F (flat)
 - 2F (horizontal)
 - 3F (vertical)
 - 4F (overhead)
- Make multiple-pass V-groove welds with backing on aluminum plate in the following positions:
 - 1G (flat)
 - 2G (horizontal)
 - 3G (vertical)
 - 4G (overhead)

LEVEL THREE

AHT – PREHEATING AND POSTWELD HEAT TREATMENT OF METALS (MODULE 29301-03)

- Explain how to preheat metals.
- Describe maintaining interpass temperature.
- Explain postweld heat treatment of metals.
- Identify and explain the effects of welding on metals:
 - Heat-affected zone (HAZ)

- Cracking
- Face changes/grain structure

APM – PHYSICAL CHARACTERISTICS AND MECHANICAL PROPERTIES OF METALS (MODULE 29302-03)

- Identify and explain the composition and classification of base metals.
- Explain and demonstrate field identification methods for base metals.
- Identify and explain the physical characteristics and mechanical properties of metals.
- Identify and explain forms and shapes of structural metals.
- Explain metallurgical considerations for welding metals.

GMP – GAS METAL ARC WELDING (GMAW) – PIPE (MODULE 29303-03)

- Prepare GMAW equipment for open-root V-groove pipe welds.
- Identify and explain open-root V-groove pipe weld techniques.
- Perform open-root V-groove pipe welds using GMAW in the following positions:
 - 1G-ROTATED
 - 2G
 - 5G
 - 6G

FWP – FLUX CORED ARC WELDING (FCAW) – PIPE (MODULE 29304-03)

- Prepare FCAW equipment for open-root V-groove pipe weld techniques.
- Identify and explain open-root V-groove pipe welds.
- Perform open-root V-groove pipe welds using FCAW in the following positions:
 - 1G-ROTATED
 - 2G
 - 5G
 - 6G

TCP – GAS TUNGSTEN ARC WELDING (GTAW) – CARBON STEEL PIPE (MODULE 29305-03)

- Set up GTAW equipment.
- Identify and explain open-root V-groove pipe weld techniques.
- Perform open-root V-groove pipe welds using GTAW in the following positions:
 - 1G-ROTATED
 - 2G
 - 5G
 - 6G

TSP – GAS TUNGSTEN ARC WELDING (GTAW) – LOW-ALLOY AND STAINLESS STEEL PIPE (MODULE 29306-03)

- Set up GTAW equipment to perform stainless and/or low-alloy steel pipe welding.
- Identify and explain open-root V-groove pipe weld techniques.
- Perform open-root V-groove pipe welds using GTAW in the following positions:

- G-ROTATED
- 2G
- 5G
- 6G

TAP – GAS TUNGSTEN ARC WELDING (GTAW) – ALUMINUM PIPE (MODULE 29307-03)

- Set up GTAW equipment to perform aluminum pipe welding.
- Identify and explain V-groove and modified U-groove pipe weld techniques.
- Perform V-groove or modified U-groove pipe welds using GTAW in the following positions:
 - 2G
 - 5G
 - 6G

GAP – GAS METAL ARC WELDING (GMAW) – ALUMINUM PLATE AND PIPE (MODULE 29308-03)

- Explain GMAW, and set up equipment to weld aluminum.
- Build a pad with stringer beads and weave beads, using aluminum wire and shielding gas.
- Perform multiple-pass fillet welds on aluminum plate in the following positions, using aluminum wire and shielding gas:
 - 1F (flat)
 - 2F (horizontal)
 - 3F (vertical)
 - 4F (overhead)
- Perform V-groove welds on aluminum plate in the following positions, using aluminum wire and shielding gas:
 - 1G (flat)
 - 2G (horizontal)
 - 3G (vertical)
 - 4G (overhead)
- Perform V-groove welds on aluminum pipe in the following positions, using aluminum wire and shielding gas:
 - 1G-ROTATED (flat)
 - 2G (horizontal)
 - 5G (multiple)
 - 6G (inclined multiple)

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Teacher Academy Executive Summary.....	82
Course Outlines.....	86
Teacher Academy Competencies and Objectives.....	91
Teacher Academy Competency Profile	98
Appendix A: 21st Century Skills Standards	101
Appendix B: MS Academic Standards	103
Appendix C: ACT College Readiness Standards.....	133
Appendix D: Pathway Content Standards.....	147
Appendix E: National Educational Technology Standards for Students	150

Teacher Academy Executive Summary

Program Description

Teacher Academy is a pathway for students in the Human Science, Art, and Humanities career cluster. The Teacher Academy program is a high school course designed to attract students to the field of education, to provide information and field experiences relevant to pursuing a degree in education, and to prepare students for the rigors of a career in education so they will remain long-term educators. The Teacher Academy pathway includes classroom and hands-on experiences that will prepare students for employment or continuing education in the education field.

The Teacher Academy is a pathway course that will do the following:

1. Recruit and hook high-quality high school students for the teaching profession
2. Give qualified high school students an opportunity to begin successful career paths to teaching
3. Offer the opportunity to recruit and train high-quality students who may return to the district as tomorrow's high-quality teachers. This is a "grow your own" solution to the current and looming shortage in the teaching profession.
4. Provide a framework for building solid partners with area institutions of higher education and offer exciting challenges and opportunities for the district's students

Industry Certification

This curriculum was written to incorporate the National Council for Accreditation of Teacher Education (**NCATE preprofessional**) learning standards. The Teacher Academy curriculum includes three major units: Teachers as Professionals; Principles of Teaching, Learning, and Assessment; and The Learning Environment.

Assessment

Students will be assessed using Teacher Academy MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the Human Sciences, Arts, and Humanities Instructional Design Specialists at the Research and Curriculum Unit at 662-325-2510.

Suggested Student Prerequisites

1. Proficient or advanced on MCT
2. 92% attendance rate
3. Minimum GPA 2.5
4. C or higher in English from the previous year

5. Application (Including short essay)
6. Interview process
7. Discipline (No more than three referrals from the previous year; severity of infractions to be determined according to the Mississippi Discipline Codes)
8. Instructor approval

Retention in Program (Semester/Annual Review)

1. C average or better
2. Attendance review (maintain 92% ADA)
3. Grade review
4. Discipline review
5. Work ethic review
6. Teacher interview/conference

Proposed Applied Academic Credit

The academic credit is still pending for this curriculum.

Licensure Requirements

The 971 licensure endorsement is needed to teach the Teacher Academy pathway. The requirements for the 971 licensure endorsement are listed below:

1. Applicants must hold a 4-year college degree (bachelor's degree) from an accredited institution of higher education with a currently valid 5-year standard (or higher) teaching license.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized professional development plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicants must have successfully completed or be in the process of completing the National Board Teacher Certification process or have a terminal degree in the field of education.
5. Applicants must successfully complete an MDE-approved computer literacy certification exam.
6. Applicants must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
7. Applicants must successfully complete the Teacher Academy certification workshop, module, or course that is approved by the MDE.

Admission to Teacher Education Requirements

Contact hours required for admission to teacher education can be met by completing Teacher Academy (four Carnegie units) including documentation of 100 hours of field experience required.

Professional Learning

The Professional Learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, you will need to contact the Research and Curriculum Unit at 662-325-2510 and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows options for local school districts to meet student needs and scheduling demands. Option one groups units into four one-Carnegie-unit courses. The second option groups units into two two-Carnegie-unit courses. Further discussion of each option is presented below.

Option 1

This option groups units into four one-Carnegie-unit courses that should be completed in the following sequence:

1. Foundations of an Educator (Course Code: 996302)
2. Practices of an Educator (Course Code: 996303)
3. Exploring Diversities and Communication (Course Code: 996304)
4. Progressive Practices of Teacher Academy (Course Code: 996305)

Course Description: Foundations of an Educator provides students with the opportunity to gain foundational skills needed to enhance them as learners, future educators, and communicators. Students receive history, theory, and professionalism needed to understand the educational system. Students should have the opportunity to observe skills learned in class at various educational settings (one Carnegie unit).

Course Description: Practices of an Educator provides students with the opportunity to gain knowledge and practice needed to enhance themselves as future educators. Students receive practice in communication skills, planning, teaching, and assessment strategies needed to understand the educational system. Students should have the opportunity to observe and/or practice skills learned in class at various educational settings using school-to-career skills obtained in class (one Carnegie unit).

Course Description: Exploring Diversities and Communication provides students with the opportunity to gain knowledge and understand advanced information that must be instilled in educators. Students receive information pertaining to advanced communication skills, diverse learners, and various subject areas needed to work in the educational system. Students should have the opportunity to observe and/or practice skills learned in class at various educational settings using school-to-career skills obtained in class (one Carnegie unit). Before students can enroll in the Exploring Diversities and Communication course, they must meet the following requirements:

1. Score 80% or higher on the MC-CPAS2 summative assessment

2. Attendance rate of 92% or better in the Foundations of an Educator (Course Code: 996302) and the Practices of an Educator (Course Code: 996303)
3. Successfully complete a grade, discipline, and work ethic review by the teacher
4. Present an updated portfolio during the review by teacher session

Course Description: Progressive Practices of Teacher Academy provides students with the opportunity to gain knowledge and understand progressive practices that must be instilled in educators. Students receive information pertaining to advanced planning instruction, teaching strategies, assessment, and professional learning needed to work in the educational system. Students should have the opportunity to observe and/or practice skills learned in class at various educational settings (one Carnegie unit).

Foundations of an Educator (One Carnegie Unit)

Course Code: 996302

Unit	Title	Hours
1	Orientation and Safety	15
2	History and Trends in American Education	25
3	Human Growth and Development	30
4	Communication Skills I	30
5	Learning Environment	30
13	Observation Experience	10
		140

Practices of an Educator (One Carnegie Unit)

Course Code: 996303

Unit	Title	Hours
6	The Effective Teacher	40
7	Planning Instruction I	40
8	Assessing, Teaching, and Learning I	40
13	Field Experience/Observation	20

			140
--	--	--	------------

Exploring Diversities and Communication (One Carnegie Unit)

Course Code: 996304

Unit	Title	Hours
9	Orientation and Safety	15
10	Communication Skills II	20
11	Appreciating Diverse Learners	40
12	Subject Area Knowledge	30
13	Field Experience/Observation	30
		135

Progressive Practices of Teacher Academy (One Carnegie Unit)

Course Code: 996305

Unit	Title	Hours
14	Planning Instruction II	30
16	Assessing, Teaching and Learning II	30
17	Professional Learning	30
13	Field Experience/Observation	40
		130

Option 2

This option groups units into two-Carnegie-unit courses that should be completed in the following sequence.

1. Teacher Academy I (Course Code: 996300)
2. Teacher Academy II (Course Code: 996301)

Course Description: Teacher Academy I is an entry-level course. Students in Education I gain foundation competencies related to students as learners, planning and assessing teaching, teaching strategies, and communication skills. Students receive hands-on field experiences (two Carnegie units).

Course Description: Teacher Academy II provides students with the opportunity to gain advanced skills needed to enhance them as learners, teachers, and communicators. Students receive advanced hands-on field experiences (two Carnegie units).

Teacher Academy I (Two Carnegie Units)

Course Code: 996300

Unit	Title	Hours
1	Orientation and Safety	15
2	History and Trends in American Education	25
3	Human Growth and Development	30
4	Communication Skills I	30
5	Learning Environment	30
6	The Effective Teacher	40
7	Planning Instruction I	40
8	Assessing Teaching and Learning I	40
13	Field Experience/Observation	30
		280

Teacher Academy II (Two Carnegie Units)

Course Code: 996301

Unit	Title	Hours
9	Orientation and Safety	15
10	Communication Skills II	20

11		Appreciating Diverse Learners	40
12		Subject Area Knowledge	30
13		Field Experience/Observation	70
14		Planning Instruction II	30
15		Assessing Teaching and Learning II	30
17		Professional Learning	30
			265

Teacher Academy Competencies and Objectives

Unit 1: Orientation and Safety

1. Identify and research educational, occupational, and leadership opportunities in the Teacher Academy. (DOK 1)
 - a. Introduce career opportunities and emerging technologies in education. (DOK 1)
 - b. Discuss the students' career educational plans (resume, cover letter). (DOK 1)
 - c. Identify and describe leadership opportunities available from student youth organizations (Future Educators Association FEA) in the school and community. (DOK 1)
 - d. Explain to students what the Teacher Academy is, why it is important, and how it will be delivered and assessed (course objectives and program policies). (DOK 1)
2. Determine knowledge, skills, and dispositions needed to work in the teaching profession. (DOK 1)
 - a. List dispositions of effective teachers. (DOK 1)
 - b. Discuss the importance of self-directed learning. (DOK 1)
 - c. Discuss the importance that all students can learn. (DOK 1)
 - d. Discuss that students learn at different paces even when exposed to the same educational experience. (DOK 1)
 - e. Identify diverse interests of students (e.g., classic literature, automotives, family, and politics). (DOK 1)
3. Analyze the importance of using technology in the instructional process (ongoing). (DOK 3)
 - a. Examine acceptable policies for use of technology in schools, including strategies for addressing threats to security. (DOK 1)
 - b. Identify legal/ethical behavior and safety issues regarding the use of technology and information. (DOK 2)
 - c. Analyze advantages and disadvantages of widespread use and reliance on technology in teaching and in society as a whole. (DOK 2)
 - d. Explain how technology can be used to enhance teaching and learning. (DOK 2)
 - e. List and discuss the various types of technology. (i.e., calculators and Wynn readers. (DOK 1)
 - f. Explore and use technology to solve problems and make decisions. (Blackboard introduction and exploration). (DOK 3)
4. Apply safety procedures in the Teacher Academy classroom and lab. (DOK 2)
 - a. Discuss the proper classroom and lab safety procedures. (DOK 1)
 - b. Discuss the healthy schools regulations. (DOK 2)
 - c. Demonstrate proper care and use of various equipment in the Teacher Academy classroom and lab (i.e., lamination machine and Die-Cut Machine). (DOK 2)
 - d. Complete CPR/first aid certification. (DOK 4)

Unit 2: History and Trends in American Education

1. Understand how the historical and social contexts of education have influenced contemporary schools. (DOK 2)
 - a. Review the history of education (people, events). (DOK 1)

- b. Understand the evolution of the educational system (one room school house to modern schools). (DOK 2)
 - c. Discuss events that have influenced educational reform in America. (DOK 2)
 - d. Examine current trends and issues that affect the future of education in different types of educational setting. (DOK 2)
2. Discuss the relationship of school and society. (DOK 2)
 - a. Explain the role of education in society. (DOK 2)
 - b. Explain governance of schools at the state, local, and building levels. (DOK 2)
 3. Analyze the role of service learning in teaching and learning. (DOK 2)
 - a. Define service learning. (DOK 1)
 - b. Research service learning opportunities in the community. (DOK 2)
 - c. Design and carry out a service learning project in the community. (Ongoing) (DOK 3)

Unit 3: Human Growth and Development

1. Identify the cognitive, physical, emotional, and social development characteristics of the learning from birth to adolescence. (DOK 2)
 - a. Examine the developmental stages of cognitive development. (DOK 2)
 - b. Examine the developmental stages of physical development. (DOK 2)
 - c. Examine the developmental stages of emotional development. (DOK 2)
 - d. Examine the developmental stages of social development. (DOK 2)
 - e. Discuss how social issues and relationships affect students. (DOK 1)

Unit 4: Communication Skills I

1. Identify, demonstrate, and evaluate communications skills in the field of education. (DOK 2)
 - a. Explain the powerful role of language and communication in learning. (DOK 1)
 - b. Explain the interrelationships among reading, writing, listening, speaking, viewing, and visual representation. (DOK 2)
 - c. Explain methods for assessing communications skills. (DOK 2)
 - d. Explain concepts of communication in the educational setting. (DOK 1)
 - e. Become familiar with the practice active listening skills. (DOK 2)
 - f. Explore and practice the various ways to communicate effectively (verbal, nonverbal, and written). (DOK 2)
 - g. Use effective technological communication (e.g., e-mail, authoring, collaboration writing, video conferencing, publication, facsimile, and internet). (DOK 2)
 - h. Review and use the five steps of the writing process. (DOK 3)
2. Formulate a plan for an effective job search. (DOK 4)
 - a. Create a generic cover letter using the writing process. (DOK 3)
 - b. Create a high-quality one-page resume. (DOK 3)
 - c. Construct an electronic portfolio. (DOK 4)

Unit 5: Learning Environment

1. Research, describe, and design an effective learning environment. (DOK 3)

- a. Research and describe an effective learning environment. (DOK 2)
- b. Discuss classroom climate (the importance of a community of learners). (DOK 1)
- c. Explain the role of peers in a learning climate. (DOK 1)
- d. Explain that individuals respond to different motivational strategies (intrinsic and extrinsic). (DOK 2)
- e. Identify and discuss classroom management styles and strategies. (DOK 2)
- f. Discuss and design an effective physical classroom setting. (DOK 3)

Unit 6: The Effective Teacher

1. Analyze characteristics, skills, and resources necessary for effective teaching. (DOK 2)
 - a. Identify personal strengths and areas for improvement as potential teachers. (DOK 1)
 - b. Describe characteristics of an outstanding teacher. (DOK 1)
 - c. Research and analyze ways in which a teacher's personality impacts instructional style and interaction. (DOK 2)
 - d. Explain time on task and how it relates to instructional pacing. (DOK 2)
 - e. Establish classroom routines. (DOK 1)
 - f. Identify how to maintain student attention and engage students in active learning. (DOK 2)
 - g. Identify components of effective classroom climate, management, and discipline. (DOK 2)
 - h. Use technology when selecting needed resources necessary for effective teaching. (DOK 2)
 - i. Exhibit collaboration and team building. (DOK 2)
2. Determine teacher characteristics that promote an effective learning environment. (DOK 2)
 - a. List and demonstrate positive teaching characteristics (i.e., acceptance of differences, warmth, caring, friendliness, openness, compassion, tolerance, humor, mutual respect, honesty, fairness, enthusiasm, and cheerfulness). (Ongoing) (DOK 2)
 - b. Recognize the teacher's responsibility for the learning climate. (DOK 2)
 - c. Explain that a teacher is a role model. (DOK 1)

Unit 7: Planning Instruction I

1. Analyze components of instructional planning. (DOK 2)
 - a. Explore Mississippi academic and career and technical curriculum frameworks. (DOK 2)
 - b. Identify behavioral objective/performance indicators within the frameworks. (DOK 1)
 - c. Identify what the teacher will do and what the students will do within the lesson plan procedure. (DOK 2)
 - d. Compare and contrast the difference between guided practice and independent practice. (DOK 3)
 - e. Prepare an opening (hook and anticipatory set) and closing to the lesson. (DOK 3)
 - f. List materials, equipment, supplies, and preparations. (DOK 2)
 - g. Illustrate appropriate sequence of instruction. (DOK 2)
 - h. Identify assessment strategies. (DOK 2)
2. Implement research-based instructional strategies into lesson planning. (DOK 2).

- a. Recognize effective teaching strategies. (DOK 2)
- b. Discuss Bloom's Taxonomy and Webb's Depth of Knowledge. (DOK 2)
- c. Explain time on task and how it relates to instructional pacing. (DOK 1)

Unit 8: Assessing Teaching and Learning I

1. Describe types of assessments and how they should be used as part of the learning process. (DOK 2)
 - a. Define the purposes of assessment. (DOK 1)
 - b. Distinguish between formative and summative assessment. (DOK 2)
 - c. Identify and explain advantages and disadvantages of standardized testing. (DOK 2)
 - d. Identify and explain performance and authentic assessments (rubric, project based, checklist, observation). (DOK 2)
 - e. Identify and use self-assessments. (DOK 2)
 - f. Identify and explain the importance of multiple measures of assessment. (DOK 2)
 - g. Explain how objectives, instruction, and assessment should be aligned. (DOK 3)
 - h. Define and use mean, median, and mode. (DOK 2)

Teacher Academy II Competencies and Objectives

Unit 9: Orientation and Safety II

1. Review educational, occupational, and leadership opportunities in the Teacher Academy. (DOK 2)
 - a. Review student rules and regulations for the local school. (DOK 1)
 - b. Review career opportunities and emerging technologies in education. (DOK 1)
 - c. Review and update the students' career and educational plans. (DOK 2)
 - d. Review leadership opportunities available from student youth organizations in the school and community. (DOK 1)
 - e. Give an overview of the second course and practical field experience expectations. (DOK 2)
 - f. Update the students' teaching and learning professional portfolio of exemplary work. (DOK 2)
 - g. Review online learning system (Blackboard). (DOK 2)
2. Apply safety procedures in the Teacher Academy classroom and lab. (DOK 2)
 - a. Review the proper classroom and lab safety procedures. (DOK 1)
 - b. Care for and use all equipment correctly. (DOK 1)
 - c. Review the Healthy schools regulations and requirements. (DOK 2)
 - d. Review the use of safety with technology. (DOK 1)
 - e. Review the procedures for using various pieces of equipment in the Teacher Academy classroom and lab i.e., laminating machine and Ellison Machine. (DOK 2)
 - f. Review regulations and licensing related to the following:
 - Family Educational rights and Privacy Act (FERPA)
 - CPR/first aid (DOK 2)

3. Determine knowledge and skills needed to work in the teaching profession, and demonstrate personal characteristics dispositions needed to work in the teaching profession. (DOK 2)
 - a. Review characteristics of effective teachers, administrators, and school counselors. (DOK 1)
 - b. Continue to exhibit curiosity, cooperation, flexibility, pride in teaching, and a personal objective for continuous improvement, as well as a respect for the diverse interest of students. (DOK 2)
 - c. Continue to demonstrate the importance of self-directed learning, lifelong learning, and collaboration in teaching. (DOK 2)
 - d. Continue to demonstrate the belief that all students can learn and do so at different paces. (DOK 2)
4. Review the importance of technology in the instructional process. (Ongoing) (DOK 1)
 - a. Review the social, legal, ethical, and cultural issues of using technology in the classroom. (DOK 1)
 - b. Review the procedures for using the various technologies. (DOK 1)

Unit 10: Communication Skills II

1. Demonstrate effective communication skills in teaching (DOK 3)
 - a. Demonstrate communicating clear directions and the appropriate use of vocabulary in the classroom. (DOK 3)
 - b. Demonstrate the five steps in the writing process. (DOK 3)
 - c. Use a variety of literacy learning opportunities (ex. Reading, writing, thinking, reacting, and responding). (DOK 2)
 - d. Promote cultural and gender sensitivity in communication among learners. (DOK 2)
 - e. Use a variety of educational media communication tools. (DOK 3)
2. Formulate a plan for an effective job search. (DOK 4)
 - a. Create a generic cover letter using the writing process. (DOK 3)
 - b. Create a high-quality one-page resume. (DOK 3)
 - c. Construct an electronic portfolio. (DOK 4)

Unit 11: Appreciating Diverse Learners

1. Review the cognitive, physical, emotional, and social development characteristics of the learner from birth to adolescence. (DOK 1)
 - a. Review and analyze the developmental characteristics (cognitive, physical, emotional, and social) of learners. (DOK 1)
2. Compare and contrast various learning styles/multiple intelligences. (DOK 3)
 - a. Explore and define the role of the brain in cognitive development. (DOK 2)
 - b. Analyze the four learning styles (visual, auditory, tactile, and kinesthetic). (DOK 3)
 - c. Identify and analyze Howard Gardner's Multiple Intelligences. (DOK 2)
 - d. Students will formulate their own personal learning profiles in terms of both multiple intelligences and learning styles' preferences. (DOK 3)
3. Describe examples of diversity and how they affect the learning process (e.g., cultural, religious, regional, gender, ethnic, and physical.) (DOK 2)

- a. Recognize the importance of looking beyond the physical qualities of people to develop an appreciation for individuals who may be different. (DOK 2)
- b. Explore how culture, religion, region, gender, and ethnic differences impact the teaching/learning process. (DOK 2)
- 4. Define types of learner exceptionality (e.g., physical and health disabilities, learning disabilities, mental retardation, emotional and behavioral disorders, and gifted learning), and summarize services and resources to meet exceptional learning needs. (DOK 2)
 - a. Develop awareness of the obstacles that individuals with disabilities face both in school and within the community. (DOK 2)
 - b. Distinguish different disabilities and/or exceptionalities and how they influence the teaching learning process (special education and gifted education). (DOK 2)
 - c. Distinguish between the continuum of placement of options for disabled students. (DOK 2)
 - d. Identify methods for modifying lessons to accommodate learning differences (both special educations and gifted education). (DOK 2)

Unit 12: Subject Area Knowledge

- 1. Analyze the importance of subject matter knowledge and integrated learning. (DOK 2)
 - a. Explain a specific discipline's place in the school wide curriculum. (DOK 2)
 - b. Identify content standards and their source(s) for a specific discipline. (DOK 2)
- 2. Explore a minimum of two content area classrooms. (DOK 4)
 - a. Identify content and grade level the student wants to teach. (DOK 1)
 - b. Observe lessons at your content and grade level. (DOK 2)
 - c. Investigate co-teaching model. (DOK 2)
 - d. Design a lesson to co-teach in the content and grade level class. (DOK 4)

Unit 13: Observations and Field Experience

- 1. Participate in preschool, elementary, and secondary classroom experiences. (DOK 3)
 - a. Work under the guidance of the Teacher Academy instructor and the classroom teacher. (DOK 3)
 - b. Display effective interpersonal skills. (DOK 2)
 - c. Demonstrate the ability to relate to students in a classroom setting. (DOK 3)
 - d. Exercise tact, discretion, and confidentiality. (DOK 3)
 - e. Submit a resume and cover letter to the principal and supervising teacher prior to beginning field experience. (DOK 4)
 - f. Observe and record the classroom teacher's actions, the students' progress, and classroom procedures. (DOK 3)
 - g. Discuss assigned duties with classroom teacher. (DOK 2)
 - h. Prepare lesson materials, bulletin boards, displays, and instructional games. (DOK 4)
 - i. Prepare lesson plans according to guidelines set by the Teacher Academy instructor and the classroom teacher. (DOK 3)
 - j. Tutor and assist students individually or in small groups, as directed by the teacher. (DOK 4)

- k. Distribute teaching materials to students (textbooks, papers, and supplies). (DOK 3)
- l. Present mini-lessons/ activities to students under the direction and guidance of the teacher. (DOK 4)
- m. Assist students with technology in the classroom. (DOK 4)
- n. Provide extra assistance to students with special needs (those with physical or mental disabilities; non-English-speaking students). (DOK 3)

Unit 14: Planning Instruction II

- 1. Develop lesson plans that identify the elements of an effective lesson for all learners. (DOK 3)
 - a. Locate competencies and objectives within the Mississippi Curriculum Framework. (DOK 2)
 - b. State clear long-term and short-term educational goals and objectives for learners. (DOK 2)
 - c. Create a lesson plan to aid learners in meeting competencies and objectives. (DOK 3)
 - d. Explain the alignment of specific goals, instructional plans, and assessment. (DOK 3)
 - e. Identify strategies for instructional planning for diverse learners. (DOK 2)
 - f. Locate and use instructional resources. (DOK 3)

Unit 15: Assessing Teaching and Learning II

- 1. Analyze assessment results as part of the learning process. (DOK 3)
 - a. Define assessment as a means for improving instructions and learning. (DOK 2)
 - b. Observe and determine when the classroom teacher provides feedback and re-teachers. (DOK 2)
 - c. Discuss mastery learning. (DOK 2)
 - d. Maintain personal records of assignments and progress (the student's personal grades). (DOK 3)

Unit 16: Professional Learning

- 1. Research and analyze professional learning in the field of educational. (DOK2)
 - a. Identify the purpose of the INTASC (Interstate New Teachers Assessment and Support Consortium) National Standards for New Teachers. (DOK 2)
 - b. Identify professional learning resources. (DOK 2)
- 2. Develop a plan for professional growth. (DOK 3)
 - a. Participate in student-teaching focused organizations such as Future Educators Association, FEA. (DOK 3)
 - b. Have students update their teaching and learning portfolios. (DOK 3)

Teacher Academy Competency Profile

Program CIP: 13.0101

Unit 1: Orientation and Safety

Identify and research educational, occupational, and leadership opportunities

- _____ 1. in the Teacher Academy. (DOK 1)

Determine knowledge, skills, and dispositions needed to work in the teaching

- _____ 2. profession. (DOK 1)

Analyze the importance of using technology in the instructional process

- _____ 3. (ongoing). (DOK 3)

- _____ 4. Apply safety procedures in the Teacher Academy classroom and lab. (DOK 2)

Unit 2: History and Trends in American Education

Understand how the historical and social contexts of education have

- _____ 1. influenced contemporary schools. (DOK 2)

- _____ 2. Discuss the relationship of school and society. (DOK 2)

- _____ 3. Analyze the role of service learning in teaching and learning. (DOK 2)

Unit 3: Human Growth and Development

Identify the cognitive, physical, emotional, and social development

- _____ 1. characteristics of the learner from birth to adolescence. (DOK 2)

Unit 4: Communication Skills I

Identify, demonstrate, and evaluate communication skills in the field of

- _____ 1. education. (DOK 2)

- _____ 2. Formulate a plan for an effective job search. (DOK 4)

Unit 5: Learning Environment

- _____ 1. Research, describe, and design an effective learning environment. (DOK 3)

Unit 6: The Effective Teacher

Analyze characteristics, skills, and resources necessary for effective teaching.

- _____ 1. (DOK 2)

Determine teacher characteristics that promote an effective learning

- _____ 2. environment. (DOK 2)

Unit 7: Planning Instruction I

- _____ 1. Analyze components of instructional planning. (DOK 2)

Implement research-based instructional strategies into lesson planning. (DOK

- _____ 2. 2)

Unit 8: Assessing Teaching and Learning I

- _____ 1. Describe types of assessments and how they should be used as part of the

learning process. (DOK 2)

Unit 9: Orientation and Safety

Review educational, occupational, and leadership opportunities in the Teacher

-
1. Academy. (DOK 2)

 2. Apply safety procedures in the Teacher Academy classroom and lab. (DOK 2)

 3. Determine knowledge and skills needed to work in the teaching profession, and demonstrate personal characteristics (dispositions) needed to work in the teaching profession. (DOK 2)

 4. Review the importance of technology in the instructional process. (DOK 1)

Unit 10: Communication Skills II

-
1. Demonstrate effective communication skills in teaching. (DOK 3)

 2. Formulate a plan for an effective job search. (DOK 4)

Unit 11: Appreciating Diverse Learners

Review the cognitive, physical, emotional, and social development

-
1. characteristics of the learner from birth to adolescence. (DOK 1)

 2. Compare and contrast various learning styles/multiple intelligences. (DOK 3)

 3. Describe examples of diversity and how they affect the learning process (e.g., cultural, religious, regional, gender, ethnic, and physical). (DOK 2)

 4. Define types of learner exceptionality (e.g., physical and health disabilities, learning disabilities, mental retardation, emotional and behavioral disorders, and gifted learning), and summarize services and resources to meet exceptional learning needs. (DOK 2)

Unit 12: Subject Area Knowledge

Analyze the importance of subject matter knowledge and integrated learning.

-
1. (DOK 2)

 2. Explore a minimum of two content area classrooms. (DOK 4)

Unit 13: Observation and Field Experience

Participate in preschool, elementary, and secondary classroom experiences.

-
1. (DOK 3)

Unit 14: Planning Instruction II

Develop lesson plans that identify the elements of an effective lesson for all

-
1. learners (ongoing). (DOK 3)

Unit 15: Assessing Teaching and Learning II

-
1. Analyze assessment results as part of the learning process. (DOK 3)

Unit 16: Professional Learning

-
1. Research and analyze professional learning in the field of education. (DOK 2)

_____ 2. Develop a plan for professional growth. (DOK 3)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

4. Using 21st century skills to understand and address global issues
5. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
6. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

4. Knowing how to make appropriate personal economic choices
5. Understanding the role of the economy in society
6. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

4. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
5. Exercising the rights and obligations of citizenship at local, state, national, and global levels
6. Understanding the local and global implications of civic decisions

CS4 Health Literacy

6. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
7. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
8. Using available information to make appropriate health-related decisions
9. Establishing and monitoring personal and family health goals
10. Understanding national and international public health and safety issues

CS5 Environmental Literacy

5. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
6. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
7. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
8. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

4. Think Creatively
5. Work Creatively with Others

- 6. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 5. Reason Effectively
 - 6. Use Systems Thinking
 - 7. Make Judgments and Decisions
 - 8. Solve Problems
- CS8 Communication and Collaboration**
 - 3. Communicate Clearly
 - 4. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 3. Access and Evaluate Information
 - 4. Use and Manage Information
- CS10 Media Literacy**
 - 3. Analyze Media
 - 4. Create Media Products
- CS11 ICT Literacy**
 - 2. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 3. Adapt to change
 - 4. Be Flexible
- CS13 Initiative and Self-Direction**
 - 4. Manage Goals and Time
 - 5. Work Independently
 - 6. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 3. Interact Effectively with others
 - 4. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 3. Manage Projects
 - 4. Produce Results
- CS16 Leadership and Responsibility**
 - 3. Guide and Lead Others
 - 4. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

2. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- h. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- i. Explain the causes and characteristics of tides. (DOK 1)
- j. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- k. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
 - l. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
 - m. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
 - Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
 - n. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
 - Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
- 3. Apply an understanding of the diverse organisms found in aquatic environments.**
- g. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
 - Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
 - h. Research, calculate, and interpret population data. (DOK 2)
 - i. Research and compare reproductive processes in aquatic organisms. (DOK 2)
 - j. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
 - k. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
 - l. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
- 4. Draw conclusions about the relationships between human activity and aquatic organisms.**
- j. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
 - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
 - k. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
 - l. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
 - Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- b. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- m. Formulate questions that can be answered through research and experimental design. (DOK 3)
- n. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- o. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- p. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- q. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- r. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- h. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
 - Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- i. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- j. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- k. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
 - Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- l. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
 - Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- m. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
 - ATP structure
 - ATP function
- n. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
 - Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- d. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
 - Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- e. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- f. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- e. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- f. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- g. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- h. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- e. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- f. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- g. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - h. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- f. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - g. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - h. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - i. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - j. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - i. Clarify research questions and design laboratory investigations. (DOK 3)
 - j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- e. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - f. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - g. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - h. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- f. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - g. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - h. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- i. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
 - Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
 - j. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- j. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
 - Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
 - k. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
 - l. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
 - m. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
 - n. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
 - o. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
 - p. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
 - q. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
 - r. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- c. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
 - d. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- i. Formulate questions that can be answered through research and experimental design. (DOK 3)
- j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- f. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- g. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- h. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- i. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- j. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- g. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- h. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- i. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- j. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- k. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- l. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- e. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- f. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- g. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- h. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- e. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- f. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- g. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- h. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- i. Clarify research questions and design laboratory investigations. (DOK 3)
- j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- h. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
 - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
 - Substances and mixtures
 - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
- i. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- j. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
 - Properties and interactions of the three fundamental particles of the atom
 - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
- k. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
 - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
 - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- l. Compare the properties of compounds according to their type of bonding. (DOK 1)
 - Covalent, ionic, and metallic bonding
 - Polar and nonpolar covalent bonding
 - Valence electrons and bonding atoms
- m. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- n. Develop a three-dimensional model of molecular structure. (DOK 2)
 - Lewis dot structures for simple molecules and ionic compounds
 - Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

- e. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- f. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
 - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations

- Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- g. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- h. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
- 4. Analyze the relationship between microscopic and macroscopic models of matter.**
- e. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- f. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- g. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- h. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
- 5. Compare factors associated with acid/base and oxidation/reduction reactions.**
- d. Analyze and explain acid/base reactions. (DOK 2)

- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- e. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
- f. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- i. Formulate questions that can be answered through research and experimental design. (DOK 3)
- j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- m. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

- g. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- h. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- i. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- j. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- k. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- l. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- d. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- e. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- f. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- i. Formulate questions that can be answered through research and experimental design. (DOK 3)
- j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- e. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- f. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- g. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- h. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
 - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- i. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
 - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
 - j. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
 - k. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
 - l. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
 - m. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
 - n. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
 - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
 - o. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
 - p. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
- 4. Demonstrate an understanding of earth systems relating to weather and climate.**
- f. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
 - Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
 - g. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
 - h. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
 - i. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - j. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- e. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
 - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- f. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- g. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
 - Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- h. Cite evidence about how dramatic changes in earth’s atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- i. Formulate questions that can be answered through research and experimental design. (DOK 3)

- j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
 - l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
 - m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
- 2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.**
- h. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
 - i. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
 - j. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
 - k. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
 - l. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
 - m. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
 - n. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)
- 3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**
- d. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
 - e. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

- f. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- i. Clarify research questions and design laboratory investigations. (DOK 3)
- j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- h. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- i. Describe how organic components are integral to biochemical processes. (DOK 2)
- j. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- k. Explain the significance of the discovery of nucleic acids. (DOK 1)
- l. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- m. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- n. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- h. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- i. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- j. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- k. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- l. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- m. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- n. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- i. Formulate questions that can be answered through research and experimental design. (DOK 3)

- j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
 - l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
 - m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
- l. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
 - m. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
 - n. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
 - o. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
 - p. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
 - q. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
 - r. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
 - s. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
 - t. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
 - u. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
 - v. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- i. Identify questions that can be answered through scientific investigations. (DOK 3)
- j. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- k. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- l. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- n. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- f. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- g. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)

- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
 - h. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
 - i. Draw and assess conclusions about charges and electric current. (DOK 2)
 - Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
 - j. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- e. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
 - f. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
 - g. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
 - The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
 - h. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- e. Cite evidence to summarize the atomic theory. (DOK 1)
 - Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
 - f. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
 - g. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
 - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)

- h. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
 - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table

5. Investigate and apply principles of physical and chemical changes in matter.

- d. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
- e. Balance chemical equations. (DOK 2)
- f. Classify types of chemical reactions (e.g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. Investigate and apply principles of physical and chemical changes in matter.

- h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- i. Clarify research questions, and design laboratory investigations. (DOK 3)
- j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Develop an understanding of concepts related to forces and motion.

- e. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
 - Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
 - f. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
 - g. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
 - h. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
 - Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
- f. Explain and apply the conservation of energy and momentum. (DOK 2)
 - Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
 - g. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
 - h. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
 - i. Investigate and summarize the principles of thermodynamics. (DOK 2)
 - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
 - j. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**
- f. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
 - Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.

- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - g. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - h. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - i. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - j. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- d. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
 - e. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - f. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- c. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - d. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- h. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- i. Clarify research questions, and design laboratory investigations. (DOK 3)
- j. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

- k. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
 - l. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - m. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - n. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
- 2. Demonstrate the basic concepts of remote sensing. (E, P)**
- g. Describe the characteristics of the electromagnetic spectrum.
 - h. Using images and graphs, interpret the absorption/reflection spectrum.
 - i. Distinguish between passive vs. active sensor systems.
 - j. Analyze the effects of changes in spatial, temporal, and spectral resolution.
 - k. Analyze the effects on images due to changes in scale.
 - l. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- i. Formulate questions that can be answered through research and experimental design. (DOK 3)
- j. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- k. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- l. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- m. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - n. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- e. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
 - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
 - f. Identify and describe characteristics of the major phyla. (DOK 1)
 - Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
 - g. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
 - h. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
 - Phylogenic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- f. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
 - g. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
 - Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
 - h. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
 - i. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
 - Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
 - j. Contrast food chains and food webs. (DOK 2)
- 4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- c. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- d. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.

- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.

- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.

- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.

- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.

- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.

- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).

- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.

- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.

- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.

- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

National Board Professional Teaching Standards

NBPTS 1: Teachers are Committed to Students and Learning

- 1.1 NBCTs are dedicated to making knowledge accessible to all students. They believe all students can learn.
- 1.2 They treat students equitably. They recognize the individual differences that distinguish their students from one another and they take account for these differences in their practice.
- 1.3 NBCTs understand how students develop and learn.
- 1.4 They respect the cultural and family differences students bring to their classroom.
- 1.5 They are concerned with their students' self-concept, their motivation and the effects of learning on peer relationships.
- 1.6 NBCTs are also concerned with the development of character and civic responsibility.

NBPTS 2: Teachers Know the Subjects They Teach and How to Teach Those Subjects to Students.

- 2.1 NBCTs have mastery over the subject(s) they teach. They have a deep understanding of the history, structure and real-world applications of the subject.
- 2.2 They have skill and experience in teaching it, and they are very familiar with the skills gaps and preconceptions students may bring to the subject.
- 2.3 They are able to use diverse instructional strategies to teach for understanding.

NBPTS 3: Teachers are Responsible for Managing and Monitoring Student Learning.

- 3.1 NBCTs deliver effective instruction. They move fluently through a range of instructional techniques, keeping students motivated, engaged and focused.
- 3.2 They know how to engage students to ensure a disciplined learning environment, and how to organize instruction to meet instructional goals.
- 3.4 NBCTs know how to assess the progress of individual students as well as the class as a whole.
- 3.5 They use multiple methods for measuring student growth and understanding, and they can clearly explain student performance to parents.

NBPTS 4: Teachers Think Systematically about Their Practice and Learn from Experience.

- 4.1 NBCTs model what it means to be an educated person – they read, they question, they create, and they are willing to try new things.
- 4.2 They are familiar with learning theories and instructional strategies and stay abreast of current issues in American education.
- 4.3 They critically examine their practice on a regular basis to deepen knowledge, expand their repertoire of skills, and incorporate new findings into their practice.

NBPTS 5: Teachers are Members of Learning Communities.

- 5.1 NBCTs collaborate with others to improve student learning.
- 5.2 They are leaders and actively know how to seek and build partnerships with community groups and businesses.
- 5.3 They work with other professionals on instructional policy, curriculum development and staff development.
- 5.4 They can evaluate school progress and the allocation of resources in order to meet state and local education objectives.
- 5.5 They know how to work collaboratively with parents to engage them productively in the work of the school.

PRAXIS Standards

P1 Students as Learners

- Student Development and the Learning Process
- Students as Diverse Learners
- Student Motivation and the Learning Environment

P2 Instruction and Assessment

- Instruction and Assessment
- Planning Instruction
- Assessment Strategies

P3 Teacher Professionalism

- The Reflective Practitioner
- The Larger Community

P4 Communication Techniques

- Basic, effective verbal and nonverbal communication techniques

- Effect of cultural and gender differences on communications in the classroom
- Types of communication and interactions that can stimulate discussion in different ways for particular purposes.

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Metal Fabrication Executive Summary	157
Course Outlines.....	161
Metal Fabrication Competencies and Objectives	165
Metal Fabrication Competency Profile.....	174
Appendix A: 21st Century Skills Standards	177
Appendix B: MS Academic Standards	179
Appendix C: ACT College Readiness Standards.....	209
Appendix D: Pathway Content Standards.....	223
Appendix E: National Educational Technology Standards for Students	238

Metal Fabrication Executive Summary

Program Description

The Metal Fabrication pathway is designed as a secondary program for preparation to enter the field of metalworking. The Metal Fabrication program includes an introduction to the basic machining metalworking processes as well as an introduction to the basic welding profession. The purpose of the course is to prepare students to continue study in a postsecondary metals program (Welding or Machine Tool Operation) or to begin work at the entry level in a metal occupation. The machining courses in this curriculum is written to the National Institute for Metalworking Skills (NIMS) credentialing standards and the welding courses are written to the National Center for Construction Education and Research (NCCER) certification standards.

Industry Certification

The NIMS is a nationally recognized nonprofit organization that was established in 1995 to help develop industry standards to maintain the United States' global competitiveness. NIMS sets industry standards and certifies individuals who meet the quality requirements contained in the industry standards. NIMS also accredit training programs and facilities that meet NIMS quality requirements. The NIMS organization and standards are accredited by the American National Standards Institute (ANSI) in the metalworking field.

NIMS metalworking standards reflect expertise in areas such as stamping, press brake, roll forming, machining, tool and die making, mold making, screw machining, and machine maintenance and repair. All NIMS standards are industry written and industry validated and is subject to regular, periodic reviews under the procedures accredited and audited by ANSI.

The NIMS Level 1 credential consists of bench work, layout, milling, drill press, surface grinding, and lathing between centers. The students are required to perform a NIMS-approved project in each area in order to attain credentialing in those areas. The student must be able to complete the NIMS project with 100% accuracy before being allowed to take an additional online written test. Once both the performance evaluation and the online test are administered and passed, the student will receive a NIMS certification for each area successfully completed, i.e. bench work, layout, milling, drill press, surface grinding, and lathing between centers. The NIMS organization awards credentials for each area of competency in the Level 1 module after successful completion of projects and written tests.

NIMS credentials are used throughout the United States by industry to recruit, hire, place, and promote individual workers. NIMS may also be used to measure performance of individuals pursuing metalworking careers. Articulation may be established using the NIMS credentials for articulation among training programs.

Students who study basic machine metalworking processes may pursue, at their cost, a certification with the National Institute for Metalworking Skills, Inc. (NIMS). Students who study this curriculum may pursue certification of the NIMS Level 1 standards for machining.

Attaining this certification is an option for the student; therefore, the student is responsible for the financial costs attributed with achievement of the certification.

This curriculum has also been aligned to modules in the Contren program as endorsed by the National Center for Construction Education and Research (NCCER). Students who study this curriculum using the CONTREN materials under the supervision of an instructor who has been certified by the NCCER are eligible to be tested on each module in the welding area. Students who successfully pass these tests may be certified to the NCCER by the instructor and will receive documentation from NCCER. The Manufacturing welding curriculum framework is aligned to the NCCER Core and Welding.

Articulation

This program was designed to articulate to postsecondary Automotive Machinist Tech and postsecondary Machine Tool Operations.

High School Program	Community College Program	Community College Course
Metal Fabrication	Automotive Machinist Tech	MST 1114—Power Machinery I
	Machine Tool Operations	AUV 1116—Fundamentals for Automotive Machinists

Assessment

Students will be assessed using the Metal Fabrication MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the Manufacturing Cluster Instructional Design Specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Metal Fabrication program, the following student prerequisites are in place:

1. C or Higher in English (the previous year)
2. C or Higher in Math
3. Instructor Approval and TABE Reading Score (eighth grade or higher)

OR

4. Instructor Approval

Proposed Applied Academic Credit

The mathematics content in the Metal Fabrication program is meaningful and useful to students who are entering the manufacturing industry. Applied mathematics content was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that

upon the completion of this program, students will earn 1/2 Applied Mathematics Credit that can be used for graduation requirements.

The applied academic credit has *not* been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

The 976 licensure endorsement is needed to teach the Metal Fabrication program. The requirements for the 976 licensure endorsement are listed below:

1. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education*.
2. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
Applicant with a bachelor's or higher degree must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
4. Applicant must complete the individualized professional development plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must successfully complete the Certificate of Special Merit from the National Institution for Metalworking Skills (NIMS).
6. Applicant must successfully complete the Contren Instructor Certification Training Program (ICTP).
7. Applicant must successfully complete an MDE-approved computer literacy certification exam.
8. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
9. Applicant must successfully complete the manufacturing certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a **976** endorsement—a 5-year license. If the applicant does not meet all requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

***Exception:** Teachers with a currently valid license and endorsement #359 Machine Shop or #361 Metal Trades may earn this endorsement based on that #359 or #361 endorsement even if a 2-year college degree is not earned. All other requirements for this endorsement must be satisfied.

Professional Learning

The Professional Learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, you will need to contact the Research and Curriculum Unit at 662.325.2510 and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows options for local school districts to meet students' needs and scheduling demands. A discussion of each option is listed in the following material.

Option 1

This curriculum consists of two two-Carnegie-unit courses.

Course Description: Metal Fabrication I content includes orientation and leadership; basic safety; math, measuring tools, and instruments; blueprints; hand and power tools; lathe theory and operation; milling machine theory and operation; and grinding operations. Safety is emphasized in each unit and every activity.

Course Description: Metal Fabrication II included advanced precision machining techniques and an emphasis on welding processes. Welding topics include employability skills, safety, basic oxy-fuel cutting, plasma arc cutting (PAC), gas metal arc welding (GMAW), flux core arc welding (FCAW), gas tungsten arc welding (GTAW), and shielded metal arc welding (SMAW). The course should be taken after the student has successfully passed Metal Fabrication I.

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete Metal Fabrication courses with a score of 80/C or higher in class work to advance to the next level.

Option 1

Metal Fabrication I (Course Code: 993200)

Unit	Title	Hours
1	Orientation, Leadership, and Basic Safety	25
2	Math, Measuring Tools, and Instruments	20
3	Introduction to Blueprints and Hand and Power Tools	25
4	Drill Press and Band Saw Theory and Operation	20
5	Milling Machine Theory and Operation	30
6	Lathe Theory and Operation	75
7	Grinding Theory and Operation	25

			220
--	--	--	------------

Metal Fabrication II (Course Code: 993201)

Unit	Title	Hours
8	Orientation, Advanced Leadership, and Employability Skills	10
9	Basic Safety (Review and Reinforcement)	10
10	Advanced Lathe Operation	55
11	Advanced Milling Operation	35
12	Computerized Numerical Control	10
13	Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)	15
14	Shielded Metal Arc Welding (SMAW)	45
15	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	25
16	Introduction to Gas Tungsten Arc Welding (GTAW)	15
		220

Option 2

Upon completion of this option, the student will be trained to take the **NIMS Level 1 Certification and Contren Welding Module certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

1. Metal Fabrication I (Course Code: 993202)
2. Metal Fabrication II (Course Code: 993203)
3. Metal Fabrication III (Course Code: 993204)
4. Metal Fabrication IV (Course Code: 993205)

Course Description: Metal Fabrication I (Course Code: 993202) includes an introduction to the field as well as fundamentals of safety, tools, math, blueprint reading, and milling machinery. This is a one-Carnegie-unit course.

Course Description: Metal Fabrication II (Course Code: 993203) emphasizes an overview of safety and leadership, the lathe theory, and grinding operations. This course gives student's real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Metal Fabrication I.

Course Description: Metal Fabrication III (Course Code: 993204) includes an study of precision machining techniques. This course also reinforces safety related to the construction industry. This one-Carnegie-unit course should only be taken after students successfully pass Metal Fabrication II.

Course Description: Metal Fabrication IV (Course Code: 993205) includes an study of basic oxy-fuel cutting, plasma arc cutting, gas metal arc, flux core arc, and introduction to gas tungsten arc and shielded metal arc welding. This course also reinforces safety related to the construction industry. This one-Carnegie-unit course should only be taken after students successfully pass Metal Fabrication III.

Option 2

Metal Fabrication I (Course Code: 993202)

Unit	Title	Hours
1	Orientation, Leadership, and Basic Safety	15
2	Math, Measuring Tools, and Instruments	20
3	Introduction to Blueprints and Hand and Power Tools	25
4	Drill Press and Band Saw Theory and Operation	20
5	Milling Machine Theory and Operation	30
		110

Metal Fabrication II (Course Code: 993203)

Unit	Title	Hours
8	Orientation, Advanced Leadership, and Employability Skills	5
9	Basic Safety (Review and Reinforcement)	5
4	Lathe Theory and Operation	75
6	Grinding Theory and Operation	25
		110

Metal Fabrication III (Course Code: 993204)

Unit	Title	Hours
7	Orientation, Advanced Leadership, and Employability Skills	5
8	Basic Safety (Review and Reinforcement)	5
10	Advanced Lathe Operation	55
11	Advanced Milling Operation	35
12	Computerized Numerical Control	10
		110

Metal Fabrication IV (Course Code: 993205)

Unit	Title	Hours
7	Orientation, Advanced Leadership, and Employability Skills	5
8	Basic Safety (Review and Reinforcement)	5
13	Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)	15
14	Shielded Metal Arc Welding (SMAW)	45
15	Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	25
16	Introduction to Gas Tungsten Arc Welding (GTAW)	15
		110

Metal Fabrication Competencies and Objectives

Unit 1: Orientation, Leadership, and Basic Safety

1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
 - a. Describe local program and vocational/career technical center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations. (DOK 1)
2. Describe employment opportunities and responsibilities. (DOK 2)
 - a. Relate employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements to students' success in a secondary or postsecondary manufacturing curriculum. (DOK 2)
 - b. Describe basic employee responsibilities. (DOK 1)
3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2)
 - a. Demonstrate effective team-building and leadership skills. (DOK 1)
 - b. Practice appropriate work ethics. (DOK 2)
 - c. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 1)
 - d. Discuss the history of the metal trade industry to include materials, terminology, and techniques. (DOK 1)
4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)
 - a. Describe how to avoid on-site accidents. (DOK 1)
 - b. Explain the relationship between housekeeping and safety. (DOK 1)
 - c. Explain the importance of following all safety rules and company safety policies. (DOK 1)
 - d. Explain the importance of reporting all on-the-job injuries and accidents. (DOK 1)
 - e. Explain the need for evacuation policies and the importance of following them. (DOK 1)
 - f. Investigate employer's substances abuse policy and how it relates to safety. (DOK 1)
 - g. Demonstrate the safety procedures when working near pressurized or high temperature. (DOK 1)
5. Identify and apply safety around Manufacturing operations. (DOK 1)
 - a. Use proper safety practices when performing Manufacturing operations. (DOK 1)
 - b. Recognize and explain personal protective equipment. (DOK 1)
 - c. Inspect and care for personal protective equipment. (DOK 1)
6. Explain lifting. (DOK 3)
 - a. Identify and explain the procedures for lifting heavy objects. (DOK 3)
7. Explain the material safety data sheet (MSDS). (DOK 2)
 - a. Explain the function of the MSDS. (DOK 2)
 - b. Interpret the requirements of the MSDS. (DOK 1)

8. Explain fires. (DOK 1)
 - a. Explain the process by which fires start. (DOK 1)
 - b. Explain fire prevention of various flammable liquids. (DOK 1)
 - c. Explain the classes of fire and the types of extinguishers. (DOK 1)
9. Explain safety in and around Manufacturing and electrical situations. (DOK 2)
 - a. Explain injuries when electrical contact occurs. (DOK 1)
 - b. Explain safety around Manufacturing and electrical hazards. (DOK 1)
 - c. Explain action to take when an electrical shock occurs. (DOK 1)

Unit 2: Math, Measuring Tools, and Instruments

1. Apply the four basic math skills with whole numbers, fractions, and percents. (DOK 1)
 - a. Add, subtract, multiply, and divide whole numbers, decimals, and fractions. (DOK 1)
 - b. Convert whole numbers to fractions, and convert fractions to whole numbers. (DOK 1)
 - c. Convert decimals to percents and percents to decimals. (DOK 1)
 - d. Convert fractions to decimals. (DOK 1)
 - e. Convert fractions to percents. (DOK 1)
2. Perform basic mathematical calculations related to machine shop operations. (DOK 1)
 - a. Convert metric measurements to English measurements. (DOK 1)
 - b. Solve basic angles and sides. (DOK 1)
 - c. Calculate the amount of material for a given project. (DOK 1)
 - d. Compute distances according to a drawn plan. (DOK 1)
3. Identify and perform functions using various measuring tools and instruments (micrometers, dial indicators, height gauge, and digital caliper). (DOK 2)
 - a. Read a rule to the nearest $1/32$ in. (DOK 1)
 - b. Lay out lines with a rule. (DOK 2)
 - c. Describe the care and use of various rules. (DOK 1)

Unit 3: Introduction to Blueprints and Hand and Power Tools

1. Read, analyze, and design a blueprint. (DOK 2)
 - a. Identify terms and symbols commonly used on blueprints. (DOK 1)
 - b. Relate information on prints to real parts/models. (DOK 2)
 - c. Interpret various symbols to locate various elements. (DOK 1)
 - d. Interpret a plan to determine layout. (DOK 2)
 - e. Explain basic layout of a blueprint. (DOK 2)
 - f. Describe the information in a title block. (DOK 1)
 - g. Identify the lines used on blueprints. (DOK 1)
2. Demonstrate the use and maintenance of various hand and power tools. (DOK 3)
 - a. Identify and discuss the use of common hand and power tools. (DOK 1)
 - b. Discuss rules of safety. (DOK 1)
 - c. Select and demonstrate the use of tools. (DOK 2)
 - d. Explain the procedures for maintenance. (DOK 3)

Unit 4: Drill Press and Band Saw Theory and Operation

1. Identify and describe the safe operation of the types of power saws. (DOK 2)
 - a. Identify and describe rules for safe use of power saws. (DOK 1)
 - b. Describe factors that determine saw blade selection. (DOK 2)
 - c. Describe factors to consider in the care and cleaning of power saws. (DOK 2)
 - d. Lay out and cut stock with a band saw according to specifications. (DOK 1)
2. Identify and describe the types of drilling machines, including hand powered and drill press, and the rules for safe operation of each. (DOK 2)
 - a. Describe safety rules for the safe use of a hand power drill and drill press. (DOK 1)
 - b. Identify work-holding and setup devices in drill press operations. (DOK 2)
 - c. Lay out holes and drill, ream, countersink, and counter bore according to project specifications. (DOK 2)

Unit 5: Milling Machine Theory and Operation

1. Differentiate between the types of milling machines. (DOK 2)
 - a. Identify the different types of milling machines. (DOK 2)
 - b. Explain the use and safety of each type of milling machine. (DOK 1)
2. Identify the parts, cutting tools, and basic maintenance of a vertical milling machine. (DOK 2)
 - a. Identify the major parts of a horizontal and vertical mill. (DOK 1)
 - b. Identify the cutting tools used on a horizontal and vertical mill. (DOK 1)
 - c. Clean and lubricate a horizontal and vertical mill following manufacturer's specifications. (DOK 3)
 - d. Determine the rpm and feed rate. (DOK 2)
3. Perform operations on a milling machine. (DOK 4)
 - a. Perform operations on a vertical milling machine. (DOK 4)
 - i. Perform an end milling operation, side milling, slotting, drilling, reaming, boring, and fly cutting, mounting cutters and cutter holders, and mounting and aligning a swivel vise; mill a key seat, a given angle, and a straight boring operation; align the head square to the table, mill operation with head tilted to 45°, and divide head operations.

Unit 6: Lathe Theory and Operation

1. Identify the parts, rules, and care of the metal lathe. (DOK 3)
 - a. Identify the four major parts of the lathe. (DOK 1)
 - b. Set up a lathe, and determine the rpm and feed rate according to manufacturer's specifications for the basic lathe operations. (DOK 3)
 - c. Explain the advantages and disadvantages of carbide tip cutting tools, and demonstrate how to freehand grind a high-speed steel (hss) turning tool. (DOK 1)
 - i. Explain the turning of a piece of stock.
 - ii. Describe how to chuck a piece of stock.
 - iii. Describe facing, center drilling, filing, tapping, and cutoff.

2. Perform procedures for a machining operation. (DOK 3)
 - a. Identify terms and procedures for lathe operations. (DOK 1)
 - b. Discuss rules of safety. (DOK 1)
 - c. Demonstrate centering a workpiece in a four-jaw chuck on the lathe. (DOK 3)
 - d. Face a part to length. (DOK 3)
 - e. Perform a straight turning operation. (DOK 3)
 - f. Perform a chamfer operation. (DOK 3)
 - g. Perform a center drilling operation. (DOK 2)
 - h. Perform a knurling operation. (DOK 2)
 - i. Perform a cutoff operation. (DOK 2)
 - j. Tap a blind hole. (DOK 2)
 - k. Cut external and internal threads on the lathe. (DOK 3)
 - l. Complete NIMS turning-chucking Level I project. (DOK 3)
 - m. Complete NIMS turning between centers Level I project. (DOK 3)
 - n. Install a chuck on a lathe. (DOK 3)
 - o. Mount and align a part in a four-jaw chuck on a lathe to instructor's specifications. (DOK 3)
 - p. Turn a taper with a compound rest and a taper attachment. (DOK 3)
 - q. Perform a boring operation. (DOK 2)
 - r. Perform wet and dry cuts. (DOK 1)

Unit 7: Grinding Theory and Operation

1. Describe safety, magnetic chuck work, surface grinding operations, and reasons for truing and balancing a grinding wheel. (DOK 3)
 - a. Describe grinding safety. (DOK 1)
 - b. Describe safety rules that apply to magnetic chuck work. (DOK 1)
 - c. Identify surface grinding operations. (DOK 1)
 - d. Explain reasons for truing and balancing grinding wheels. (DOK 3)
2. Perform maintenance operations to manufacturer's specifications and grinding operations to teacher's specifications. (DOK 4)
 - a. Remove and replace a grinding wheel. (DOK 2)
 - b. Dress a wheel flat. (DOK 4)
 - c. Grind a workpiece flat and parallel. Grind a workpiece square, to an angular surface, and to dimension. (DOK 4)

Unit 8: Orientation, Advanced Leadership, and Employability Skills

1. Describe local program and vocational center policies and procedures. (DOK 1)
 - a. Describe local program and vocational center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations. (DOK 1)
2. Describe employment opportunities and responsibilities. (DOK 2)

- a. Describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. (DOK 1)
- b. Describe basic employee responsibilities. (DOK 1)
- c. Design a resume, and complete a job application. (DOK 2)
- 3. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2)
 - a. Perform welding projects through written instruction. (DOK 2)
 - b. Perform welding projects through oral instruction. (DOK 2)

Unit 9: Basic Safety (Review and Reinforcement)

- 1. Describe general safety rules for working in a shop/lab and industry. (DOK 1)
 - a. Describe how to avoid on-site accidents. (DOK 1)
 - b. Explain the relationship between housekeeping and safety. (DOK 1)
 - c. Explain the importance of following all safety rules and company safety policies. (DOK 1)
 - d. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. (DOK 1)
 - e. Explain the need for evacuation policies and the importance of following them. (DOK 1)
 - f. Explain the employer's substances abuse policy and how it relates to safety. (DOK 1)
 - g. Explain the safety procedures when working near pressurized or high temperature. (DOK 1)
- 2. Identify and apply safety around Manufacturing operations. (DOK 1)
 - a. Use proper safety practices when welding or working around Manufacturing operations. (DOK 1)
 - b. Use proper safety practices when welding in or near trenches and excavations. (DOK 1)
 - c. Explain the term "proximity work." (DOK 1)
- 3. Identify and explain use of various barriers and confinements. (DOK 2)
 - a. Explain the safety requirements for working in confined areas. (DOK 1)
 - b. Explain and practice lock-out/tag-out procedures. (DOK 2)
 - c. Explain the different barriers and barricades and how they are used. (DOK 2)
 - d. Recognize and explain personal protective equipment (PPE). (DOK 1)
 - e. Inspect and care for personal protective equipment (PPE). (DOK 1)
- 4. Explain lifting and the use of ladders and scaffolds. (DOK 2)
 - a. Identify and explain the procedures for lifting heavy objects. (DOK 1)
 - b. Inspect and safely work with various ladders and scaffolds. (DOK 2)
- 5. Explain the material safety data sheet (MSDS). (DOK 1)
 - a. Explain the function of the MSDS. (DOK 1)
 - b. Interpret the requirements of the MSDS. (DOK 2)
- 6. Explain fires. (DOK 2)
 - a. Explain the process by which fires start. (DOK 1)

- b. Explain fire prevention of various flammable liquids. (DOK 1)
- c. Explain the classes of fires and the types of extinguishers. (DOK 2)
- 7. Explain safety in and around electrical situations. (DOK 3)
 - a. Explain injuries when electrical contact occurs. (DOK 1)
 - b. Explain safety around electrical hazards. (DOK 3)
 - c. Explain actions to take when an electrical shock occurs. (DOK 1)

Unit 10: Advanced Lathe Operation

- 1. Describe safety precautions, methods for measuring thread pitch diameters, and calculation of dimensions using taper formulas. (DOK 2)
 - a. Describe safety precautions. (DOK1)
 - b. Describe methods for measuring thread pitch diameters. (DOK2)
 - c. Calculate dimensions using taper formulas. (DOK2)
- 2. Perform various operations according to specifications. (DOK 2)
 - a. Perform chamfer, recessing, knurling, drill and recess a hole, align and start a tap using a lathe center, and cutoff. (DOK2)
 - b. Perform turning a taper with taper attachment, turning a taper with compound, boring, cutting external threads to relief, pick up threads, and cutting internal threads. (DOK2)

Unit 11: Advanced Milling Operation

- 1. Explore vertical milling operations. (DOK 2)
 - a. Describe and apply safety rules. (DOK1)
 - b. Identify the types of milling machines and describe the major components. (DOK1)
 - c. Identify work-holding devices, cutting tools, tool holders, and other attachments. (DOK2)
 - d. Describe the different types of horizontal milling operations. (DOK1)
- 2. Adjust speed and feed rates, clean and lubricate, mount arbors and adjust arbor support bushing, mount a cutter, mill a key-way, and perform selected horizontal operations. (DOK 2)
 - a. Adjust machine speed and feed rates; clean and lubricate. (DOK2)
 - b. Mount arbors and adjust arbor support bushing and mount a cutter according to specifications. (DOK2)
 - c. Perform selected operations according to specifications. (DOK2)
- 3. Mount and remove cutters and cutter holders, align a vise using a dial indicator, and perform selected vertical milling and boring operations. (DOK 2)
 - a. Mount and remove cutters and cutter holders; mount and align a vise. (DOK2)
 - b. Perform selected milling and boring operations according to specifications. (DOK2)

Unit 12: Computerized Numerical Control

1. Describe computerized numerical control (CNC), including the codes and the input of a pre-written program. (DOK 2)
 - a. Describe the operations of CNC. (DOK1)
 - b. Describe codes used in a CNC machine. (DOK2)

Unit 13: Basic Oxy-fuel and Plasma Arc Cutting (PAC)

1. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding and brazing. (DOK 3)
 - a. Identify and explain joint design and considerations. (DOK1).
 - b. Prepare base metal joints for welding, oxy-fuel welding, and brazing. (DOK1)
 - c. Properly secure portable gas cylinders and cutting equipment. (DOK1)
 - d. Set up oxy-fuel equipment. (DOK2)
 - e. Light and adjust the oxy-fuel cutting torch. (DOK2)
 - f. Properly shut down oxy-fuel equipment. (DOK2)
 - g. Perform the different types of cuts using an oxy-fuel torch. (DOK3)
 - h. Change out empty cylinders. (DOK1)
2. Perform various operations of welding, oxy-fuel welding, and brazing using the proper equipment. (DOK 1)
 - a. Oxy-fuel weld in the flat position. (DOK1)
 - b. Braze in the flat position. (DOK1)
3. Explain safety, and identify the major components. (DOK 1)
 - a. Identify and understand plasma arc cutting processes. (DOK1)
 - b. Identify plasma arc cutting equipment. (DOK1)
4. Set up and perform operations using the plasma arc cutting process. (DOK 2)
 - a. Perform necessary setup. (DOK2)
 - b. Cut mild steel. (DOK2)

Unit 14: Shielded Metal Arc Welding (SMAW)

1. Identify and explain safety, setup, weld cleanup, and maintenance of arc welding equipment. (DOK 3)
2. Identify and use procedures for joint fit-up and alignment. (DOK 1)
 - a. Identify and explain job code specifications. (DOK1)
 - b. Use fit-up gauges and measuring devices to check joint fit-up. (DOK1)
 - c. Use plate fit-up tools to fit up joints. (DOK1)
 - d. Identify and explain distortion and how it is controlled. (DOK1)
 - e. Check for joint misalignment and poor fit-up. (DOK1)
3. Identify and explain filler metal and selection of electrodes. (DOK 1)
 - a. Identify and explain the AWS/ASME filler metal classification system. (DOK1)

- b. Explain the storage and control of filler metals. (DOK1)
- c. Identify the factors that affect electrode selection. (DOK1)
- 4. Construct various welds using different positions and electrodes. (DOK 4)
 - a. Weld beads on plate in the flat position using E6010 and E7018 electrodes. (DOK2)
 - b. Make fillet welds in the horizontal position using E6010 and E7018 electrodes. (DOK2)
 - c. Make fillet welds in the vertical position using E6010 and E7018 electrodes. (DOK3)
 - d. Make fillet welds in the overhead position using E6010 and E7018 electrodes. (DOK4)
- 5. Identify quality welds, and make various advanced welds in different positions. (DOK 4)
 - a. Identify and explain weld imperfections and their causes. (DOK1)
 - b. Identify and explain non-destructive examination practices. (DOK1)
 - c. Identify and explain welder qualification tests. (DOK1)
 - d. Explain the importance of quality workmanship. (DOK1)
 - e. Weld plate, V-butt with backing, using E7018 electrodes in the flat position. (DOK2)
 - f. Weld beads on plate using E7018 electrodes in the horizontal position. (DOK2)
 - g. Weld plate, V-butt with backing, using E7018 electrodes in the horizontal position. (DOK2)
 - h. Weld beads on plate using E7018 electrodes in the vertical position. (DOK3)
 - i. Weld plate, V-butt with backing, using E7018 electrodes in the vertical position. (DOK3)
 - j. Weld beads on plate using E7018 electrodes in the overhead position. (DOK4)
 - k. Weld plate, V-butt with backing, using E7018 electrodes in the overhead position. (DOK4)
- 6. Weld various plates using various electrodes in different positions. (DOK 4)
 - a. Weld plate, open V-butt-joint, using E6010 electrodes in the flat position. (DOK2)
 - b. Weld beads on plate using E6010 electrodes in the horizontal position. (DOK2)
 - c. Weld plate, open V-butt-joint, using E6010 electrodes in the horizontal position. (DOK2)
 - d. Weld beads on plate using E6010 electrodes in the vertical position. (DOK3)
 - e. Weld plate, open V-butt-joint, using E6010 electrodes in the vertical position. (DOK3)
 - f. Weld beads on plate using E6010 electrodes in the overhead position. (DOK4)
 - g. Weld plate, open V-butt-joint, using E6010 electrodes in the overhead position. (DOK4)

Unit 15: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)

- 1. Demonstrate and discuss safety procedures, applications, and the advantages and limitations, and identify the machine controls for GMAW and FCAW. (DOK 2)
- 2. Perform various welds according to specifications. (DOK 4)
 - a. Perform GMAW welds (in the flat position)
 - i. Fabricate a butt-joint weld. (DOK2)
 - ii. Fabricate a lap-joint fillet weld. (DOK2)

- iii. Fabricate a T-joint fillet weld. (DOK2)
- iv. Fabricate a V-groove butt-joint weld in the flat and horizontal positions (vertical and overhead optional) according to specifications. (DOK4)
- b. Perform FCAW welds.
 - i. Fabricate a multi-pass fillet weld (vertical and overhead optional) according to specifications. (DOK4)
 - ii. Fabricate a V-grooved butt-joint weld in the flat and horizontal positions (vertical and overhead optional) according to specifications. (DOK4)

Unit 16: Introduction to Gas Tungsten Arc Welding (GTAW)

- 1. Identify proper safety procedures, principles, and parts; and perform a setup. (DOK 2)
 - a. Describe the different types of tungsten electrodes. (DOK1)
 - b. Identify the major controls on a machine. (DOK1)
 - c. Identify the parts of a torch and the functions of each. (DOK2)
 - d. Identify the different types of cups and the application of each. (DOK1)
- 2. Perform various welds on plate steel. (DOK 4)
 - a. Run stringer beads in the flat and horizontal positions. (DOK2)
 - b. Fabricate a square groove butt-weld in the flat and horizontal positions. (DOK4)
 - c. Fabricate a T-joint fillet weld in the flat and horizontal positions. (DOK3)

Metal Fabrication Competency Profile

Program CIP: 45.0503

Unit 1: Orientation, Leadership, and Basic Safety

- _____ 1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
- _____ 2. Describe employment opportunities and responsibilities. (DOK 2)
- _____ 3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2)
- _____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)
- _____ 5. Identify and apply safety around Manufacturing operations. (DOK 1)
- _____ 6. Explain lifting. (DOK 3)
- _____ 7. Explain the material safety data sheet (MSDS). (DOK 2)
- _____ 8. Explain fires. (DOK 1)
- _____ 9. Explain safety in and around Manufacturing and electrical situations. (DOK 2)

Unit 2: Math, Measuring Tools, and Instrument

- _____ 1. Apply the four basic math skills with whole numbers, fractions, and percents. (DOK 1)
- _____ 2. Perform basic mathematical calculations related to machine shop operations. (DOK 1)
- _____ 3. Identify and perform functions using various measuring tools and instruments (micrometers, dial indicators, height gauge, and digital caliper). (DOK 2)

Unit 3: Introduction to Blueprints and Hand and Power Tools

- _____ 1. Read, analyze, and design a blueprint. (DOK 2)
- _____ 2. Demonstrate the use and maintenance of various hand and power tools. (DOK 3)

Unit 4: Drill Press and Band Saw Theory and Operations

- _____ 1. Identify and describe the safe operation of the types of power saws. (DOK 2)
- _____ 2. Identify and describe the types of drilling machines, including hand powered and drill press, and the rules for safe operation of each. (DOK 2)

Unit 5: Milling Machine Theory and Operation

- _____ 1. Differentiate between the types of milling machines. (DOK 2)
- _____ 2. Identify the parts, cutting tools, and basic maintenance of a vertical milling machine. (DOK 2)
- _____ 3. Perform operations on a milling machine. (DOK 4)

Unit 6: Lathe Theory and Operation

- _____ 1. Identify the parts, rules, and care of the metal lathe. (DOK 3)
- _____ 2. Perform procedures for a machining operation. (DOK 3)

Unit 7: Grinding Theory and Operation

- _____ Describe safety, magnetic chuck work, surface grinding operations, and reasons for truing and balancing a grinding wheel. (DOK 3)
- _____ 1. Perform maintenance operations to manufacturer’s specifications and grinding operations to teacher’s specifications. (DOK 4)
- _____ 2.

Unit 8: Orientation, Advanced Leadership, and Employability Skills

- _____ Describe local program and vocational center policies and procedures. (DOK 1)
- _____ 1. 1)
- _____ 2. Describe employment opportunities and responsibilities. (DOK 2)
- _____ Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2)
- _____ 3.

Unit 9: Basic Safety (Review and Reinforcement)

- _____ Describe general safety rules for working in a shop/lab and industry. (DOK 1)
- _____ 1. 1)
- _____ 2. Identify and apply safety around Manufacturing operations. (DOK 1)
- _____ 3. Identify and explain the use of various barriers and confinements. (DOK 2)
- _____ 4. Explain lifting and the use of ladders and scaffolds. (DOK 2)
- _____ 4. Explain the material safety data sheet (MSDS). (DOK 1)
- _____ 6. Explain fires. (DOK 2)
- _____ 7. Explain safety in and around electrical situations. (DOK 3)

Unit 10: Advanced Lathe Operation

- _____ Describe safety precautions, methods for measuring thread pitch diameters, and calculation of dimensions using taper formulas. (DOK 2)
- _____ 1.
- _____ 2. Perform various operations according to specifications. (DOK 2)

Unit 11: Advanced Milling Operations

- _____ 1. Explore vertical milling operations.
Adjust speed and feed rates, clean and lubricate, mount arbors and adjust arbor support bushing, mount a cutter, mill a key-way, and perform selected horizontal operations. (DOK 2)
- _____ 2. Mount and remove cutters and cutter holders, align a vise using a dial indicator, and perform selected vertical milling and boring operations. (DOK 2)
- _____ 3. 2)

Unit 12: Power Machinery – Computerized Numerical Control

- _____ Describe computerized numerical control (CNC), including the codes and the input of a pre-written program. (DOK 2)
- _____ 1.

Unit 13: Gas Welding/Cutting Processes – Basic Oxy-fuel Cutting and Plasma Arc Cutting (PAC)

- Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding and brazing.
- _____ 1. (DOK 3)
 - _____ 2. Perform various operations of welding, oxy-fuel welding, and brazing using the proper equipment. (DOK 1)
 - _____ 3. Explain safety, and identify the major components. (DOK 2)
 - _____ 4. Set up and perform operations using the plasma arc cutting process. (DOK 4)

Unit 14: Gas Welding/Cutting Processes – Shielded Metal Arc Welding (SMAW)

- Identify and explain safety, setup, weld cleanup, and maintenance of arc welding equipment. (DOK 3)
- _____ 1. (DOK 3)
 - _____ 2. Identify and use procedures for joint fit-up and alignment. (DOK 1)
 - _____ 3. Identify and explain filler metal and selection of electrodes. (DOK 1)
 - _____ 4. Construct various welds using different positions and electrodes. (DOK 4)
 - _____ 5. Identify quality welds, and make various advanced welds in different positions. (DOK 3)
 - _____ 6. Weld various plates using various electrodes in different positions. (DOK 4)

Unit 15: Gas Welding/Cutting Processes – Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)

- Demonstrate and discuss safety procedures, applications, and the advantages and limitations, and identify the machine controls for GMAW and FCAW.
- _____ 1. (DOK 2)
 - _____ 2. Perform various welds according to specifications. (DOK 4)

Unit 16: Gas Welding/Cutting Processes – Introduction to Gas Tungsten Arc Welding (GTAW)

- Identify proper safety procedures, principles, and parts; and perform a setup.
- _____ 1. (DOK 2)
 - _____ 2. Perform various welds on plate steel. (DOK 4)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

7. Using 21st century skills to understand and address global issues
8. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
9. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

7. Knowing how to make appropriate personal economic choices
8. Understanding the role of the economy in society
9. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

7. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
8. Exercising the rights and obligations of citizenship at local, state, national, and global levels
9. Understanding the local and global implications of civic decisions

CS4 Health Literacy

11. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
12. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
13. Using available information to make appropriate health-related decisions
14. Establishing and monitoring personal and family health goals
15. Understanding national and international public health and safety issues

CS5 Environmental Literacy

9. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
10. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
11. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
12. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

7. Think Creatively
8. Work Creatively with Others

- 9. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 9. Reason Effectively
 - 10. Use Systems Thinking
 - 11. Make Judgments and Decisions
 - 12. Solve Problems
- CS8 Communication and Collaboration**
 - 5. Communicate Clearly
 - 6. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 5. Access and Evaluate Information
 - 6. Use and Manage Information
- CS10 Media Literacy**
 - 5. Analyze Media
 - 6. Create Media Products
- CS11 ICT Literacy**
 - 3. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 5. Adapt to change
 - 6. Be Flexible
- CS13 Initiative and Self-Direction**
 - 7. Manage Goals and Time
 - 8. Work Independently
 - 9. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 5. Interact Effectively with others
 - 6. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 5. Manage Projects
 - 6. Produce Results
- CS16 Leadership and Responsibility**
 - 5. Guide and Lead Others
 - 6. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

3. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- o. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- p. Explain the causes and characteristics of tides. (DOK 1)
- q. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- r. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
 - s. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
 - t. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
 - Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
 - u. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
 - Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
- 3. Apply an understanding of the diverse organisms found in aquatic environments.**
- m. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
 - Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
 - n. Research, calculate, and interpret population data. (DOK 2)
 - o. Research and compare reproductive processes in aquatic organisms. (DOK 2)
 - p. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
 - q. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
 - r. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
- 4. Draw conclusions about the relationships between human activity and aquatic organisms.**
- s. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
 - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
 - t. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
 - u. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
 - Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- c. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- v. Formulate questions that can be answered through research and experimental design. (DOK 3)
- w. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- x. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- y. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- z. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- aa. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- o. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
 - Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- p. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- q. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- r. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
 - Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- s. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
 - Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- t. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
 - ATP structure
 - ATP function
- u. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
 - Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- g. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
 - Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- h. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- i. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- i. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- j. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- k. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- l. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- i. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- j. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- k. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - l. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- k. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - l. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - m. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - n. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - o. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - p. Clarify research questions and design laboratory investigations. (DOK 3)
 - q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- i. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - j. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - k. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - l. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- k. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - l. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - m. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- n. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- o. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- s. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- t. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- u. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- v. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- w. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- x. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- y. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- z. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- aa. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- e. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- f. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- p. Formulate questions that can be answered through research and experimental design. (DOK 3)
- q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- k. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- l. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- m. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- n. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- o. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- m. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- n. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- o. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- p. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- q. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- r. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- i. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- j. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- k. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- l. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- i. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- j. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- k. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- l. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- p. Clarify research questions and design laboratory investigations. (DOK 3)
- q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- o. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
 - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
 - Substances and mixtures
 - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
- p. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- q. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
 - Properties and interactions of the three fundamental particles of the atom
 - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
- r. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
 - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
 - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- s. Compare the properties of compounds according to their type of bonding. (DOK 1)
 - Covalent, ionic, and metallic bonding
 - Polar and nonpolar covalent bonding
 - Valence electrons and bonding atoms
- t. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- u. Develop a three-dimensional model of molecular structure. (DOK 2)
 - Lewis dot structures for simple molecules and ionic compounds
 - Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

- i. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- j. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
 - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations

- Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- k. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- l. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
4. **Analyze the relationship between microscopic and macroscopic models of matter.**
- i. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- j. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- k. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- l. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- g. Analyze and explain acid/base reactions. (DOK 2)

- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- h. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
- i. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- p. Formulate questions that can be answered through research and experimental design. (DOK 3)
- q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- t. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

- m. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- n. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- o. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- p. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- q. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- r. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- g. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- h. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- i. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- p. Formulate questions that can be answered through research and experimental design. (DOK 3)
- q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- i. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- j. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- k. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- l. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
 - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- q. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
 - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
 - r. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
 - s. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
 - t. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
 - u. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
 - v. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
 - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
 - w. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
 - x. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
- 4. Demonstrate an understanding of earth systems relating to weather and climate.**
- k. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
 - Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
 - l. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
 - m. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
 - n. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - o. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- i. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
 - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- j. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- k. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
 - Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- l. Cite evidence about how dramatic changes in earth’s atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- p. Formulate questions that can be answered through research and experimental design. (DOK 3)

- q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

- o. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
- p. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
- q. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- r. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
- s. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- t. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- u. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

- g. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
- h. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

- i. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- p. Clarify research questions and design laboratory investigations. (DOK 3)
- q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- o. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- p. Describe how organic components are integral to biochemical processes. (DOK 2)
- q. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
 - Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- r. Explain the significance of the discovery of nucleic acids. (DOK 1)
- s. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- t. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- u. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- o. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- p. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- q. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- r. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- s. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- t. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- u. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- p. Formulate questions that can be answered through research and experimental design. (DOK 3)

- q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

- w. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- x. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- y. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- z. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- aa. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- bb. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- cc. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- dd. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- ee. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
- ff. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
- gg. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- p. Identify questions that can be answered through scientific investigations. (DOK 3)
- q. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- r. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- s. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- u. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- k. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- l. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)

- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- m. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- n. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- o. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- i. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- j. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
- k. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
- l. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- i. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
- j. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
- k. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)

1. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
 - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
5. **Investigate and apply principles of physical and chemical changes in matter.**
 - g. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
 - h. Balance chemical equations. (DOK 2)
 - i. Classify types of chemical reactions (e.g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- | | |
|--------|--|
| PHYI 1 | Apply inquiry-based and problem-solving processes and skills to scientific investigations. |
| PHYI 2 | Develop an understanding of concepts related to forces and motion. |
| PHYI 3 | Develop an understanding of concepts related to work and energy. |
| PHYI 4 | Discuss the characteristics and properties of light and sound. |
| PHYI 5 | Apply an understanding of magnetism, electric fields, and electricity. |
| PHYI 6 | Analyze and explain concepts of nuclear physics. |

1. **Investigate and apply principles of physical and chemical changes in matter.**
 - o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
 - p. Clarify research questions, and design laboratory investigations. (DOK 3)
 - q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
2. **Develop an understanding of concepts related to forces and motion.**

- i. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
 - Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- j. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- k. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- l. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
 - Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
 - k. Explain and apply the conservation of energy and momentum. (DOK 2)
 - Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
 - l. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
 - m. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
 - n. Investigate and summarize the principles of thermodynamics. (DOK 2)
 - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
 - o. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**
 - k. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
 - Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.

- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - l. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - m. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - n. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - o. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- g. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
 - h. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - i. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- e. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - f. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

- SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- o. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- p. Clarify research questions, and design laboratory investigations. (DOK 3)
- q. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

- r. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
 - s. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - t. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - u. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
- 2. Demonstrate the basic concepts of remote sensing. (E, P)**
- m. Describe the characteristics of the electromagnetic spectrum.
 - n. Using images and graphs, interpret the absorption/reflection spectrum.
 - o. Distinguish between passive vs. active sensor systems.
 - p. Analyze the effects of changes in spatial, temporal, and spectral resolution.
 - q. Analyze the effects on images due to changes in scale.
 - r. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- o. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- p. Formulate questions that can be answered through research and experimental design. (DOK 3)
- q. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- r. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- s. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- t. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- u. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- i. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- j. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- k. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- l. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenetic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- k. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- l. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- m. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- n. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- o. Contrast food chains and food webs. (DOK 2)
- 4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- e. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- f. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author’s Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

CONTREN CORE

SAF - Basic Safety

- Explain the role that safety plays in the construction crafts.
- Describe the meaning of jobsite safety.
- Describe the characteristics of a competent person and a qualified person.
- Explain the appropriate safety precautions to take around common jobsite hazards.
- Demonstrate the use and care of appropriate personal protective equipment (PPE).
- Properly don and remove personal protective equipment (safety goggles, hard hat, and personal fall protection).
- Follow the safety procedures required for lifting heavy objects.
- Describe safe behavior on and around ladders and scaffolds.
- Explain the importance of Hazard Communications (HazCom) and material safety data sheets (MSDSs).
- Describe fire prevention and firefighting techniques.
- Define safe work procedures to use around electrical hazards.

MAT - Introduction to Construction Math

- Add, subtract, multiply, and divide whole numbers, with and without a calculator.
- Use a standard ruler and a metric ruler to measure.
- Add, subtract, multiply, and divide fractions.
- Add, subtract, multiply, and divide decimals, with and without a calculator.
- Convert decimals to percentages and percentages to decimals.
- Convert fractions to decimals and decimals to fractions.
- Explain what the metric system is and how it is important in the construction trade.
- Recognize and use metric units of length, weight, volume, and temperature.
- Recognize some of the basic shapes used in the construction industry, and apply basic geometry to measure them.

HTO - Introduction to Hand Tools

- Recognize and identify some of the basic hand tools used in the construction trade.
- Use hand tools safely.
- Describe the basic procedures for taking care of hand tools.

PTO - Introduction to Power Tools

- Identify power tools commonly used in the construction trades.
- Use power tools safely.

- Explain how to maintain power tools properly.

BLU - Introduction to Blueprints

- Recognize and identify basic blueprint terms, components, and symbols.
- Relate information on blueprints to actual locations on the print.
- Recognize different classifications of drawings.
- Interpret and use drawing dimensions.

MBR - Basic Rigging

- Identify and describe the use of slings and common rigging hardware.
- Describe basic inspection techniques and rejection criteria used for slings and hardware.
- Describe basic hitch configurations and their proper connections.
- Describe basic load-handling safety practices.
- Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COM - Basic Communication Skills

- Demonstrate the ability to interpret information and instructions presented in both written and verbal form.
- Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

EMP - Basic Employability Skills

- Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.
- Demonstrate critical-thinking skills and the ability to solve problems using those skills.
- Demonstrate knowledge of computer systems, and explain common uses for computers in the construction industry.
- Demonstrate effective relationship skills with teammates and supervisors, the ability to work on a team, and appropriate leadership skills.
- Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

CONTREN METAL TRADES—FIRST YEAR - MACHINING

MOT - Orientation to the Trade

- Describe the types of work performed by millwrights.
- Identify career opportunities available to millwrights.
- Explain the purpose and objectives of an apprentice training program.

- Explain the responsibilities of a millwright.
- Explain the importance of safety in relation to millwrights.
- Explain the role of NCCER in the training process.

MHT - Millwright Hand Tools

- Explain the purpose of each of the tools commonly used by millwrights.
- Describe how to maintain each of the tools used by millwrights.
- Demonstrate the proper use of selected millwright tools.

MFA - Fasteners and Anchors

- Identify and explain the use of threaded fasteners.
- Identify and explain the use of non-threaded fasteners.
- Identify and explain the use of anchors.
- Select the correct fasteners and anchors for given applications.
- Install fasteners and anchors.

MBL - Basic Layout

- Identify layout tools, and explain their uses.
- Lay out baselines using the arc method.
- Lay out baselines using the 3-4-5 method.
- Scribe straight lines.
- Scribe perpendicular lines to baselines using a square.
- Scribe perpendicular lines to an edge using a combination square.
- Scribe angled lines using a combination square and a protractor.
- Scribe circles using dividers and trammel points.
- Scribe perpendicular lines from baselines using dividers and reference points.
- Bisect lines using dividers.
- Divide a line into equal parts.
- Divide a circle into equal parts.
- Lay out equipment locations.

MGO - Gaskets and O-rings

- Identify the various types of gaskets, and explain their uses.
- Identify the various types of gasket materials, and explain their applications.
- Lay out, cut, and install a flange gasket.
- Describe the use of O-rings.
- Explain the importance of selecting the correct O-ring for an application.
- Select an O-ring for a given application, and install it.

MOC - Oxy-fuel Cutting

- Identify and explain the use of oxy-fuel cutting equipment.
- Set up oxy-fuel cutting equipment.
- Light and adjust an oxy-fuel torch.
- Shut down oxy-fuel cutting equipment.
- Disassemble oxy-fuel cutting equipment.
- Change empty cylinders.
- Perform oxy-fuel cutting.
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing
- Operate a motorized, portable oxy-fuel gas cutting machine.

MIM - Intermediate Trade Math

- Use ratios and proportions.
- Solve basic algebra problems.
- Solve area problems.
- Solve volume problems.
- Solve circumference problems.
- Solve circular speed problems.
- Use tables.

MFS - Field Sketching

- Sketch straight lines.
- Sketch angles.
- Sketch arcs and circles.
- Sketch ellipses.
- Sketch dimensions.
- Make orthographic sketches.
- Make pictorial sketches.

MIB - Intermediate Blueprint Reading

- Explain orthographic projection.
- Interpret schematic drawings.
- Interpret isometric drawings.

MST - Specialty Tools

- Use torque multipliers.

- Use cable cutters.
- Use nut splitters.
- Use keyseat rules.
- Use depth gauges.
- Use bevels.
- Use telescoping gauges.
- Use radius gauges.
- Use drill gauges.
- Use thickness gauge stock.
- Use a plasti-gauge.
- Explain hardness testers.
- Explain surface roughness testers.

MPT - Power Tools

- Explain power tool safety.
- Use and care for drill presses.
- Use and care for hydraulic presses.
- Use and care for pipe threading machines.
- Use and care for nibblers.
- Use and care for band saws.
- Identify and explain belt sanders.
- Identify and explain Woodruff keyseaters.
- Identify and explain key broaches.
- Use and care for bearing heaters.
- Use and care for drills.
- Perform precision drilling.

MRG - Rigging

- Identify and describe the uses of common rigging hardware and equipment.
- Inspect common rigging equipment.
- Select, use, and maintain special rigging equipment, including the following:
 - Chain hoists
 - Come-alongs
 - Jacks
 - Tugger
- Tie knots used in rigging.
- Use and understand the correct hand signals to guide a crane operator.
- Identify basic rigging and crane safety procedures.

- Explain load balancing.

MAM - Advanced Trade Math

- Use right triangle trigonometry.
- Solve acute right triangles.

MPT - Precision Measuring Tools

- Use levels.
- Use feeler gauges.
- Use calipers.
- Use micrometers.
- Use dial indicators.
- Use protractors.
- Use parallels and gauge blocks.
- Use trammels.
- Use precision straightedges.
- Use speed measurement tools.
- Use pyrometers.

CONTREN METAL TRADES—SECOND YEAR - WELDING

WSS - Welding Safety

- Identify some common hazards in welding.
- Explain and identify proper personal protection equipment used in welding.
- Demonstrate how to avoid welding fumes.
- Explain some of the causes of accidents.
- Identify and explain uses for material safety data sheets (MSDSs).
- Demonstrate safety techniques for storing and handling cylinders.
- Explain how to avoid electric shock when welding.
- Demonstrate proper material handling methods.

WOC - Oxy-fuel Cutting

- Identify and explain the use of oxy-fuel cutting equipment.
- Set up oxy-fuel equipment.
- Light and adjust an oxy-fuel torch.
- Shut down oxy-fuel cutting equipment.
- Disassemble oxy-fuel equipment.
- Change empty cylinders.
- Perform oxy-fuel cutting.

- Straight line and square shapes
- Piercing and slot cutting
- Bevels
- Washing
- Gouging
- Operate a motorized, portable oxy-fuel gas cutting machine.

BMP - Base Metal Preparation

- Clean base metal for welding or cutting.
- Identify and explain joint design.
- Explain joint design considerations.
- Using a nibbler, cutter, or grinder, mechanically prepare the edge of a mild steel plate 1/4-in. to 3/4-in. thick at 22 1/2° (or 30° depending on equipment available).
- Using a nibbler, cutter, or grinder, mechanically prepare the end of a pipe with a 30° or 37 1/2° bevel (depending on equipment available) and a 3/32-in. land. Use 6-in., 8-in., or 10-in. Schedule 40 or Schedule 80 mild steel pipe.
- Select the proper joint design based on a welding procedure specification (WPS) or instructor direction.

WQT - Weld Quality

- Identify and explain codes governing welding.
- Identify and explain weld imperfections and their causes.
- Identify and explain nondestructive examination practices.
- Identify and explain welder qualification tests.
- Explain the importance of quality workmanship.
- Identify common destructive testing methods.

SWS - Equipment and Setup (SMAW)

- Identify and explain shielded metal arc welding (SMAW) safety.
- Identify and explain welding electrical current.
- Identify and explain arc welding machines.
- Explain setting up arc welding equipment.
- Set up a machine for welding.
- Identify and explain tools for weld cleaning.

SES - Electrodes and Selection (SMAW)

- Identify factors that affect electrode selection.
- Explain the American Welding Society (AWS) and the American Society of Mechanical Engineers (ASME) filler metal classification system.

- Identify different types of filler metals.
- Explain the storage and control of filler metals.
- Explain filler metal traceability requirements and how to use applicable code requirements.
- Identify and select the proper electrode for an identified welding task.

SBF - Beads and Fillet Welds (SMAW)

- Set up shielded metal arc welding (SMAW) equipment.
- Describe methods of striking an arc.
- Properly strike and extinguish an arc.
- Describe causes of arc blow and wander.
- Make stringer, weave, and overlapping beads.
- Make fillet welds in the following positions:
 - Horizontal (2F) position
 - Vertical (3F) position
 - Overhead (4F) position

GWB - Groove Welds with Backing (SMAW)

- Identify and explain groove welds.
- Identify and explain groove welds with backing.
- Set up shielded metal arc welding (SMAW) equipment for making V-groove welds.
- Perform SMAW for V-groove welds with backing in the following positions:
 - Flat (1G) position
 - Horizontal (2G) position
 - Vertical (3G) position
 - Overhead (4G) position

JFA - Joint Fit-up and Alignment

- Identify and explain job code specifications.
- Use fit-up gauges and measuring devices to check joint fit-up.
- Identify and explain distortion and how it is controlled.
- Fit up joints using plate and pipe fit-up tools.
- Check for joint misalignment and poor fit-up before and after welding.

WSY - Welding Symbols

- Identify and explain the various parts of a welding symbol.
- Identify and explain fillet and groove weld symbols.
- Read welding symbols on drawings, specifications, and welding procedure specifications.

- Interpret welding symbols from a print.
- Draw welding symbols based on the observation of actual welds.

RWD - Reading Welding Detail Drawings

- Identify and explain a welding detail drawing.
- Identify and explain lines, material fills, and sections.
- Identify and explain object views.
- Identify and explain dimensioning.
- Identify and explain notes and bill of materials.
- Interpret basic elements of a welding detail drawing.
- Develop basic welding drawings.

PAC - Plasma Arc Cutting (PAC)

- Identify and understand plasma arc cutting processes.
- Identify plasma arc cutting equipment.
- Prepare and set up plasma arc cutting equipment.
- Use plasma arc cutting equipment to make various types of cuts.
- Properly store equipment and clean the work area after use.

GFM - Equipment and Filler Metals (GMAW and FCAW)

- Explain gas metal arc welding (GMAW) and flux cored arc welding (FCAW) safety.
- Explain the characteristics of welding current and power sources.
- Identify and explain the use of GMAW and FCAW equipment.
 - Spray transfer
 - Globular
 - Short circuiting
 - Pulse
- Identify and explain the use of GMAW and FCAW shielding gases and filler metals.
- Set up GMAW and FCAW equipment, and identify tools for weld cleaning.

GFP - GMAW and FCAW – PLATE

- Perform GMAW multiple-pass fillet welds on plate, using solid or composite wire and shielding gas in multiple positions.
- Perform GMAW multiple-pass open-root V-groove welds on plate, using solid or composite wire and shielding gas, in multiple positions.
- Perform GMAW spray fillet and open-root V-groove welds on plate, using solid or composite wire and shielding gas, in flat and horizontal positions.
- Perform FCAW multiple-pass fillet welds on plate in multiple positions using flux cored wire and, if required, shielding gas.

- Perform FCAW multiple-pass open-root V-groove welds on plate in multiple positions using flux cored wire and, if required, shielding gas.

TFM - Equipment and Filler Metals (GTAW)

- Explain gas tungsten arc welding (GTAW) safety.
- Identify and explain the use of GTAW equipment.
- Identify and explain the use of GTAW filler metals.
- Identify and explain the use of GTAW shielding gases.
- Set up GTAW equipment.

TPW - Plate (GTAW)

- Build a pad in the flat position with stringer beads using GTAW and carbon steel filler metal.
- Make multiple-pass open-root V-groove welds on carbon steel plate in the 1G (flat) position using GTAW and carbon steel filler metal.
- Make multiple-pass open-root V-groove welds on carbon steel plate in the 2G (horizontal) position using GTAW and carbon steel filler metal.
- Make multiple-pass open-root V-groove welds on carbon steel plate in the 3G (vertical) position using GTAW and carbon steel filler metal.
- Make multiple-pass open-root V-groove welds on carbon steel plate in the 4G (overhead) position using GTAW and carbon steel filler metal.

PTM - Preheating and Post-weld Heat Treatment of Metals

- Explain how to preheat metals.
- Describe maintaining interpass temperature.
- Explain post-weld heat treatment of metals.
- Identify and explain the effects of welding on metals.
 - Heat-affected zone (HAZ)
 - Cracking
 - Face changes/grain structure

CPM - Physical Characteristics and Mechanical Properties of Metals

- Identify and explain the composition and classification of base metals.
- Explain and demonstrate field identification methods for base metals.
- Identify and explain the physical characteristics and mechanical properties of metals.
- Identify and explain forms and shapes of structural metals.
- Explain metallurgical considerations for welding metals.

National Institute for Metalworking Skills (NIMS)

NIMS Machining Level 1

L1B - Benchwork

Given a process plan, blueprint, and access to hand tools, produce a part with two holes prepared for hand tapping, a hole prepared (reamed) for the press fit of a bushing, and a stud for one of the tapped holes. Deburr the part, hand drill and hand tap the holes, press in the bushing, and install the stud. File chamfer.

Other Evaluation Criteria

1. Free of sharp edges or burrs
2. Go/NoGo gauge for the threads
3. Length of stud within 0.03 of basic dimension and square to surface

Accuracy Level: +/- 0.015 unless otherwise specified on the blueprint

L1L - Layout

Given a surface plate, surface gage, layout height gage, combination set, scribe, layout ink, prick punch, ball-peen hammer, process plan, and part print, lay out hole locations, radii, and surfaces matching the specifications.

Other Evaluation Criteria

1. Layout ink is applied to the surface appropriately.
2. Lines are struck once.
3. Intersections are clean and clear.
4. Punch marks are centered on intersections.

Accuracy Level: +/- 0.015 unless otherwise specified on the blueprint

1VM - Vertical Milling

Given raw material, print, hand, precision, and cutting tools, as well as access to an appropriate vertical milling machine and its accessories, produce a part matching the blueprint specifications using appropriate trade techniques and speeds and feeds. The part specified should require squaring up from the raw state, have at least one milled slot, require the location of at least two drilled and reamed holes within positional tolerance of 0.014 in., and have three steps controlled by tolerances of +/- 0.005 in.

Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.

2. No sharp edges

Accuracy Level: +/- 0.015 on all fractions, +/- 0.005 on all decimals unless otherwise specified on the blueprint

Finished surfaces are to be square within 0.005 over 4 in.

Finished surfaces are to be 125 Ra microinches unless otherwise specified.

1DP - Drill Press

Given a part print and hand, precision, and cutting tools, as well as access to a drill press and its accessories, produce a part matching the process plan and the blueprint specifications. Each hole must have at least two secondary operations. The secondary operations will consist of reaming, spot facing, countersinking, counterboring, and counterdrilling. At least one hole must be a blind hole and one a through hole. At least one hole will/may be power tapped.

Other Evaluation Criteria

1. Finishes are at least 250 Ra microinches.
2. No sharp edges
3. The mouths of all holes are lightly countersunk.

Accuracy Level: +/- 1/64 on all fractions, holes square within 0.005 per inch, drilled diameters, +0.006, -0.000

Reamed diameters are +0.001, -0.000, +/- 0.005 on all decimals unless otherwise specified on the blueprint.

1SG - Surface Grinding

Given a block squared up on a mill, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel, produce a part matching the print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been squared up and milled. Finishing the part will require the precision finishing of the six faces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Other Evaluation Criteria

1. Finishes are at least 32 Ra microinches or better.
2. Free of sharp edges

Accuracy Level: +/- 0.001 on all decimals unless otherwise specified on the print. Square within 0.001 over 4 in.

1TB - Turning – Between Centers

Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within ± 0.002 , one UNC external thread, one UNF external thread, and require part be turned end for end to complete.

Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.
2. No sharp edges

Accuracy Level: ± 0.015 on all fractions, ± 0.005 on all decimals unless otherwise specified on the part print

Diameters are to be coaxial within 0.002 total runout.

1TC - Turning – Chucking

Given raw material, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least three diameters within ± 0.005 in., two bores within ± 0.005 in., one UNC external thread, and require at least two chuckings or other workholding setup.

Other Evaluation Criteria

1. Finishes are at least 125 Ra microinches.
2. No sharp edges

Accuracy Level: ± 0.015 on all fractions, ± 0.005 on all decimals unless otherwise specified on the blueprint

Diameters are to be coaxial within 0.002 total runout.

1CM - CNC Milling

Performance Standard

Write a program at the machine or off-line. Set up the machining operation, and perform standards given on mill operations (2.10) to develop a simple part (with linear and circular interpolations).

Accuracy Level: Match the requirements of the part print and 63 Ra microinch finish.

1CT - CNC Turning

Performance Standard

Write a program at the machine or off-line. Set up the machining operation, and perform all standards given on lathe operations (2.9) to develop a simple part (with linear and circular interpolations).

Accuracy Level: Match the requirements of the part print.

NIMS Machining Level II

2TB - Turning – Between Centers

Given raw material, process plan, part print, and hand, precision, and cutting tools, as well as access to an appropriate turning machine and its accessories, produce a part matching the process plan and the part print specifications using appropriate trade techniques and speeds and feeds. The part specified should have at least two straight diameters within ± 0.001 and an appropriate taper at each end of the part, and it should require a reversal of the part end for end.

Accuracy Level: ± 0.015 on all fractions and ± 0.005 on all decimals unless otherwise specified on the part print. Diameters are to be concentric within 0.001 TIR.

Surface finish of 63 Ra microinches or better

2TC - Turning – Chucking

Given a print detailing a part requiring milling, drilling, turning, and grinding, verbal instructions, and appropriate references, formulate a set of strategies to manufacture the part, and write a detailed process plan including a quality plan for that part. Provide sketches as needed. Make a presentation explaining each of the process plan steps to be taken; identify all major components and functions of the machine tools, all major hand tools, measuring tools, tools and fixtures, and work materials; and provide the rationale for the speeds and feeds selected.

2PL - Milling – Precision Locations

Produce three bores to specification. The holes will be between 0.75 and 1.5, and their locations are to be held within ± 0.001 and hold diameters within ± 0.0005 . One hole is to be counterbored to a decimal depth holding ± 0.002 and counterbore diameter within ± 0.005 .

Accuracy Level: ± 0.005 on all decimals unless otherwise specified on the part print and 63 microinch finish

2FA - Grinding – Flats and Angles

Given a block roughed out on a mill, a process plan, part print, hand and precision tools, and choice of a grinding wheels, as well as access to a surface grinder and its accessories, dress the wheel and grind the specified radii and angled surfaces to a finish matching the process

plan and the part print specifications using appropriate trade techniques. The part specified will be in the semi-finished state having been roughed out. Finishing the part will require the precision finishing of the specified surfaces of the block to tolerances common to precision grinding for squareness, size, and surface finish characteristics.

Accuracy Level: +/- 0.0005 on all decimals unless otherwise specified on the part print

Square within 0.0001 over 1 in. Angles are to be held within +/- 15'. Radii +/- 001

2CG - Cylindrical Grinding

Dress the wheel. Given a part rough finished on three diameters, mount the part between centers and grind the required diameters to finish.

Accuracy Level: +/- 0.005 on decimals, +/- 0.0005 on ground diameters

2CM - CNC Milling

Given a CNC mill, create a qualified CNC program, set up and operate the mill, change tool values as necessary, and replace and qualify tooling as necessary.

Accuracy Level: Match the requirements of the part print and 63 Ra microinch finish.

2CT - CNC Turning

Given a CNC lathe, create a qualified CNC program, set up and operate the lathe, change tool values as necessary, and replace and qualify tooling as necessary.

Accuracy Level: Match the requirements of the part print and 63 Ra microinch finish.

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Marketing and Economics Executive Summary.....	245
Course Outlines.....	247
Marketing and Economics I Competencies and Objectives	250
Marketing and Economics II Competencies and Objectives	256
Marketing and Economics I Competency Profile.....	261
Marketing and Economics II Competency Profile.....	263
Appendix A: 21st Century Skills Standards	265
Appendix B: MS Academic Standards	267
Appendix C: ACT College Readiness Standards.....	297
Appendix D: Pathway Content Standards.....	312
Appendix E: National Educational Technology Standards for Students	316

Marketing and Economics Executive Summary

Program Description

Business Marketing and Economics programs provide instruction in basic business and marketing skills. Courses in the program provide a foundation of skills and knowledge related to basic principles of marketing, related economic fundamentals, management, merchandising, communications and career development, personal and business finance, human relations, ethics, and business etiquette. Instruction is also provided on specialized topics related to fashion, international marketing, e-commerce, entrepreneurship, financial marketing/stock market, as well as sports, special events and entertainment marketing.

Industry Certifications

This document was developed according to national standards for marketing education, as prepared by the National Marketing Education Resource Center, 2000; the National Educational Technology Standards for Students (NETS), 2000–02, developed by the International Society for Technology in Education (ISTE); and the SCANS Competencies published by the U.S. Department of Labor, 1992.

Articulation

An articulation agreement is currently under development. As soon as the agreement is finalized, this document will be updated to reflect the proposed agreement.

Assessment

Students will be assessed using the Secondary Marketing and Economics CPAS2 test. This exam will be administered to students after the completion of the fourth Carnegie unit.

Student Pre-requisites

In order for students to be able to experience success in the Secondary Marketing and Economics program, the following student prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in Pre-Algebra
3. Instructor approval

or

1. TABE Reading Score (Eighth grade or higher)

or

1. Instructor approval

Applied Academic Credit

Personal Finance content from the curriculum was aligned to the 2004 Mississippi Personal Finance Framework Revised Academic Benchmarks. Upon the completion of this program, students will earn 1/2 Personal Finance credit that can be used for graduation requirements. The curriculum framework includes economics content aligned to the 2004 Mississippi Economics Framework Revised Academic Benchmarks. Upon completion of this program, students will earn 1/2 Economics credit to meet graduation requirements.

Licensure Requirements

The 956 licensure endorsement is needed to teach the Marketing and Economics program. The requirements for the 956 licensure endorsement are listed below:

1. New teachers hired after June 30, 2008, must have a BS or BA degree in an appropriate field.
2. Hold one of the following endorsements:
 - a. 105 Business Education (7–12)
 - b. 318 Marketing (7–12)
 - c. 192 Social Studies (7–12)
 - d. 193 Economics (7–12)
3. Applicants must successfully complete the Master Teacher of Economics certification.
4. Applicants must successfully complete an approved computer literacy certification exam.
5. Applicants must successfully complete a certification for an online learning workshop, module, or course that is approved by the Mississippi Department of Education.
6. Applicants must successfully complete a certification workshop, module, or course that is approved by the Mississippi Department of Education.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

Options for Delivery

This curriculum framework provides multiple options for local school districts to implement based on the local needs of industry and students.

Option 1

- The Marketing and Economics program is presented in two courses: Marketing and Economics I, which is taken during the first year of the program, and Marketing and Economics II, which is taken during the second year. Marketing and Economics I includes training in basic business skills and provides a foundation for in-depth applications in the Marketing and Economics II course.

Business and Marketing Fundamentals (2 Carnegie Units)

Course Code: 992300

Unit	Title	Hours
1	Introduction to Business	10
2	Communication and Interpersonal Skills	20
3	Professional Development	15
4	Economics	70
5	Business, Management, and Entrepreneurship	55
6	Business Law	30
7	Personal Finance	30
	Total	230

Marketing and Economics (2 Carnegie Units)

Course Code: 992400

Unit	Title	Hours
8	Introduction to Marketing	25
9	Pricing	20
10	Promotion	35
11	Selling	35
12	Product/Service Management	20
13	Distribution	20
14	Marketing Planning	20
15	International Marketing	20
16	Fashion Marketing	20
17	Sports, Special Events, and Entertainment Marketing	20
	Total	235

Option 2

- This option consists of four courses that should be completed in the following sequence:
- Introduction to Marketing includes basic business skills including introduction to business, communication and interpersonal skills, professional development, and economics. Business Management, Law, and Operations provides opportunities for students to apply management and entrepreneurship skills. Marketing Essentials encompasses introductory marketing concepts. Sales and Distribution provides advanced marketing skills.

Business and Marketing Fundamentals, Part A (1 Carnegie Unit)

Course Code: 992301

Unit	Title	Hours
1	Introduction to Business	10
2	Communication and Interpersonal Skills	20
3	Professional Development	15
4	Economics	70
	Total	115

Business and Marketing Fundamentals, Part B (1 Carnegie Unit)

Course Code: 992302

Unit	Title	Hours
5	Business, Management, and Entrepreneurship	55
6	Business Law	30
7	Personal Finance	30
	Total	115

Marketing Essentials (1 Carnegie Unit)

Course Code: 992401

Unit	Title	Hours
8	Introduction to Marketing	25
9	Pricing	20
10	Promotion	35
11	Selling	35
	Total	115

Sales and Distribution (1 Carnegie Unit)

Course Code: 992402

Unit	Title	Hours
12	Product Service Management	20
13	Distribution	20
14	Marketing Planning	20
15	International Marketing	20
16	Fashion Marketing	20
17	Sports, Special Events, and Entertainment Marketing	20
	Total	120

Marketing and Economics I Competencies and Objectives

Unit 1: Introduction to Business

1. Identify school and program policies and procedures. (DOK 1)
 - a. Preview the school handbook and all safety procedures for the classroom level and building level. (DOK 1)
2. Discuss the purpose of the course. (DOK 1)
 - a. Identify student and course expectations. (DOK 1)
 - b. Explore student organizations and their roles in individual career development. (DOK 1)
3. Implement Green Business Practices. (DOK 3)
 - a. Discuss the importance of Green Business Practices. (DOK 1)
 - b. Discuss the financial implications of Green Business Practices. (DOK 2)
 - c. Implement Green Business Practices in the classroom. (DOK 3)

Unit 2: Communication and Interpersonal Skills

1. Apply the fundamentals of communication. (DOK 2)
 - a. Discuss elements of effective written and oral communications, listening skills, and communication barriers. (DOK 1)
 - b. Demonstrate effective verbal and nonverbal communication principles. (DOK 2)
 - c. Demonstrate use of proper telephone techniques. (DOK 2)
 - d. Deliver oral presentations to inform, persuade, and entertain. (DOK 2)
 - e. Demonstrate appropriate netiquette for electronic communication. (DOK 2)
2. Demonstrate interpersonal skills that contribute to positive work relationships. (DOK 2)
 - a. Demonstrate teamwork skills. (DOK 1)
 - b. Develop skills needed to maintain effective working relationships. (DOK 2)
3. Demonstrate the ability to interact and handle conflict in the business environment. (DOK 2)
 - a. Demonstrate the use of proper procedures for solving customer issues using effective customer service skills. (DOK 2)
 - b. Demonstrate problem-solving and negotiation skills. (DOK 2)

Unit 3: Professional Development

1. Research career opportunities and employment skills. (DOK 2)
 - a. Apply criteria for self-development. (DOK 1)
 - b. Explore career opportunities in business. (DOK 2)

- c. Create an application letter, resume, follow-up letter, and letter of resignation. (DOK 2)
 - d. Demonstrate appropriate interview skills. (DOK 2)
- 2. Demonstrate appropriate workplace ethics. (DOK 2)
 - a. Critique the behavior of entrepreneurs, businesses, and/or managers to determine whether their actions and decisions are ethical. (DOK 2)
 - b. Discuss privacy issues and safeguarding information in the business environment. (DOK 1)
 - c. Explain concepts of sexual harassment and a hostile work environment. (DOK 2)
 - d. Discuss ethical ways of communicating and the consequences of unethical conduct. (DOK 1)
 - e. Explain the employee's role in expense control. (DOK 1)
 - f. Discuss the role of ethics in operations. (DOK 2)
- 3. Demonstrate appropriate business etiquette skills. (DOK 3)
 - a. Demonstrate appropriate greetings and introductions. (DOK 2)
 - b. Demonstrate appropriate table etiquette in a business setting. (DOK 2)
 - c. Compare and contrast international business etiquette strategies. (DOK 2)

Unit 4: Economics

- 1. Apply basic economic concepts. (DOK 1)
 - a. Define terms and concepts related to economics. (DOK 1)
 - b. Construct and graph supply and demand schedules. (DOK 2)
 - c. Describe how the laws of supply and demand interact. (DOK 1)
 - d. Analyze the importance of imports and exports. (DOK 1)
 - e. Compare the relationship of microeconomics and macroeconomics. (DOK 1)
 - f. Discuss production and production activities. (DOK 1)
- 2. Examine the characteristics of economic systems, and discuss the relationships among them. (DOK 2)
 - a. Compare the types of economic systems. (DOK 1)
 - b. Discuss the meaning of economic freedom and its essential elements. (DOK 1)
 - c. Discuss the role of organized labor on the United States economy. (DOK 2)
 - d. Describe the American banking system. (DOK 1)
 - e. Compare and contrast domestic and global economic systems. (DOK 2)
 - f. Explain the operation of the stock market. (DOK 1)
- 3. Examine economic indicators and trends such as production, distribution, and consumption of goods and services. (DOK 2)
 - a. Discuss economic indicators. (DOK 1)

- b. Define and discuss the terms “consumer price index” and “gross domestic product.” (DOK 1)
 - c. Explain how unemployment impacts the economy. (DOK 2)
 - d. Explain how economists compute a country’s standard of living. (DOK 1)
 - e. Explain how the scarcity of productive resources (e.g., human, capital, technological, natural, etc.) requires the development of economic systems to make decisions about how goods and services are produced and distributed. (DOK 2)
4. Demonstrate the ability to apply and interpret social studies tools (e.g., timelines, maps, globes, graphs, charts, a compass, technology, primary and secondary documents, political cartoons, etc.). (DOK 2)
- a. Interpret special purpose maps. (DOK 2)
 - b. Analyze information on graphs, charts, tables, and timelines. (DOK 3)
 - c. Analyze political cartoons. (DOK 2)
 - d. Utilize primary and secondary sources. (DOK 2)

Unit 5: Business, Management, and Entrepreneurship

1. Identify potential business threats and opportunities to protect a business’s financial well-being. (DOK 3)
 - a. Describe the concept of insurance. (DOK 1)
 - b. Obtain insurance coverage. (DOK 3)
 - c. Settle insurance losses. (DOK 2)
2. Discuss fundamental concepts of business to include business risk. (DOK 1)
 - a. Discuss the role of business in society. (DOK 1)
 - b. Describe the types of business ownership to include sole proprietorship, partnership, and corporation. (DOK 1)
 - c. Discuss ways business is regulated by government. (DOK 1)
 - d. Explain the role of insurance in reducing business risk. (DOK 1)
3. Discuss the fundamental functions of marketing management. (DOK 1)
 - a. Describe the seven functions of marketing to include financing, information management, distribution, product/service management, pricing, promotion, and selling. (DOK 1)
 - b. Discuss the functions of management to include planning, organizing, implementing, and controlling. (DOK 1)
 - c. Explain levels of management to include top, middle, and supervisory, and explain vertical and horizontal management. (DOK 1)
 - d. Differentiate among leadership styles to include autocratic (directive), democratic (consultative), and laissez-faire (participative). (DOK 1)
 - e. Discuss the qualities that determine an effective supervisor. (DOK 1)

4. Research entrepreneurship opportunities. (DOK 4)
 - a. Review the definition of entrepreneurship. (DOK 1)
 - b. Research opportunities for business ventures. (DOK 1)
 - c. Analyze components of a business plan. (DOK 4)
 - d. Determine sources of funding for venture creation/start-up. (DOK 1)
 - e. Design a business layout. (DOK 3)
 - f. Define start-up costs for a business. (DOK 1)

Unit 6: Business Law

1. Discuss business laws and regulations. (DOK 1)
 - a. Describe legal and ethical considerations for businesses including patents, copyrights, and trademarks. (DOK 1)
 - b. Discuss human resource and workplace regulations including Occupational Health and Safety (OSHA) Standards Act, Equal Employment Opportunity (EEO) Act, Americans with Disabilities Act, Family Medical Leave Act, and Fair Labor Standards Act. (DOK 1)
 - c. Describe basic torts. (DOK 1)
 - d. Discuss business tax regulations including reasons for taxes, uses of tax monies, income tax, Social Security (FICA) withholdings, sales tax, property tax, and payroll tax. (DOK 1)
 - e. Identify health concerns. (DOK 1)
 - f. Review safety procedures for a given career field. (DOK 1)
 - g. Investigate federal safety regulations and procedures for reporting noncompliance. (DOK 1)
2. Determine the various aspects of contract law. (DOK 1)
 - a. Describe the four types of contracts including expressed, implied, unilateral, and bilateral. (DOK 1)
 - b. Discuss contractual concept of mistake, misrepresentation, and fraud. (DOK 1)
3. Determine legalities of borrowing money and paying bills. (DOK 1)
 - a. Define various types of negotiable instruments, such as checks, contracts, bill of sale, types of stock, bonds, and documents of title. (DOK 1)
 - b. Explain the difference in a secured and unsecured credit transaction. (DOK 1)
 - c. Discuss the laws prohibiting abuses in credit. (DOK 1)
 - d. Discuss various types and aspects of bankruptcy. (DOK 1)
4. Define and discuss sales and property law. (DOK 1)
 - a. Define the legal aspects of a bill of sale. (DOK 1)
 - b. Determine the rights of the seller and buyer in a contractual agreement. (DOK 1)

Unit 7: Personal Finance

1. Explain the fundamental principles of financial exchanges. (DOK 2)
 - a. Explain forms of financial exchange. (DOK 1)
 - b. Identify types of currency. (DOK 1)
 - c. Describe functions of money. (DOK 1)
 - d. Describe sources of income. (DOK 1)
 - e. Explain the time value of money. (DOK 1)
 - f. Explain the purposes and importance of credit. (DOK 2)
 - g. Explain legal responsibilities associated with financial exchanges. (DOK 1)
2. Manage personal finances to achieve financial goals. (DOK 3)
 - a. Discuss financial needs. (DOK 2)
 - b. Set financial goals. (DOK 2)
 - c. Develop personal budgets. (DOK 1)
 - d. Discuss tax liabilities. (DOK 1)
 - e. Interpret a pay stub. (DOK 1)
 - f. Read and reconcile bank statements. (DOK 2)
 - g. Maintain financial records. (DOK 1)
 - h. Discuss strategies for the wise use of credit. (DOK 3)
 - i. Explain the importance of maintaining a positive credit history. (DOK 2)
 - j. Protect against identity theft. (DOK 1)
 - k. Prepare personal income tax forms. (DOK 3)
3. Recognize the role of financial services providers in achieving financial goals. (DOK 2)
 - a. Describe types of financial services providers. (DOK 1)
 - b. Discuss considerations for selecting a financial services provider. (DOK 2)
4. Apply investment strategies to ensure financial well-being. (DOK 2)
 - a. Explain types of investments. (DOK 2)
 - b. Explain the nature of capital investment. (DOK 2)
 - c. Establish investment goals and objectives. (DOK 2)
5. Apply payroll concepts. (DOK 3)
 - a. Compare and calculate the various types of pay schedules. (DOK 1)
 - b. Calculate pay for hourly wage employees including overtime pay, piece rate pay, salary, straight and variable (graduated) commission, and salary plus commission. (DOK 2)
 - c. Calculate time worked per day, week, and pay period (including overtime). (DOK 2)
 - d. Use tax tables to determine federal income tax withheld. (DOK 1)
 - e. Use the percentage method to determine federal income tax withheld. (DOK 2)
 - f. Use a given percent to calculate state income tax. (DOK 2)

- g. Use a variable tax base (graduated income basis) to calculate state income tax. (DOK 2)
- h. Calculate Social Security taxes to be withheld. (DOK 2)
- i. Calculate Medicare taxes to be withheld. (DOK 2)
- j. Analyze legislative history and the presidential role in the creation of the federal income tax, Social Security, and Medicare. (DOK 3)
- k. Calculate employee's share of health insurance deductions. (DOK 1)
- l. Calculate net pay. (DOK 1)
- m. Complete an earnings statement. (DOK 1)
- n. Complete a payroll register. (DOK 3)
- o. Prepare Form W4 to demonstrate the practices of citizenship for participation in a democratic society. (DOK 2)
- p. Prepare a 1040EZ income tax return. (DOK 3)

Marketing and Economics II Competencies and Objectives

Unit 8: Introduction to Marketing

1. Explain the role of marketing in everyday business functions. (DOK 3)
 - a. Explain marketing and its importance in a global economy. (DOK 2)
 - b. Describe marketing functions and related activities. (DOK 1)
2. Compare and contrast customer, client, and business behavior. (DOK 3)
 - a. Define customer, client, and business behavior. (DOK 1)
 - b. Determine actions or procedures employees can implement in order to achieve a desired result. (DOK 3)
 - c. Relate how company actions affect results. (DOK 2)

Unit 9: Pricing

1. Explain the pricing function. (DOK 4)
 - a. Analyze the process involved in effective pricing. (DOK 4)
 - b. Describe the role of business ethics in pricing. (DOK 1)
 - c. Explain the use of technology in the pricing function. (DOK 2)
 - d. Research legal considerations for pricing. (DOK 2)
2. Explain the factors that affect pricing decisions and calculate prices. (DOK 3)
 - a. Describe strategies for pricing products and services. (DOK 2)
 - b. Explain product-mix pricing strategies. (DOK 2)
 - c. Identify the basic rules for setting prices. (DOK 1)
 - d. Calculate and identify problems to determine price. (DOK 2)
 - e. Determine the cost of product. (DOK 2)

Unit 10: Promotion

1. Explain promotion as a marketing function. (DOK 2)
 - a. Apply the communication process used in promotion. (DOK 1)
 - b. Identify the roles of promotion as a marketing function. (DOK 1)
 - c. Differentiate among the types of promotion. (DOK 2)
 - d. Identify the elements of the promotional mix. (DOK 2)
 - e. Recognize the impact of negative business ethics in promotion. (DOK 2)
2. Explain the role of advertising as part of a promotional mix. (DOK 3)
 - a. Identify the types of advertising media. (DOK 1)
 - b. Identify and use the components of advertising. (DOK 1)
 - c. Critique and select the most effective direct advertising methods. (DOK 3)
 - d. Calculate media costs. (DOK 2)
 - e. Explain the components of advertisements. (DOK 2)
 - f. Evaluate effectiveness of advertising. (DOK 3)
 - g. Develop promotional mix for a product. (DOK 3)
 - h. Prepare a promotional budget. (DOK 3)

3. Explain the role of sales promotion as part of a promotional mix. (DOK 3)
 - a. List and define the types of sales and specialty promotions. (DOK 1)
 - b. Analyze the effectiveness of a sales promotion plan. (DOK 3)
4. Explain the role of publicity/public relations as part of a promotional mix. (DOK 3).
 - a. Differentiate between advertising and publicity. (DOK 2)
 - b. Evaluate the impact of public relations. (DOK 3)
 - c. Write a publicity release. (DOK 2)
 - d. Develop a public relations plan. (DOK 3)

Unit 11: Selling

1. Explain the factors that impact the selling function. (DOK 2)
 - a. Explain the importance of customer service as a component of selling. (DOK 2)
 - b. Identify the key factors in building a clientele. (DOK 1)
 - c. Evaluate the effectiveness of store selling policies. (DOK 2)
 - d. Recognize the impact of business ethics in selling. (DOK 2)
 - e. Explain the impact of technology in the selling function. (DOK 2)
 - f. Explain the purpose of selling regulations. (DOK 2)
2. Understand the need for development of product knowledge. (DOK 2)
 - a. Identify and apply methods to acquire product information for use in selling. (DOK 2)
 - b. Develop feature benefits charts. (DOK 2)
3. Explain the selling process, and demonstrate sales techniques. (DOK 2)
 - a. Identify and define the components of the selling process. (DOK 1)
 - b. Prepare for a sales presentation. (DOK 2)
 - c. Understand the impact of developing client/customer relationships. (DOK 2)
 - d. Demonstrate the methods of determining customer/client needs. (DOK 2)
 - e. Identify customers' buying motives for use in the sales process. (DOK 1)
 - f. Apply methods of facilitating customers' buying decisions. (DOK 2)
 - g. Differentiate between consumer and organizational buying. (DOK 2)
 - h. Demonstrate methods of recommending specific products. (DOK 2)
 - i. Apply techniques for demonstrating products. (DOK 2)
 - j. Demonstrate methods of recommending specific products. (DOK 2)
 - k. Demonstrate the process of prescribing solutions to customers' needs. (DOK 2)
 - l. Use methods to convert customers'/clients' objections into selling points. (DOK 2)
 - m. Demonstrate an effective sales closing. (DOK 2)
 - n. Apply suggestion selling techniques. (DOK 2)
4. Demonstrate support activities related to selling. (DOK 2)
 - a. Calculate mathematical problems related to selling. (DOK 2)
 - b. Demonstrate methods of prospecting. (DOK 2)
 - c. Create an effective sales letter. (DOK 2)

Unit 12: Product/Service Management

1. Demonstrate understanding of the nature and scope of the product/service management function. (DOK 2)

- a. Describe factors affecting product planning. (DOK 1)
- b. List the steps in new product/service planning. (DOK 1)
- c. Identify the impact of product life cycles on marketing decisions. (DOK 2)
- d. Demonstrate understanding of the concept of product positioning. (DOK 2)
- e. Debate ethics issues in product development. (DOK 2)
2. Design a product/service mix. (DOK 3)
 - a. Define and compare product mix strategies. (DOK 3)
 - b. Develop services to provide to customers. (DOK 2)
 - c. Analyze customer service options. (DOK 3)
3. Describe factors used by marketers to position a product, service, or business. (DOK 3)
 - a. Define branding elements. (DOK 1)
 - b. Explain the importance of branding in product planning. (DOK 2)
 - c. Classify branding strategies. (DOK 2)
 - d. Evaluate the impact of product packaging and labeling. (DOK 3)
4. Evaluate the importance of quality assurances on product/service management. (DOK 3)
 - a. Describe uses of grades and standards in marketing products. (DOK 2)
 - b. Distinguish different types of warranties and guarantees. (DOK 2)
 - c. Demonstrate the understanding of the importance of warranties and guarantees in product planning. (DOK 3)

Unit 13: Distribution

1. Examine the distribution process. (DOK 2)
 - a. Examine the channels of distribution. (DOK 1)
 - b. Explain the relationship between customer service and distribution. (DOK 2)
 - c. Describe the use of technology in the distribution process. (DOK 2)
 - d. Explain the legal and ethical considerations in the distribution process. (DOK 2)
2. Examine the process of warehousing and stock handling. (DOK 2)
 - a. Identify and describe the shipping and receiving processes. (DOK 1)
 - b. Explain and evaluate the concept of warehousing and storing. (DOK 2)
 - c. Demonstrate stock handling techniques used in receiving deliveries. (DOK 2)
 - d. Examine the types of inventory control systems. (DOK 2)

Unit 14: Marketing Planning

1. Develop a marketing plan using marketing information. (DOK 3)
 - a. Explain the concept of marketing strategies and identify market segments. (DOK 3)
 - b. Explain marketing planning. (DOK 2)
 - c. Conduct market analysis. (DOK 2)
 - d. Develop a marketing plan. (DOK 3)
2. Assess marketing strategies to improve return on marketing investment. (DOK 3)
 - a. Describe measures used to control marketing planning. (DOK 1)
 - b. Describe strategies used to link performance measures to financial outcomes. (DOK 3)
 - c. Interpret performance measures to determine financial outcomes. (DOK 3)

Unit 15: International Marketing

1. Understand marketing's role and function in business to facilitate economic exchanges with customers in the international business communities. (DOK 2)
 - a. Explain marketing and its importance in a global economy. (DOK 1)
 - b. Describe marketing functions and related activities as it relates to International Marketing. (DOK 1)
 - c. Assess global trends and opportunities. (DOK 2)
2. Understand the impact of global trade in business decision making. (DOK 3)
 - a. Explain the nature of global trade. (DOK 2)
 - b. Identify the effects of global trade on retailing. (DOK 3)
 - c. Explain current retail trends driven by global trade. (DOK 2)
 - d. Describe the determinants of exchange rates and their effects on the domestic economy. (DOK 1)
 - e. Discuss the impact of cultural and social environments on global trade. (DOK 1)
 - f. Explain labor issues associated with global trade. (DOK 2)

Unit 16: Fashion

1. Explain the basic concepts of fashion marketing. (DOK 2)
 - a. Define terms commonly used in the fashion marketing industry. (DOK 1)
 - b. Differentiate among the different phases of the fashion cycle. (DOK 2)
 - c. Distinguish between fads and classics. (DOK 2)
 - d. Compare the five predominant types of fashion retailers based upon fashion product mix in the United States. (DOK 2)
 - e. Classify fashion collections. (DOK 1)
2. Examine and analyze the major fashion components. (DOK 3)
 - a. Identify the major environmental influences on fashion demand. (DOK 1)
 - b. Classify the primary principles of design. (DOK 3)
 - c. Distinguish between the basic elements of design. (DOK 2)
 - d. Identify and illustrate common natural and manufactured fibers. (DOK 3)
 - e. Analyze a current or emerging fashion trend. (DOK 3)
3. Assimilate information about various careers in fashion marketing. (DOK 2)
 - a. Investigate a career in fashion marketing. (DOK 1)
 - b. Explore ways to prepare for a career in the fashion industry. (DOK 2)

Unit 17: Sports, Special Events, and Entertainment Marketing

1. Discuss the importance of marketing to sports, special events, and entertainment industries. (DOK 1)
 - a. Identify the various sports, special events, and entertainment industries. (DOK 1)
 - b. Describe related products in the sports, special events, and entertainment marketing fields, and discuss how those products are marketed. (DOK 1)

2. Explain the function of public relations/publicity and the agent/personal manager in sports, special events, and entertainment marketing. (DOK 2)
 - a. Discuss public relations/publicity in sports, special events, and entertainment marketing. (DOK 1)
 - b. Review the agent's/personal manager's role in sports, special events, and entertainment marketing. (DOK 2)
3. Discuss legal issues related to sports, special events, and entertainment marketing. (DOK 2)
 - a. Discuss types of contracts including expressed, implied, unilateral, and bilateral. (DOK 1)
 - b. List legal implications of contracts and breach of contract. (DOK 2)
4. Examine licensing and copyright laws as they relate to sports and entertainment marketing. (DOK 2)
 - a. Explain the concept of licensing and copyright laws, including sports products and music or video products. (DOK 2)
 - b. Explain why it is illegal to copy via Internet or scanning equipment. (DOK 2)
5. Discuss the role of sponsorships in sports, special events, and entertainment marketing. (DOK 2)
 - a. Discuss the reasons that companies sponsor sports, special events, and entertainment industries. (DOK 1)
 - b. Discuss ways companies can get involved in sponsoring a sports, a special events, or an entertainment program. (DOK 2)

Marketing and Economics I Competency Profile

Program CIP: 52.1801

Unit 1: Introduction to Business

- _____ 1. Identify school and program policies and procedures. (DOK 1)
- _____ 2. Discuss the purpose of the course. (DOK 1)
- _____ 3. Implement Green Business Practices. (DOK 3)

Unit 2: Communication and Interpersonal Skills

- _____ 1. Apply the fundamentals of communication. (DOK 2)
Demonstrate interpersonal skills that contribute to positive work
- _____ 2. relationships. (DOK 2)
Demonstrate the ability to interact and handle conflict in the business
- _____ 3. environment. (DOK 3)

Unit 3: Professional Development

- _____ 1. Research career opportunities and employment skills. (DOK 2)
- _____ 2. Demonstrate appropriate workplace ethics. (DOK 2)
- _____ 3. Demonstrate appropriate business etiquette skills. (DOK 2)

Unit 4: Economics

- _____ 1. Apply basic economic concepts. (DOK 1)
Examine the characteristics of economic systems, and discuss the
- _____ 2. relationships among them. (DOK 2)
Examine economic indicators and trends such as production, distribution, and
- _____ 3. consumption of goods and services. (DOK 2)
Demonstrate the ability to apply and interpret social studies tools (e.g.,
- _____ 4. timelines, maps, globes, graphs, charts, a compass, technology, primary and
secondary documents, political cartoons, etc.). (DOK 3)

Unit 5: Business, Management, and Entrepreneurship

- _____ 1. Identify potential business threats and opportunities to protect a business's
financial well-being. (DOK 3)
- _____ 2. Discuss fundamental concepts of business to include business risk. (DOK 1)
- _____ 3. Discuss the fundamental functions of marketing management. (DOK 1)
- _____ 4. Research entrepreneurship opportunities. (DOK 4)

Unit 6: Business Law

- _____ 1. Discuss business laws and regulations. (DOK 1)
- _____ 2. Determine the various aspects of contract law. (DOK 1)
- _____ 3. Determine legalities of borrowing money and paying bills. (DOK 1)

_____ 4. Define and discuss sales and property law. (DOK 1)

Unit 7: Personal Finance

_____ 1. Explain the fundamental principles of financial exchanges. (DOK 2)

_____ 2. Manage personal finances to achieve financial goals. (DOK 3)
Recognize the role of financial services providers in achieving financial

_____ 3. goals. (DOK 2)

_____ 4. Apply investment strategies to ensure financial well-being. (DOK 2)

_____ 5. Apply payroll concepts. (DOK 3)

Marketing and Economics II Competency Profile

Unit 8: Introduction to Marketing

- _____ 1. Explain the role of marketing in everyday business functions. (DOK 3)
- _____ 2. Compare and contrast customer, client, and business behavior. (DOK 3)

Unit 9: Pricing

- _____ 1. Explain the pricing function. (DOK 2)
- _____ 2. Explain the factors that affect pricing decisions and calculate prices. (DOK 3)

Unit 10: Promotion

- _____ 1. Explain promotion as a marketing function. (DOK 2)
- _____ 2. Explain the role of advertising as part of a promotional mix. (DOK 3)
- _____ 3. Explain the role of sales promotion as part of a promotional mix. (DOK 3)
- _____ 4. Explain the role of publicity/public relations as part of a promotional mix. (DOK 3)

Unit 11: Selling

- _____ 1. Explain the factors that impact the selling function. (DOK 2)
- _____ 2. Understand the need for development of product knowledge. (DOK 2)
- _____ 3. Explain the selling process, and demonstrate sales techniques. (DOK 2)
- _____ 4. Demonstrate support activities related to selling (DOK 2)

Unit 12: Product/Service Management

- _____ 1. Demonstrate understanding of the nature and scope of the product/service management function. (DOK 2)
- _____ 2. Design a product/service mix. (DOK 3)
- _____ 3. Describe factors used by marketers to position a product, service, or business. (DOK 3)
- _____ 4. Evaluate the importance of quality assurances on product/service management. (DOK 3)

Unit 13: Distribution

- _____ 1. Examine the distribution process. (DOK 2)
- _____ 2. Examine the process of warehousing and stock handling. (DOK 2)

Unit 14: Marketing Planning

- _____ 1. Develop a marketing plan using marketing information. (DOK 3)
- _____ 2. Assess marketing strategies to improve return on marketing investment. (DOK 3)

Unit 15: International Marketing

Understand marketing's role and function in business to facilitate economic exchanges with customers in the international business communities.

- _____ 1. (DOK 2)
- _____ 2. Understand the impact of global trade in business decision making. (DOK 3)

Unit 16: Fashion

- _____ 1. Explain the basic concepts of fashion marketing. (DOK 2)
- _____ 2. Examine and analyze the major fashion components. (DOK 3)
- _____ 3. Assimilate information about various careers in fashion marketing. (DOK 2)

Unit 17: Sports, Special Events, and Entertainment Marketing

- _____ 1. Discuss the importance of marketing to sports, special events, and entertainment industries. (DOK 1)
- _____ 2. Explain the function of public relations/publicity and the agent/personal manager in sports, special events, and entertainment marketing. (DOK 2)
- _____ 3. Discuss legal issues related to sports, special events, and entertainment marketing. (DOK 2)
- _____ 4. Examine licensing and copyright laws as they relate to sports and entertainment marketing. (DOK 2)
- _____ 5. Discuss the role of sponsorships in sports, special events, and entertainment marketing. (DOK 2)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

10. Using 21st century skills to understand and address global issues
11. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
12. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

10. Knowing how to make appropriate personal economic choices
11. Understanding the role of the economy in society
12. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

10. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
11. Exercising the rights and obligations of citizenship at local, state, national, and global levels
12. Understanding the local and global implications of civic decisions

CS4 Health Literacy

16. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
17. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
18. Using available information to make appropriate health-related decisions
19. Establishing and monitoring personal and family health goals
20. Understanding national and international public health and safety issues

CS5 Environmental Literacy

13. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
14. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
15. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
16. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

10. Think Creatively
11. Work Creatively with Others

- 12. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 13. Reason Effectively
 - 14. Use Systems Thinking
 - 15. Make Judgments and Decisions
 - 16. Solve Problems
- CS8 Communication and Collaboration**
 - 7. Communicate Clearly
 - 8. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 7. Access and Evaluate Information
 - 8. Use and Manage Information
- CS10 Media Literacy**
 - 7. Analyze Media
 - 8. Create Media Products
- CS11 ICT Literacy**
 - 4. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 7. Adapt to change
 - 8. Be Flexible
- CS13 Initiative and Self-Direction**
 - 10. Manage Goals and Time
 - 11. Work Independently
 - 12. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 7. Interact Effectively with others
 - 8. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 7. Manage Projects
 - 8. Produce Results
- CS16 Leadership and Responsibility**
 - 7. Guide and Lead Others
 - 8. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

4. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- v. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- w. Explain the causes and characteristics of tides. (DOK 1)
- x. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- y. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- z. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- aa. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
 - Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
- bb. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
 - Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
- 3. Apply an understanding of the diverse organisms found in aquatic environments.**
 - s. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
 - Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
 - t. Research, calculate, and interpret population data. (DOK 2)
 - u. Research and compare reproductive processes in aquatic organisms. (DOK 2)
 - v. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
 - w. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
 - x. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
- 4. Draw conclusions about the relationships between human activity and aquatic organisms.**
 - bb. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
 - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
 - cc. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
 - dd. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
 - Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- d. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- ee. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ff. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- gg. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- hh. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ii. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- jj. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- v. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
 - Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- w. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- x. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- y. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
 - Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- z. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
 - Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- aa. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
 - ATP structure
 - ATP function
- bb. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
 - Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- j. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
 - Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- k. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- l. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- m. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- n. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- o. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- p. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- m. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- n. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- o. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - p. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- p. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - q. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - r. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - s. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - t. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - w. Clarify research questions and design laboratory investigations. (DOK 3)
 - x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- m. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - n. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - o. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - p. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- p. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - q. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - r. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- s. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- t. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- bb. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- cc. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- dd. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- ee. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- ff. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- gg. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- hh. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- ii. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- jj. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- g. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- h. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- w. Formulate questions that can be answered through research and experimental design. (DOK 3)
- x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- p. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- q. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- r. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- s. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- t. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- s. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- t. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- u. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- v. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- w. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- x. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- m. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- n. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- o. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- p. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- m. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- n. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- o. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- p. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- w. Clarify research questions and design laboratory investigations. (DOK 3)
- x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- v. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
 - Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
 - Substances and mixtures
 - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
- w. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- x. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
 - Properties and interactions of the three fundamental particles of the atom
 - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
- y. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
 - Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
 - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- z. Compare the properties of compounds according to their type of bonding. (DOK 1)
 - Covalent, ionic, and metallic bonding
 - Polar and nonpolar covalent bonding
 - Valence electrons and bonding atoms
- aa. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- bb. Develop a three-dimensional model of molecular structure. (DOK 2)
 - Lewis dot structures for simple molecules and ionic compounds
 - Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

- m. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- n. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
 - Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations

- Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- o. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- p. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
4. **Analyze the relationship between microscopic and macroscopic models of matter.**
- m. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- n. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- o. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- p. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- j. Analyze and explain acid/base reactions. (DOK 2)

- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- k. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
- l. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- w. Formulate questions that can be answered through research and experimental design. (DOK 3)
- x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- aa. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

- s. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
 - Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- t. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- u. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
 - Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- v. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- w. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- x. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
 - Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- j. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
 - Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- k. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
 - Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- l. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- | | |
|----|--|
| E1 | Apply inquiry-based and problem-solving processes and skills to scientific investigations. |
| E2 | Develop an understanding of the history and evolution of the universe and earth. |
| E3 | Discuss factors that are used to explain the geological history of earth. |
| E4 | Demonstrate an understanding of earth systems relating to weather and climate. |

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- w. Formulate questions that can be answered through research and experimental design. (DOK 3)
- x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- m. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- n. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- o. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- p. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
 - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- y. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
 - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
 - z. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
 - aa. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
 - bb. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
 - cc. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
 - dd. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
 - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
 - ee. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
 - ff. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
- 4. Demonstrate an understanding of earth systems relating to weather and climate.**
- p. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
 - Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
 - q. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
 - r. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
 - s. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - t. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- m. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- n. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- o. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
- Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- p. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- w. Formulate questions that can be answered through research and experimental design. (DOK 3)

- x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
 - z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
 - aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
- 2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.**
- v. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
 - w. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
 - x. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
 - y. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
 - z. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
 - aa. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
 - bb. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)
- 3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**
- j. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
 - k. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

1. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- w. Clarify research questions and design laboratory investigations. (DOK 3)
- x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- v. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- w. Describe how organic components are integral to biochemical processes. (DOK 2)
- x. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
 - Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- y. Explain the significance of the discovery of nucleic acids. (DOK 1)
- z. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- aa. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- bb. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- v. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- w. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- x. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- y. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- z. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- aa. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- bb. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- w. Formulate questions that can be answered through research and experimental design. (DOK 3)

- x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
 - z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
 - aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
- hh. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
 - ii. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
 - jj. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
 - kk. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
 - ll. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
 - mm. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
 - nn. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
 - oo. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
 - pp. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
 - qq. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
 - rr. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- w. Identify questions that can be answered through scientific investigations. (DOK 3)
- x. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- y. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- z. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- bb. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- p. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- q. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)

- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
 - r. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
 - s. Draw and assess conclusions about charges and electric current. (DOK 2)
 - Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
 - t. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- m. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
 - n. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
 - o. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
 - The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
 - p. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- m. Cite evidence to summarize the atomic theory. (DOK 1)
 - Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
 - n. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
 - o. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
 - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)

- p. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
5. **Investigate and apply principles of physical and chemical changes in matter.**
- j. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
- k. Balance chemical equations. (DOK 2)
- l. Classify types of chemical reactions (e. g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**

- v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- w. Clarify research questions, and design laboratory investigations. (DOK 3)
- x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. **Develop an understanding of concepts related to forces and motion.**

- m. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- n. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- o. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- p. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
- p. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
- q. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- r. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- s. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
- t. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**
- p. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
- Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.

- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - q. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - r. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - s. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - t. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- j. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
 - k. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - l. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- g. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - h. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- v. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- w. Clarify research questions, and design laboratory investigations. (DOK 3)
- x. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

- y. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
 - z. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - aa. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - bb. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)
- 2. Demonstrate the basic concepts of remote sensing. (E, P)**
- s. Describe the characteristics of the electromagnetic spectrum.
 - t. Using images and graphs, interpret the absorption/reflection spectrum.
 - u. Distinguish between passive vs. active sensor systems.
 - v. Analyze the effects of changes in spatial, temporal, and spectral resolution.
 - w. Analyze the effects on images due to changes in scale.
 - x. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- v. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- w. Formulate questions that can be answered through research and experimental design. (DOK 3)
- x. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- y. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- z. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- aa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- bb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- m. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- n. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- o. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- p. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenetic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- p. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- q. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- r. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- s. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- t. Contrast food chains and food webs. (DOK 2)
- 4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- g. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- h. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.

- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.

- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.

- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer's position
 - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:

- Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
- Using simple vocabulary
- Using simple sentence structure
- Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
- Using simple but appropriate vocabulary
- Using a little sentence variety, though most sentences are simple in structure
- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

National Business Core Standards¹

Business Core

- BC1 Understands the responsibility of business to know, abide by, and enforce laws, regulations, and ethical behavior that affect business operations and transactions
- BC2 Understands the concepts, strategies, and systems used to obtain and convey ideas and information
- BC3 Understands the techniques and strategies used to foster positive, ongoing relationships with customers
- BC4 Understands the economic principles and concepts fundamental to business operations
- BC5 Understands techniques, strategies, and systems used to foster self-understanding and enhance relationships with others
- BC6 Understands the concepts, processes, and skills associated with identifying new ideas, opportunities, and methods and with creating or starting a new project or venture
- BC7 Understands tools, strategies, and systems used to maintain, monitor, control, and plan the use of financial resources
- BC8 Understands the tools, techniques, and systems that businesses use to plan, staff, lead, and organize its human resources
- BC9 Understands tools, strategies, and systems needed to access, process, maintain, evaluate, and disseminate information to assist in business decision making
- BC10 Understands the tools, techniques, and systems that businesses use to create exchanges and satisfy organizational objectives
- BC11 Understands the processes and systems implemented to monitor, plan, and control the day-to-day activities required for continued business functioning
- BC12 Understands concepts, tools, and strategies used to explore, obtain, and develop in a business career
- BC13 Understands the concepts and processes needed to move, store, locate, and/or transfer ownership of goods and services

¹ *Business Management and Administration Career Cluster Status Report – Marketing Education Resource Center.* (2008). Retrieved November 27, 2007, from <http://www.mark-ed.org>. Reprinted with permission. 2008, MarkED/Career Paths. Columbus, OH www.Mark-ED.org

BC14 Understands tools, techniques, and systems that affect a business's ability to plan, control, and organize an organization/department

MA 1 Business Management and Administration Core

- Understands the techniques and strategies used to foster positive, ongoing relationships with customers
- Understands the systems, strategies, and techniques used to collect, organize, analyze, and share information known in an organization
- Understands tools, techniques, and systems that are used to plan, implement, monitor, and evaluate business projects
- Understands the need for standards and the strategies and techniques used to implement, monitor, and evaluate them
- Understands risk-management strategies and techniques used to implement, monitor, and evaluate them
- Understands risk-management strategies and techniques used to minimize business loss

MA 2 Administrative Services

- Understands the concepts, strategies, and systems used in administrative services to obtain and convey ideas and information
- Understands techniques, strategies, and systems used in administrative services to foster self-understanding and enhance relationships with others
- Understands the tools, techniques, and systems that administrative service supervisors use to plan, staff, lead, and organize their human resources
- Understands tools, strategies, and systems administrative service employees need to access, process, maintain, evaluate, and disseminate information to support managers
- Understands the processes and systems implemented to monitor, plan, and control the day-to-day administrative activities required for continued business functioning
- Understands concepts, tools, and strategies used to explore, obtain, and develop in an administrative services career

MA 3 Business Information Management

- Understands business's responsibility to know, abide by, and enforce laws and regulations that affect business operations and transactions
- Understands tools, strategies, and systems used to maintain, monitor, control, and plan the use of financial resources
- Understands tools, strategies, and systems needed to access, process, maintain, evaluate, and disseminate information to assist business decision making
- Understands the processes and systems implemented to monitor, plan, and control the day-to-day activities required for continued business functioning
- Understands concepts, tools, and strategies used to explore, obtain, and develop in a business information management career
- Understands tools, techniques, and systems that affect a business's ability to plan, control, and organize an organization/department

MA 4 General Management

- Understands business's responsibility to know, abide by, and enforce laws and regulations that affect business operations and transactions
- Understands the concepts, strategies, and systems used by management to obtain and convey ideas and information
- Understands the economic principles and concepts fundamental to business operations
- Understands techniques, strategies, and systems used by management to foster self-understanding and enhance relationships with others
- Understands tools, strategies, and systems managers use to maintain, monitor, control, and plan the use of financial resources
- Understands the processes and systems that managers implement to monitor, plan, and control the day-to-day business activities required for continued business functioning
- Understands concepts, tools, and strategies used to explore, obtain, and develop in a management career
- Understands tools, techniques, and systems that affect a manager's ability to plan, control, and organize

MA 5 Human Resource Management

- Understands business's responsibility to know, abide by, and enforce laws and regulations that affect business operations and transactions
- Understands the concepts, strategies, and systems used by management to obtain and convey ideas and information
- Understands techniques, strategies, and systems used by human resources management to foster self-understanding and enhance relationships with others
- Understands tools, strategies, and systems managers use to maintain, monitor, control, and plan the use of financial resources
- Understands the tools techniques, and systems that businesses use to plan, staff, lead, and organize human resources
- Understands tools, strategies, and systems human resources management needs to access, process, maintain, evaluate, and disseminate information to support managers
- Understands the tools, techniques, and systems that businesses use to create, communicate, and deliver value to customers and to manage customer relationships in ways that benefit the organization and its stakeholders
- Understands the processes and systems that human resources management implements to monitor, plan, and control the day-to-day business activities required for continued business functioning
- Understands concepts, tools, and strategies used to explore, obtain, and develop in a human resources management career
- Understands tools, techniques, and systems that affect human resources management's ability to plan, control, and organize

MA 6 Operations Management

- Understands business's responsibility to know, abide by, and enforce laws and regulations that affect business operations and transactions

- Understands the techniques and strategies used to foster positive, ongoing relationships with customers
- Understands tools, strategies, and systems used to maintain, monitor, control, and plan the use of financial resources
- Understands tools, strategies, and systems needed to access, process, maintain, evaluate, and disseminate information to assist operations management decision making
- Understands the processes and systems that operations managers implement to monitor, plan, and control the day-to-day business activities required for continued business functioning
- Understands concepts, tools, and strategies used to explore, obtain, and develop in an operations management career

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Installation and Service: Industrial Maintenance Executive Summary	323
Course Outlines.....	324
Installation and Service: Industrial Maintenance Competencies and Objectives	327
Installation and Service: Industrial Maintenance Competency Profile.....	333
Appendix A: 21st Century Skills Standards	336
Appendix B: MS Academic Standards	338
Appendix C: ACT College Readiness Standards.....	368
Appendix D: Pathway Content Standards.....	382
Appendix E: National Educational Technology Standards for Students	393

Installation and Service: Industrial Maintenance Executive Summary

Program Description

Industrial Maintenance Trades is an instructional program that prepares individuals to repair and maintain industrial machinery, equipment, and buildings. It includes instruction in blueprint reading, metal repair, electricity, oxyfuel cutting, preventive maintenance, plumbing, rigging, hoisting, pumps, gear boxes, fasteners, and anchors.

Certification by the National Center for Construction Education and Research (NCCER):

This curriculum has been aligned to modules in the Contren Learning Series as endorsed by the National Center for Construction Education and Research (NCCER). Students who study this curriculum using the Contren Learning Series materials under the supervision of an instructor who has been certified by the NCCER are eligible to be tested on each module. Students who successfully pass these tests may be certified to the NCCER by the instructor and will receive documentation from NCCER.

Course Outlines

This curriculum framework allows options for local school districts to implement based on student needs and scheduling demands. This curriculum offers a four-Carnegie-unit program.

Option 1

Upon completion of this option, the student will be trained to take the **NCCER Level 1 Certification and Industrial Maintenance Level 1 certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

- Installation and Service, Part A (Course Code: 993002)
- Installation and Service, Part B (Course Code: 993003)
- Installation and Service II—Industrial Maintenance, Part A (Course Code: 993012)
- Installation and Service II—Industrial Maintenance, Part B (Course Code: 993013)

Course Description: Installation and Service, Part A (Course Code: 993002) includes an introduction to the field as well as fundamentals of safety, math, blueprint reading, hand and power tools. This is a one-Carnegie-unit course.

Course Description: Installation and Service, Part B (Course Code: 993003) emphasizes an overview of safety and leadership, Introduction to HVAC. This course gives student's real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Installation and Service, Part A.

Course Description: Installation and Service II—Industrial Maintenance, Part A (Course Code: 993012) includes an in-depth study of the industrial maintenance profession, maintenance tools, types of fasteners and anchors used in the maintenance field, gaskets and packing, pumps and pump drivers, types of valves, machine lubrication, and welding. This course also reinforces safety related to the industrial maintenance industry. This one-Carnegie-unit course should only be taken after students successfully pass Installation and Service, Part B.

Course Description: Installation and Service II—Industrial Maintenance, Part B (Course Code: 993013) includes an in-depth study of test equipment, material handling and rigging, and mobile and support equipment, National Electrical Code, electrical theory, conductor terminations and splices, and hydraulic and pneumatic controls. This course also reinforces safety related to the industrial maintenance industry. This one-Carnegie-unit course should only be taken after students successfully pass Installation and Service II—Industrial Maintenance, Part A.

- Safety will be reinforced and tested at the beginning of each course.
- Students must complete installation and service courses with a score of 80/C or higher in class work to advance to the next level.

Installation and Service, Part A (Course Code: 993002)

Unit	Title	Hours
1	Orientation and Safety	50
2	Math, Introduction to Blueprints, and Hand and Power Tools	90
		140

Installation and Service, Part B (Course Code: 993003)

Unit	Title	Hours
3	Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)	70
4	Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)	70
		140

Installation and Service II—Industrial Maintenance, Part A (Course Code: 993012)

Unit	Title	Hours
5	Orientation and Safety (Review and Reinforcement)	25
6	Gaskets and Packing, Pumps and Drivers, Introduction to Valves, Lubrication, and Welding	115
		140

Installation and Service II—Industrial Maintenance, Part B (Course Code: 993013)

Unit	Title	Hours
7	Related Construction Math, Construction Drawings, Introduction to Test Equipment, Material Handling and Rigging, and Mobile and Support Equipment	70
8	Introduction to the National Electrical Code, Electrical Theory, Conductor Terminations and Splices, and Hydraulic and Pneumatic Controls	70
		140

Option 2

Course Description: Installation and Service I includes orientation and leadership; basic safety; math, measuring tools, and instruments; blueprints; hand and power tools; introduction to industrial maintenance; and heating, ventilation, and air-conditioning. Safety is emphasized in each unit and every activity.

Course Description: Installation and Service II—Industrial Maintenance is a continuation with the emphasis on industrial maintenance. Topics include employability skills, safety, gaskets, packing, pumps, drivers, valves, lubrication, test equipment, material handling, national electrical code, conductor termination, hydraulics, and pneumatics. The course should be taken after the student has successfully passed Installation and Service I.

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete installation and service courses with a score of 80/C or higher in class work to advance to the next level.

Installation and Service I (Course Code: 993001)

Unit	Title	Hours
1	Orientation and Safety	45
2	Math, Introduction to Blueprints, and Hand and Power Tools	85
3	Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)	75
4	Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)	75
		280

Installation and Service II—Industrial Maintenance (Course Code: 993011)

Unit	Title	Hours
5	Orientation and Safety (Review and Reinforcement)	5
6	Gaskets and Packing, Pumps and Drivers, Introduction to Valves, Lubrication, and Welding	105
7	Related Construction Math, Construction Drawings, Introduction to Test Equipment, Material Handling and Rigging, and Mobile and Support Equipment	85
8	Introduction to the National Electrical Code, Electrical Theory, Conductor Terminations and Splices, and Hydraulic and Pneumatic Controls	85
		280

Installation and Service: Industrial Maintenance Competencies and Objectives

Unit 1: Orientation and Safety

1. Describe local program and vocational/career technical center policies and procedures. (CONTREN Module: 00107-04 and 00108-04) (DOK 1)
 - a. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (CONTREN Module: 00107-04, 00108-04, and 40101-07 Orientation to the Trade, IM) (DOK 2)
 - a. Describe employer expectations in the workplace. (DOK 2)
3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (CONTREN Module: 00107-04 and 00108-04) (DOK 2)
 - a. Demonstrate effective team-building and leadership skills. (DOK 2)
 - b. Demonstrate through practice appropriate work ethics. (DOK 2)
4. Describe general safety rules for working in a shop/lab and industry. (CONTREN Module: 00101-04) (DOK 1)
 - a. Discuss safety issues and prevention associated with the installation and service shop area. (DOK 1)
 - b. Explain fire safety and prevention. (DOK 1)

Unit 2: Math, Introduction to Blueprints and Hand & Power Tools

1. Apply the four basic math skills with whole numbers, fractions, and percents. (CONTREN Module: 00102-04, 00105-04, 40106-07, and 03201-07) (DOK 1)
 - a. Perform mathematic calculations relating to the installation and service trade. (DOK 1)
2. Perform basic mathematical calculations related to industrial maintenance shop operations. (CONTREN Module: 00102-04, 00105-04, and 40106-07) (DOK 1)
 - a. Use the metric system in industrial maintenance and HVAC applications. (DOK 1)
 - b. Compute distances according to a drawn plan, and then calculate the amount of material for a given project. (DOK 1)
3. Identify and perform functions using various measuring tools and instruments (CONTREN Module: 00102-04, 40106-07, and 03102-07). (DOK 2)
 - a. Read a rule and layout lines to the nearest 1/16 in. (DOK 2)
4. Read, analyze, and design a blueprint. (CONTREN Module: 00105-04) (DOK 2)
 - a. Identify and interpret terms and symbols commonly used on blueprints. (DOK 2)
5. Demonstrate the use and maintenance of various hand and power tools found in the industrial maintenance and HVAC trade. (CONTREN Module: 00101-04, 00103-04, 00104-04, and 40102-07) (DOK 3)
 - a. Identify and discuss the proper safe use of common hand and power tools. (DOK 1)

- b. Select and demonstrate the use of tools, and explain the procedures for maintaining hand and power tools. (DOK 3)

Unit 3: Orientation to the Trade, Tools of the Trade, Fasteners and Anchors and Oxy-Fuel Cutting (IM)

1. The student will research and distinguish job opportunities in the industrial maintenance field and then reflect upon the importance of the industrial maintenance mechanic's role in modern manufacturing and service industry (CONTREN: 00108-04 and 40101-07) (DOK 2)
 - a. Describe employment opportunities in the industrial maintenance profession. (DOK 2)
2. Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. (CONTREN: 00103-04, 00104-04, and 40102-07) (DOK 2)
 - a. Illustrate the use of tools used in the industrial maintenance profession. (DOK 2)
 - b. Identify and use common hand and power tools used in the industrial maintenance trade. (DOK 2)
3. Identify various fasteners and anchors found in the industrial and HVAC trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application (CONTREN Module: 40103-07 Fasteners and Anchors). (DOK 3)
 - a. Identify and install threaded fasteners, non-threaded fasteners, and anchors. (DOK 2)
 - b. Identify various grades of bolt hardness. (DOK 1)
4. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (CONTREN Module: 40104-07 Oxy-Fuel Cutting) (DOK 2)
 - a. Identify and explain the use of oxy-fuel cutting equipment. (DOK 1)
 - b. Demonstrate how to use an oxy-fuel torch. (DOK 2)
 - c. Perform oxy-fuel cutting: (DOK 2)
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing

Unit 4: Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)

1. Identify and explain heating, ventilation, and air-conditioning systems, HVAC environmental law, and job opportunities that are available in the HVAC profession (CONTREN Module: 03101-07 Introduction to HVAC) (DOK 2)
 - a. Explain the basic principles of heating, ventilating, and air-conditioning. (DOK 2)
 - b. Describe what the Clean Air Act means to the HVAC trade. (DOK 1)
 - c. Identify the types of schedules/drawings used in the HVAC trade. (DOK 1)

2. Demonstrate the safe use and routine maintenance of hand and power tools used in the HVAC trade (CONTREN Module: 00103-04, 00104-04, & 040102-07) (DOK 3).
 - a. Demonstrate the safe use and maintenance of hand and power tools used in HVAC. (DOK 2)
3. Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment. (CONTREN Module: 03103-07 Copper and Plastic Piping) (DOK 2)
 - a. Discuss and demonstrate how to use copper tubing in HVAC. (DOK 2)
 - b. Discuss and demonstrate how to use plastic tubing in HVAC. (DOK 2)
4. Prepare and solder copper piping systems in various industrial and HVAC applications and properly clean, install fittings, and braze piping (silver solder) (CONTREN Module: 40104-07 and 03104-07) (DOK 2).
 - a. Solder copper pipe in HVAC. (DOK 2)
 - b. Braze copper pipe in HVAC. (DOK 2)
5. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits (CONTREN Module: 03106-07, 40203-08, 03206-07, and 03207-07). (DOK 2)
 - a. Describe how voltage, current, resistance, and power are mathematically related. (DOK 2)
 - b. Describe the difference between series and parallel circuits, and calculate loads in each. (DOK 2)
 - c. Describe the purpose and operation of the various electrical components used in equipment. (DOK 2)

Unit 5: Orientation and Safety (Review and Reinforcement)

1. Describe local program and vocational/career technical center policies and procedures. (CONTREN Modules: 00107-04 and 00108-04) (DOK 1)
 - a. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (CONTREN Modules: 00108-04, 40101-07, and 03103-07) (DOK 2)
 - a. Describe employer expectations in the workplace. (DOK 2)
3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (CONTREN Modules: 00107-04 and 00108-07) (DOK 2)
 - a. Demonstrate effective team-building and leadership skills. (DOK 1)

- b. Demonstrate through practice appropriate work ethics. (DOK 2)
- 4. Describe general safety rules for working in a shop/lab and industry. (CONTREN Modules: 00101-04) (DOK 1)
 - a. Discuss safety issues and prevention associated with the installation and service shop area. (DOK 1)
 - b. Explain fire safety and prevention in the workplace. (DOK 1)

Unit 6: Gaskets and Packing, Pumps and Drivers, Introduction to Valves, and Lubrication

1. Identify different types of gasket and packing materials, list their applications, and install gaskets and packing (CONTREN Module: 40105-07) (DOK 1).
 - a. Identify the various types and materials of gaskets. (DOK 1)
 - b. Describe the use of O-rings in the installation and service trade. (DOK 1)
 - c. Describe the uses and methods of packing in the installation and service trade. (DOK 1)
2. Identify types of pumps and prime movers, and explain pressure differential between inlet and outlet of pumps (CONTREN Module: 40108-07) (DOK 2).
 - a. Identify and explain centrifugal, rotary, reciprocating, metering, and vacuum pumps. (DOK 1)
 - b. Explain net positive suction head and cavitation. (DOK 1)
 - c. Identify types of drivers. (DOK 1)
3. Identify types of valves, and explain how to store and properly install valves (CONTREN Module: 40109-07) (DOK 2).
 - a. Identify types of valves that start, stop, regulate, relieve pressure, and regulate direction of flow. (DOK 2)
 - b. Explain how to properly store, handle, and mount valves in various locations and positions. (DOK 2)
4. Describe and explain lubricant classification, additives, uses, and environments regulation regarding disposal of oils and greases (CONTREN Modules: 40113-07) (DOK 2).
 - a. Explain regulatory law regarding industrial lubricants. (DOK 2)
 - b. Explain how lubricants protect mechanical machinery. (DOK 1)
 - c. Explain the properties and handling of lubricants and grease. (DOK 1)

Unit 7: Related Construction Math, Construction Drawings, Introduction to Test Equipment, Material Handling and Rigging, Mobile and Support Equipment

1. Identify and explain measuring devices, solve geometric mathematical problems, and use weights and measurement standards (CONTREN Module: 00102-04 and 40106-07).

- a. Discuss mathematics used in the installation and services industry. (DOK 1)
2. Identify components of the blueprint and scales, and perform projects from blueprints (CONTREN Module: 40107-07) (DOK 2).
 - a. Read and draw a basic blueprint found in the installation and service area. (DOK 2)
3. Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices (CONTREN Module: 40110-07).
 - a. Explain the operation of the following pieces of test equipment: (DOK 2)
 - Tachometer
 - Pyrometers
 - Multimeters
 - Automated diagnostics tools
 - Wiggy voltage tester
 - Stroboscope
 - Frequency meter
 - b. Explain how to read and convert from one scale to another using the above test equipment. (DOK 2)
4. Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment (CONTREN Module: 40111-07) (DOK 2).
 - a. Identify, describe the uses of, inspect, and maintain common rigging hardware and equipment, including the following: (DOK 2)
 - Jacks
 - Block and tackle
 - Chain hoists
 - Come-alongs
 - b. Tie knots used in rigging. (DOK 2)
 - c. Identify basic rigging and crane safety procedures, and use the correct hand signals to guide a crane operator. (DOK 1)
5. Recognize types of mobile and support equipment found in the trade, explain the application for each device, and safely use equipment (CONTREN Module: 40112-07) (DOK 2).
 - a. State and explain the safety precautions, operation, and application associated with the use of motor-driven equipment commonly used in industrial plants, such as the following: (DOK 2)
 - Portable generators
 - Air compressors
 - Aerial lifts
 - Forklifts
 - Mobile cranes
 - b. Operate and perform preventive maintenance on the following equipment: (DOK 2)
 - Portable generators
 - Air compressors
 - Aerial lifts

6. Identify types of conduit and sizes, bend various radiuses, and properly install conduit according to National Electrical Code (CONTREN Module: 40208-08)(DOK 2)
 - a. Identify the methods for hand bending and installing conduit. (DOK 2)

Unit 8: Introduction to the National Electrical Code, Electrical Theory, Conductor Terminations and Splices, Hydraulic & Pneumatic Controls

1. Describe the purpose of the NEC, reference NEC code, and explain current applications of the NEC (CONTREN Modules: 40202-8) (DOK 1).
 - a. Explain the purpose and history of the National Electrical Code (NEC). (DOK 1)
 - b. Use the NEC to reference industrial applications. (DOK 1)
 - c. Explain the role of nationally recognized testing laboratories. (DOK 1)
2. Describe the units of measure of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit (CONTREN Modules: 40202-08) (DOK 3).
 - a. Discuss the properties and physical laws of electricity. (DOK 3)
 - b. Identify the meters used to measure voltage, current, and resistance. (DOK 1)
 - c. Discuss the properties of a series and parallel circuit. (DOK 3)
3. Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. (CONTREN Modules: 40213-08)(DOK 2)
 - a. Describe how to make a conductor termination. (DOK 1)
 - b. Prepare cable ends for terminations and splices, and connect the ends using lugs or connectors. (DOK 1)
 - c. Train cable at termination points. (DOK 1)
 - d. Describe the National Electrical Code requirements for making cable terminations and splices. (DOK 2)
4. Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. (HYDRAULIC AND PNEUMATIC CONTROLS) (DOK 2).
 - a. Discuss the principles of industrial hydraulics. (DOK 2)
 - b. Discuss the principles of industrial pneumatics. (DOK 2)

Installation and Service: Industrial Maintenance Competency Profile

Program CIP: 47.0303

Unit 1: Orientation and Safety

- _____ 1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
- _____ 2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (DOK 2)
- _____ 3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2)
- _____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)

Unit 2: Math, Introduction to Blueprints, and Hand and Power Tools

- _____ 1. Apply the four basic math skills with whole numbers, fractions, and percents. (DOK 1)
- _____ 2. Perform basic mathematical calculations related to industrial maintenance shop operations. (DOK 1)
- _____ 3. Identify and perform functions using various measuring tools and instruments. (DOK 2)
- _____ 4. Read, analyze, and design a blueprint. (DOK 2)
- _____ 5. Demonstrate the use and maintenance of various hand and power tools found in the industrial maintenance and HVAC trade. (DOK 3)

Unit 3: Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)

- _____ 1. The student will research and distinguish job opportunities in the industrial maintenance field and then reflect upon the importance of the industrial maintenance mechanic's role in modern manufacturing and service industry. (DOK 2)
- _____ 2. Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. (DOK 2)
- _____ 3. Identify various fasteners and anchors found in the industrial and HVAC trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application. (DOK 3)
- _____ 4. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (DOK 2)

Unit 4: Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)

Identify and explain heating, ventilation, and air-conditioning systems, HVAC environmental law, and job opportunities that are available in the

- _____ 1. HVAC profession. (DOK 2)
- _____ 2. Demonstrate the safe use and routine maintenance of hand and power tools used in the HVAC trade. (DOK 3)
- _____ 3. Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment. (DOK 2)
- _____ 4. Prepare and solder copper piping systems in various industrial and HVAC applications and properly clean, install fittings, and braze piping (silver solder). (DOK 2)
- _____ 5. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. (DOK 2)

Unit 5: Orientation and Safety (Review and Reinforcement)

Describe local program and vocational/career technical center policies and procedures. (DOK 1)

- _____ 1. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (DOK 2)
- _____ 2. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2)
- _____ 3. Describe general safety rules for working in a shop/lab and industry. (DOK 1)

Unit 6: Gaskets and Packing, Pumps and Drivers, Introduction to Valves, and Lubrication

Identify different types of gasket and packing materials, list their applications, and install gaskets and packing. (DOK 1)

- _____ 1. Identify types of pumps and prime movers, and explain pressure differential between inlet and outlet of pumps. (DOK 2)
- _____ 2. Identify types of valves, and explain how to store and properly install valves. (DOK 2)
- _____ 3. Describe and explain lubricant classification, additives, uses, and environments regulation regarding disposal of oils and greases. (DOK 2)

Unit 7: Related Construction Math, Construction Drawings, Introduction to Test Equipment, Material Handling and Rigging, and Mobile and Support Equipment

Identify and explain measuring devices, solve geometric mathematical problems, and use weights and measurement standards.

- _____ 1.

- _____ 2. Identify components of the blueprint and scales, and perform projects from blueprints. (DOK 2)
- _____ 3. Identify and explain the use of various test equipment used in the trade, differentiate between analog and digital meter readouts, and properly test circuits and mechanisms using available school metering devices.
- _____ 4. Identify and explain safe rigging practices, load distribution, hand signals, and rigging equipment. (DOK 2)
- _____ 5. Recognize types of mobile and support equipment found in the trade, explain the application for each device, and safely use equipment. (DOK 2)
- _____ 6. Identify types of conduit and sizes, bend various radiuses, and properly install conduit according to National Electrical Code. (DOK 2)

Unit 8: Introduction to the National Electrical Code, Electrical Theory, Conductor Terminations and Splices, and Hydraulic and Pneumatic Controls

- _____ 1. Describe the purpose of the NEC, reference NEC code, and explain current applications of the NEC. (DOK 1)
- _____ 2. Describe the units of measure of electricity and the types of circuits, define Ohm's and Kirchhoff's laws, and troubleshoot a simple circuit. (DOK 3)
- _____ 3. Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. (DOK 2)
- _____ 4. Identify and make connections using various types of conductors, types of fastening devices, and NEC requirements for terminations and splices. (DOK 2)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

13. Using 21st century skills to understand and address global issues
14. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
15. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

13. Knowing how to make appropriate personal economic choices
14. Understanding the role of the economy in society
15. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

13. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
14. Exercising the rights and obligations of citizenship at local, state, national, and global levels
15. Understanding the local and global implications of civic decisions

CS4 Health Literacy

21. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
22. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
23. Using available information to make appropriate health-related decisions
24. Establishing and monitoring personal and family health goals
25. Understanding national and international public health and safety issues

CS5 Environmental Literacy

17. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
18. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
19. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
20. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

13. Think Creatively
14. Work Creatively with Others

- 15. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 17. Reason Effectively
 - 18. Use Systems Thinking
 - 19. Make Judgments and Decisions
 - 20. Solve Problems
- CS8 Communication and Collaboration**
 - 9. Communicate Clearly
 - 10. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 9. Access and Evaluate Information
 - 10. Use and Manage Information
- CS10 Media Literacy**
 - 9. Analyze Media
 - 10. Create Media Products
- CS11 ICT Literacy**
 - 5. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 9. Adapt to change
 - 10. Be Flexible
- CS13 Initiative and Self-Direction**
 - 13. Manage Goals and Time
 - 14. Work Independently
 - 15. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 9. Interact Effectively with others
 - 10. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 9. Manage Projects
 - 10. Produce Results
- CS16 Leadership and Responsibility**
 - 9. Guide and Lead Others
 - 10. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

5. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- cc. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- dd. Explain the causes and characteristics of tides. (DOK 1)
- ee. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- ff. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
 - gg. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
 - hh. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
 - Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
 - ii. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
 - Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
3. **Apply an understanding of the diverse organisms found in aquatic environments.**
- y. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
 - Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
 - z. Research, calculate, and interpret population data. (DOK 2)
 - aa. Research and compare reproductive processes in aquatic organisms. (DOK 2)
 - bb. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
 - cc. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
 - dd. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
- kk. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
 - Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
 - ll. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
 - mm. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
 - Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- e. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- nn. Formulate questions that can be answered through research and experimental design. (DOK 3)
- oo. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- pp. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- qq. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- rr. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ss. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- cc. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- dd. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- ee. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- ff. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- gg. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- hh. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
 - ATP function
- ii. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- m. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- n. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- o. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- q. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- r. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- s. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- t. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- q. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- r. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- s. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - t. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- u. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - v. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - w. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - x. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - y. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - dd. Clarify research questions and design laboratory investigations. (DOK 3)
 - ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- q. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - r. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - s. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - t. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- u. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - v. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - w. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- x. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- y. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- kk. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- ll. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- mm. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- nn. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- oo. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- pp. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- qq. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- rr. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- ss. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- i. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- j. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- u. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- v. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- w. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- x. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- y. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- y. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- z. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- aa. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- bb. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- cc. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- dd. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- q. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- r. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- s. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- t. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- q. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- r. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- s. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- t. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- dd. Clarify research questions and design laboratory investigations. (DOK 3)
- ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- cc. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
 - Substances and mixtures
 - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
- dd. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- ee. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
- Properties and interactions of the three fundamental particles of the atom
 - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
- ff. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
 - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- gg. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
 - Polar and nonpolar covalent bonding
 - Valence electrons and bonding atoms
- hh. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- ii. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
 - Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

- q. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- r. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations

- Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- s. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- t. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
4. **Analyze the relationship between microscopic and macroscopic models of matter.**
- q. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- r. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- s. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- t. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- m. Analyze and explain acid/base reactions. (DOK 2)

- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- n. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
- o. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- hh. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

- y. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- z. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- aa. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- bb. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- cc. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- dd. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- m. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- n. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- o. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- q. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- r. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- s. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- t. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
 - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- gg. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
 - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
 - hh. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
 - ii. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
 - jj. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
 - kk. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
 - ll. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
 - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
 - mm. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
 - nn. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
- 4. Demonstrate an understanding of earth systems relating to weather and climate.**
- u. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
 - Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
 - v. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
 - w. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
 - x. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - y. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- q. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- r. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- s. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
- Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- t. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- dd. Formulate questions that can be answered through research and experimental design. (DOK 3)

- ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

- cc. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
- dd. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
- ee. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- ff. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
- gg. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- hh. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- ii. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

- m. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
- n. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

- o. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- dd. Clarify research questions and design laboratory investigations. (DOK 3)
- ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- cc. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- dd. Describe how organic components are integral to biochemical processes. (DOK 2)
- ee. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
 - Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- ff. Explain the significance of the discovery of nucleic acids. (DOK 1)
- gg. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- hh. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- ii. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- cc. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- dd. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- ee. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- ff. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- gg. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- hh. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- ii. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- dd. Formulate questions that can be answered through research and experimental design. (DOK 3)

- ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

- ss. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- tt. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- uu. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- vv. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- ww. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- xx. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- yy. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- zz. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- aaa. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
- bbb. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
- ccc. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- dd. Identify questions that can be answered through scientific investigations. (DOK 3)
- ee. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- ff. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- gg. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ii. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- u. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- v. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)

- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- w. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- x. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- y. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- q. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- r. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
- s. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
- t. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- q. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
- r. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
- s. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)

- t. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
5. **Investigate and apply principles of physical and chemical changes in matter.**
- m. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
- n. Balance chemical equations. (DOK 2)
- o. Classify types of chemical reactions (e.g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. **Investigate and apply principles of physical and chemical changes in matter.**

- cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- dd. Clarify research questions, and design laboratory investigations. (DOK 3)
- ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. **Develop an understanding of concepts related to forces and motion.**

- q. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- r. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- s. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- t. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
- u. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
- v. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- w. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- x. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
- y. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**
- u. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
- Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.

- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - v. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - w. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - x. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - y. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- m. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
 - n. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - o. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- i. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - j. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

- SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- cc. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- dd. Clarify research questions, and design laboratory investigations. (DOK 3)
- ee. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

- ff. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
- gg. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- hh. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ii. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

- y. Describe the characteristics of the electromagnetic spectrum.
- z. Using images and graphs, interpret the absorption/reflection spectrum.
- aa. Distinguish between passive vs. active sensor systems.
- bb. Analyze the effects of changes in spatial, temporal, and spectral resolution.
- cc. Analyze the effects on images due to changes in scale.
- dd. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- cc. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- dd. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ee. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ff. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- gg. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- hh. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ii. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- q. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- r. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- s. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- t. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenetic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- u. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- v. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- w. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- x. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- y. Contrast food chains and food webs. (DOK 2)
- 4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- i. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
 - Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- j. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

Industry Standards

CONTREN CORE

SAF – Basic Safety

- Explain the role that safety plays in the construction crafts.
- Describe the meaning of jobsite safety.
- Describe the characteristics of a competent person and a qualified person.
- Explain the appropriate safety precautions to take around common jobsite hazards.
- Demonstrate the use and care of appropriate personal protective equipment (PPE).
- Properly don and remove personal protective equipment (safety goggles, hard hat, and personal fall protection).
- Follow the safety procedures required for lifting heavy objects.
- Describe safe behavior on and around ladders and scaffolds.
- Explain the importance of Hazard Communications (HazCom) and material safety data sheets (MSDSs).
- Describe fire prevention and firefighting techniques.
- Define safe work procedures to use around electrical hazards.

MAT – Introduction to Construction Math

- Add, subtract, multiply, and divide whole numbers, with and without a calculator.
- Use a standard ruler and a metric ruler to measure.
- Add, subtract, multiply, and divide fractions.
- Add, subtract, multiply, and divide decimals, with and without a calculator.
- Convert decimals to percentages and percentages to decimals.
- Convert fractions to decimals and decimals to fractions.
- Explain what the metric system is and how it is important in the construction trade.
- Recognize and use metric units of length, weight, volume, and temperature.
- Recognize some of the basic shapes used in the construction industry, and apply basic geometry to measure them.

HTO – Introduction to Hand Tools

- Recognize and identify some of the basic hand tools used in the construction trade.
- Use hand tools safely.
- Describe the basic procedures for taking care of hand tools.

PTO – Introduction to Power Tools

- Identify power tools commonly used in the construction trades.
- Use power tools safely.
- Explain how to maintain power tools properly.

BLU – Introduction to Blueprints

- Recognize and identify basic blueprint terms, components, and symbols.
- Relate information on blueprints to actual locations on the print.
- Recognize different classifications of drawings.
- Interpret and use drawing dimensions.

RIG – Basic Rigging

- Identify and describe the use of slings and common rigging hardware.
- Describe basic inspection techniques and rejection criteria used for slings and hardware.
- Describe basic hitch configurations and their proper connections.
- Describe basic load-handling safety practices.
- Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COM – Basic Communication Skills

- Demonstrate the ability to interpret information and instructions presented in both written and verbal form.
- Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

EMP – Basic Employability Skills

- Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.
- Demonstrate critical-thinking skills and the ability to solve problems using those skills.
- Demonstrate knowledge of computer systems, and explain common uses for computers in the construction industry.
- Demonstrate effective relationship skills with teammates and supervisors, the ability to work on a team, and appropriate leadership skills.
- Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

CONTREN INDUSTRIAL MAINTENANCE TECHNICIAN

LEVEL ONE

OTI – Orientation to the Trade

- Describe the types of work performed by industrial maintenance craft workers.
- Identify career opportunities available to industrial maintenance craft workers.
- Explain the purpose and objectives of an apprentice training program.
- Explain the responsibilities and characteristics of a good industrial maintenance craft worker.
- Explain the importance of safety in relation to industrial maintenance craft workers.
- Explain the role of NCCER in the training process.

TTI – Tools of the Trade

- Explain the purpose of each of the tools commonly used by industrial maintenance craft workers.
- Describe how to maintain each of the tools used by industrial maintenance craft workers.
- Demonstrate the proper use and basic maintenance of selected industrial maintenance tools.

FAN – Fasteners and Anchors

- Identify and explain the use of threaded fasteners.
- Identify and explain the use of non-threaded fasteners.
- Identify and explain the use of anchors.
- Select the correct fasteners and anchors for given applications.
- Install fasteners and anchors.

OXC – Oxy-Fuel Cutting

- Identify and explain the use of oxy-fuel cutting equipment.
- State the safety precautions for using oxy-fuel equipment.
- Set up oxy-fuel cutting equipment.
- Light and adjust an oxy-fuel torch.
- Shut down oxy-fuel cutting equipment.
- Disassemble oxy-fuel cutting equipment.
- Change empty cylinders.
- Perform oxy-fuel cutting:
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing
- Apply a rosebud flame to remove frozen components (also for preheat and expanding larger fittings).
- Operate a motorized, portable oxy-fuel gas cutting machine.

GPI – Gaskets and Packing

- Identify the various types of gaskets, and explain their uses.
- Identify the various types of gasket materials, and explain their applications.
- Lay out, cut, and install a flange gasket.
- Describe the use of O-rings.
- Explain the importance of selecting the correct O-ring for an application.
- Select an O-ring for a given application, and install it.
- Describe the uses and methods of packing.

TMI – Craft-Related Mathematics

- Identify and explain the use of special measuring devices.
- Use tables of weights and measurements.
- Use formulas to solve basic problems.

- Solve area problems.
- Solve volume problems.
- Solve circumference problems.
- Solve right triangles using the Pythagorean theorem.

CDI – Construction Drawings

- Explain the basic layout of a blueprint.
- Describe the information included in the title block of a blueprint.
- Identify the types of lines used on blueprints.
- Identify common symbols used on blueprints.
- Understand the use of architect's and engineer's scales.
- Demonstrate the use of an architect's scale.

PAD – Pumps and Drivers

- Identify and explain centrifugal pumps.
- Identify and explain rotary pumps.
- Identify and explain reciprocating pumps.
- Identify and explain metering pumps.
- Identify and explain vacuum pumps.
- Explain net positive suction head and cavitation.
- Identify types of drivers.

ITV – Introduction to Valves

- Identify types of valves that start and stop flow.
- Identify types of valves that regulate flow.
- Identify valves that relieve pressure.
- Identify valves that regulate the direction of flow.
- Explain how to properly store and handle valves.
- Explain valve locations and positions.

ITE – Introduction to Test Equipment

- Explain the operation of and describe the following pieces of test equipment:
 - Tachometer
 - Pyrometers
 - Multimeters
 - Automated diagnostics tools
 - Wiggy voltage tester
 - Stroboscope
- Explain how to read and convert from one scale to another using the above test equipment.
- Define frequency, and explain the use of a frequency meter.

MHR – Material Handling and Hand Rigging

- Identify and describe the uses of common rigging hardware and equipment.
- Inspect common rigging equipment.
- Select, use, and maintain special rigging equipment, including the following:
 - Jacks
 - Block and tackle
 - Chain hoists
 - Come-alongs
- Tie knots used in rigging.
- Use and understand the correct hand signals to guide a crane operator.
- Identify basic rigging and crane safety procedures.

MSE – Mobile and Support Equipment

- State the safety precautions associated with the use of motor-driven equipment in industrial plants.
- Explain the operation and applications of the following motor-driven equipment commonly used in industrial plants:
 - Portable generators
 - Air compressors
 - Aerial lifts
 - Forklifts
 - Mobile cranes
- Operate and perform preventive maintenance on the following equipment:
 - Portable generators
 - Air compressors
 - Aerial lifts

LUB – Lubrication

- Explain OSHA hazard communication as pertaining to lubrication.
- Read and interpret a material data safety sheet (MSDS).
- Explain the EPA hazardous waste control program.
- Explain lubricant storage.
- Explain lubricant classification.
- Explain lubricant film protection.
- Explain properties of lubricants.
- Explain properties of greases.
- Explain how to select lubricants.
- Identify and explain types of additives.
- Identify and explain types of lubricating oils.
- Identify and use lubrication equipment to apply lubricants.
- Read and interpret a lubrication chart.

LEVEL TWO

NEC – Introduction to the National Electrical Code

- Explain the purpose and history of the National Electrical Code (NEC).
- Describe the layout of the NEC.
- Explain how to navigate the NEC.
- Describe the purpose of the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA).
- Explain the role of nationally recognized testing laboratories.

ETO – Electrical Theory

- Define voltage, and identify the ways in which it can be produced.
- Explain the difference between conductors and insulators.
- Define the units of measurement that are used to measure the properties of electricity.
- Identify the meters used to measure voltage, current, and resistance.
- Explain the basic characteristics of series and parallel circuits.
- Use Kirchhoff's current law to calculate the total and unknown currents in parallel and series-parallel circuits.
- Use Kirchhoff's voltage law to calculate voltage drops in series, parallel, and series-parallel circuits.
- Use the formula for Ohm's law to calculate voltage, current, and resistance.

ALT – Alternating Current

- Calculate the peak and effective voltage or current values for an AC waveform.
- Calculate the phase relationship between two AC waveforms.
- Describe the voltage and current phase relationship in a resistive AC circuit.
- Describe the voltage and current transients that occur in an inductive circuit.
- Define inductive reactance, and state how it is affected by frequency.
- Describe the voltage and current transients that occur in a capacitive circuit.
- Define capacitive reactance, and state how it is affected by frequency.
- Explain the relationship between voltage and current in the following types of AC circuits:
 - RL circuit
 - RC circuit
 - LC circuit
 - RLC circuit
- Explain the following terms as they relate to AC circuits:
 - True power
 - Apparent power
 - Reactive power
 - Power factor
- Explain basic transformer action.

HBE – Hand Bending

- Identify the methods for hand bending and installing conduit.
- Calculate conduit bends.
- Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
- Cut, ream, and thread conduit.

CON – Conductor Terminations and Splices

- Describe how to make a sound conductor termination.
- Prepare cable ends for terminations and splices, and connect the ends using lugs or connectors.
- Train cable at termination points.
- Describe the National Electrical Code requirements for making cable terminations and splices.
- Demonstrate crimping techniques.
- Select the proper lug or connector for the job.

LEVEL THREE

HPC – Hydraulic and Pneumatic Controls

- Explain hydraulic system safety.
- Explain the principles of hydraulics.
- Identify and explain hydraulic fluids.
- Identify and explain hydraulic system parts.
- Identify and explain hydraulic pumps.
- Identify and explain hydraulic motors.
- Explain pneumatic safety.
- Explain the physical characteristics of gases.
- Explain compressing gases.
- Explain the pneumatic transmission of energy.
- Explain the principles of compressor operation.
- Identify and explain types of compressors.
- Explain compressed-air treatment.
- Identify and explain pneumatic system components and symbols.

CONTREN HVAC

LEVEL ONE

INT – Introduction to HVAC

- Explain the basic principles of heating, ventilating, and air-conditioning.
- Identify career opportunities available to people in the HVAC trade.
- Explain the purpose and objectives of an apprentice training program.
- Describe how certified apprentice training can start in high school.

- Describe what the Clean Air Act means to the HVAC trade.
- Describe the types of regulatory codes encountered in the HVAC trade.
- Identify the types of schedules/drawings used in the HVAC trade.

TMH – Trade Mathematics

- Identify similar units of measurement in both the inch–pound (English) and metric systems, and state which units are larger.
- Convert measured values in the inch–pound system to equivalent metric values and vice versa.
- Express numbers as powers of ten.
- Determine the powers and roots of numbers.
- Solve basic algebraic equations.
- Identify various geometric figures.
- Use the Pythagorean theorem to make calculations involving right triangles.
- Convert decimal feet to feet and inches and vice versa.
- Calculate perimeter, area, and volume.
- Convert temperature values between Celsius and Fahrenheit.

CPP – Copper and Plastic Piping Practices

- State the precautions that must be taken when installing refrigerant piping.
- Select the right tubing for a job.
- Cut and bend copper tubing.
- Safely join tubing by using flare and compression fittings.
- Determine the kinds of hangers and supports needed for refrigerant piping.
- State the basic safety requirements for pressure-testing a system once it has been installed.
- Identify types of plastic pipe, and state their uses.
- Cut and join lengths of plastic pipe.

SBR – Soldering and Brazing

- Assemble and operate the tools used for soldering.
- Prepare tubing and fittings for soldering.
- Identify the purposes and uses of solder and solder fluxes.
- Solder copper tubing and fittings.
- Assemble and operate the tools used for brazing.
- Prepare tubing and fittings for brazing.
- Identify the purposes and uses of filler metals and fluxes used for brazing.
- Braze copper tubing and fittings.
- Identify the inert gases that can be used safely to purge tubing when brazing.

FMP – Ferrous Metal Piping Practices

- Identify the types of ferrous metal pipes.
- Measure the sizes of ferrous metal pipes.

- Identify the common malleable iron fittings.
- Cut, ream, and thread ferrous metal pipe.
- Join lengths of threaded pipe together, and install fittings.
- Describe the main points to consider when installing pipe runs.
- Describe the methods used to join grooved piping.

BEL – Basic Electricity

- State how electrical power is distributed.
- Describe how voltage, current, resistance, and power are related.
- Use Ohm’s law to calculate the current, voltage, and resistance in a circuit
- Use the power formula to calculate how much power is consumed by a circuit.
- Describe the difference between series and parallel circuits, and calculate loads in each.
- Describe the purpose and operation of the various electrical components used in HVAC equipment.
- State and demonstrate the safety precautions that must be followed when working on electrical equipment.
- Make voltage, current, and resistance measurements using electrical test equipment.
- Read and interpret common electrical symbols.

ITC – Introduction to Cooling

- Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
- Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
- Under supervision, use temperature- and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
- Identify commonly used refrigerants, and demonstrate the proper procedures for handling these refrigerants.
- Identify the major components of a cooling system, and explain how each type works.
- Identify the major accessories available for cooling systems, and explain how each works.
- Identify the control devices used in cooling systems, and explain how each works.
- State the correct methods to be used when piping a refrigeration system.

ITH – Introduction to Heating

- Explain the three methods by which heat is transferred, and give an example of each.
- Describe how combustion occurs, and identify the byproducts of combustion.
- Identify various types of fuels used in heating.
- Identify the major components and accessories of an induced draft and condensing gas furnace, and explain the function of each component.
- State the factors that must be considered when installing a furnace.
- Identify the major components of a gas furnace, and describe how each works.

- With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
- Identify the major components of an oil furnace, and describe how each works.
- Describe how an electric furnace works.
- With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

ADS – Air Distribution Systems

- Describe the airflow and pressures in a basic forced-air distribution system.
- Explain the differences between propeller and centrifugal fans and blowers.
- Identify the various types of duct systems, and explain why and where each type is used.
- Demonstrate or explain the installation of metal, fiberboard, and flexible duct.
- Demonstrate or explain the installation of fittings and transitions used in duct systems.
- Demonstrate or explain the use and installation of diffusers, registers, and grilles used in duct systems.
- Demonstrate or explain the use and installation of dampers used in duct systems.
- Demonstrate or explain the use and installation of insulation and vapor barriers used in duct systems.
- Identify instruments used to make measurements in air systems, and explain the use of each instrument.
- Make basic temperature, air pressure, and velocity measurements in an air distribution system.

ACS – Commercial Airside Systems

- Identify the differences in types of commercial all-air systems.
- Identify the type of building in which a particular type of system is used.
- Explain the typical range of capacities for a commercial air system.

LEVEL TWO

LDE – Leak Detection, Evacuation, Recovery, and Charging

- Identify the common types of leak detectors, and explain how each is used.
- Perform leak detection tests using selected methods.
- Identify the service equipment used for evacuating a system, and explain why each item of equipment is used.
- Perform system evacuation and dehydration.
- Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.
- Perform a refrigerant recovery.
- Evacuate a system to a deep vacuum.
- Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.
- Use nitrogen to purge a system.

- Charge refrigerant into a system by the following methods:
 - Weight
 - Superheat
 - Subcooling
 - Charging pressure chart

ALT – Alternating Current

- Describe the operation of various types of transformers.
- Explain how alternating current is developed, and draw a sine wave.
- Identify single-phase and three-phase wiring arrangements.
- Explain how phase shift occurs in inductors and capacitors.
- Describe the types of capacitors and their applications.
- Explain the operation of single-phase and three-phase induction motors.
- Identify the various types of single-phase motors and their applications.
- State and demonstrate the safety precautions that must be followed when working with electrical equipment.
- Test AC components, including capacitors, transformers, and motors.

BAE – Basic Electronics

- Explain the basic theory of electronics and semiconductors.
- Explain how various semiconductor devices such as diodes, LEDs, and photo diodes work and how they are used in power and control circuits.
- Identify different types of resistors, and explain how their resistance values can be determined.
- Describe the operation and function of thermistors and cad cells.
- Test semiconductor components.
- Identify the connectors on a personal computer.

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Heating Ventilation and Air Conditioning Executive Summary	400
Course Outlines.....	404
Heating Ventilation and Air Conditioning Competencies and Objectives	407
Heating Ventilation and Air Conditioning Competency Profile.....	412
Appendix A: 21st Century Skills Standards	415
Appendix B: MS Academic Standards	417
Appendix C: ACT College Readiness Standards.....	447
Appendix D: Pathway Content Standards.....	461
Appendix E: National Educational Technology Standards for Students	472

Heating Ventilation and Air Conditioning

Heating Ventilation and Air Conditioning Executive Summary

Program Description

The Installation and Service: HVAC concentration is an instructional program that prepares students for employment or continued education in the occupations of heating, ventilation, and air-conditioning. The curriculum framework for this program was developed in partnership with the Mississippi Construction Education Foundation (MCEF). MCEF is the accredited sponsor for the National Center for Construction Education and Research (NCCER).

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **Contren Learning Series**. When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi Construction Technology instructors will be required to successfully complete the **Instructor Certification Training Program**. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi **NCCER Accredited Training and Education Facilities (ATEF)**. In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

11. Use the approved curriculum.
12. All instructors must be NCCER certified.
13. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
14. Follow NCCER guidelines on test security and performance profiles.
15. Have an active advisory committee with at least two commercial contractors involved.
16. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
17. Involve commercial contractors in class presentations or field trips.
18. All construction programs must be included in the accreditation process.
19. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
20. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Assessment

Students will be assessed using the Installation and Service: HVAC MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the Construction and Manufacturing instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Installation and Service: HVAC program, the following student prerequisites are in place:

5. C or higher in English (the previous year)
6. C or higher in Math (last course taken or the instructor can specify the math)
- or**
7. Instructor Approval and TABE Reading Score (eighth grade or higher)
- or**
8. Instructor Approval

Proposed Applied Academic Credit

Applied Math content from the curriculum was aligned to the 2007 Mississippi Math Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Math credit that can be used for graduation requirements.

The applied academic credit has ***not*** been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A 974 educator license is required to teach the Installation and Service: HVAC concentration program. Requirements for the 974 endorsement are listed below:

10. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education.
11. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught. Applicant with a bachelor's or higher degree must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
12. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
13. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
14. Applicant must earn a passing score on Heating, Ventilation, and Air-Conditioning assessment from National Craft Assessment and Certification Program.

15. Applicant must successfully complete the Contren Instructor Certification.
16. Applicant must successfully complete an MDE-approved computer literacy certification exam.
17. Applicant must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
18. Applicant must successfully complete the Installation and Service: HVAC certification workshop, module, or course that is approved by the MDE.

Note: If the applicant meets all requirements listed above, that applicant will be issued a 974 endorsement—a 5-year license. If the applicant does not meet **all** requirements, the applicant will be issued a 3-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows options for local school districts to implement based on student needs and scheduling demands. This curriculum offers a four-Carnegie-unit program.

Option 1

Upon completion of this option, the student will be trained to take the **NCCER Core Level 1 Certification and HVAC Level 1 Certification** exams. This curriculum consists of four one-credit courses, which should be completed in the following sequence:

- Installation and Service, Part A (Course Code: 993002)
- Installation and Service, Part B (Course Code: 993003)
- Installation and Service II—HVAC, Part A (Course Code: 993022)
- Installation and Service II—HVAC, Part B (Course Code: 993023)

Course Description: Installation and Service, Part A (Course Code: 993002) includes an introduction to the field as well as fundamentals of safety, math, blueprint reading, and hand and power tools. This is a one-Carnegie-unit course.

Course Description: Installation and Service, Part B (Course Code: 993003) emphasizes an overview of safety and leadership, the lathe theory, and grinding operations. This course gives students real-world, hands-on practice in these areas. This one-Carnegie-unit course should only be taken after students successfully pass Installation and Service, Part A.

Course Description: Installation and Service II—HVAC, Part A (Course Code: 993022) includes an in-depth study of the heating, ventilation, and air-conditioning profession, HVAC math, ferrous metal piping practice, introduction to cooling, and introduction to heating. This course also reinforces safety related to the installation and service of HVAC applications. This one-Carnegie-unit course should only be taken after students successfully pass Installation and Service, Part B.

Course Description: Installation and Service II—HVAC, Part B (Course Code: 993023) includes an in-depth study of the heating, ventilation, and air conditioning profession, air distribution systems, leak detection evacuation recovery and charging, alternating current, and basic electronics. This course also reinforces safety related to the installation and service of HVAC applications. This one-Carnegie-unit course should only be taken after students successfully pass Installation and Service II—HVAC, Part A.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete installation and service courses with a score of 80/C or higher in classwork to advance to the next level.

Installation and Service, Part A (Course Code: 993002)

Unit	Title	Hours
1	Orientation and Safety	50
2	Math, Introduction to Blueprints, and Hand and Power Tools	90
		140

Installation and Service, Part B (Course Code: 993003)

Unit	Title	Hours
3	Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)	70
4	Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)	70
		140

Installation and Service II—HVAC, Part A (Course Code: 993022)

Unit	Title	Hours
5	Orientation and Safety (Review and Reinforcement)	20
6	Trade Math, Ferrous Metal Piping Practice, Introduction to Cooling, and Introduction to Heating	120
		140

Installation and Service II—HVAC, Part B (Course Code: 993023)

Unit	Title	Hours
7	Air Distribution Systems, Leak Detection Evacuation Recovery and Charging, Alternating Current, and Basic Electronics	140
		140

Option 2

Course Description: Installation and Service I is a course that students learn about Heating, Ventilation, and Air-Conditioning. Topics include Math, Introduction to Blueprints, Hand and Power Tools, Orientation to the Trade, and Introduction to HVAC. This is a two-Carnegie-unit course.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.

Course Description: Installation and Service II—HVAC is a continuation with the emphasis on Heating, Ventilation, and Air-Conditioning. Topics include employability skills, safety, ferrous metal piping, introduction to cooling, introduction to heating, air distribution, leak detection evacuation recovery and charging, alternating current, and basic electronics. The course should be taken after the student has successfully passed Installation and Service I. This is a two-Carnegie-unit course.

- Scheduling and operating more than one course in the same classroom/laboratory with the same instructor is not allowed.
- Safety will be reinforced and tested at the beginning of each course.
- Students must complete manufacturing trade courses with a score of 80/C or higher in classwork to advance to the next level.

Installation and Service I (Course Code: 993001)

Unit	Title	Hours
1	Orientation and Safety	45
2	Math, Introduction to Blueprints, and Hand and Power Tools	85
3	Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)	75
4	Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)	75
		280

Installation and Service II: HVAC (Course Code: 993021)

Unit	Title	Hours
5	Orientation and Safety (Review and Reinforcement)	5
6	Trade Math, Ferrous Metal Piping Practice, Introduction to Cooling, and Introduction to Heating	140
7	Air Distribution Systems, Leak Detection Evacuation Recovery and Charging, Alternating Current, and Basic Electronics	135
		280

Heating Ventilation and Air Conditioning Competencies and Objectives

Unit 1: Orientation and Safety

1. Describe local program and vocational/career technical center policies and procedures. (CONTREN Module: 00107-04 and 00108-04) (DOK 1)
 - a. Describe local program and vocational/career technical center policies and procedures. (DOK1)
2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (CONTREN Module: 00107-04, 00108-04, and 40101-07 Orientation to the Trade, IM) (DOK 2)
 - a. Describe employer expectations in the workplace. (DOK2)
3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (CONTREN Module: 00107-04 and 00108-04) (DOK 2)
 - a. Demonstrate effective team-building and leadership skills. (DOK2)
 - b. Demonstrate through practice appropriate work ethics. (DOK2)
4. Describe general safety rules for working in a shop/lab and industry. (CONTREN Module: 00101-04) (DOK 1)
 - a. Discuss safety issues and prevention associated with the installation and service shop area. (DOK1)
 - b. Explain fire safety and prevention. (DOK1)

Unit 2: Math, Introduction to Blueprints, and Hand and Power Tools

1. Apply the four basic math skills with whole numbers, fractions, and percents. (CONTREN Module: 00102-04, 00105-04, 40106-07, and 03201-07) (DOK 1)
 - a. Perform mathematic calculations relating to the installation and service trade. (DOK1)
2. Perform basic mathematical calculations related to industrial maintenance shop operations. (CONTREN Module: 00102-04, 00105-04, and 40106-07) (DOK 1)
 - a. Use the metric system in industrial maintenance and HVAC applications. (DOK1)
 - b. Compute distances according to a drawn plan, and then calculate the amount of material for a given project. (DOK1)
3. Identify and perform functions using various measuring tools and instruments (CONTREN Module: 00102-04, 40106-07, and 03102-07). (DOK 2)
 - a. Read a rule and lay out lines to the nearest 1/16 in. (DOK2)
4. Read, analyze, and design a blueprint. (CONTREN Module: 00105-04) (DOK 2)
 - a. Identify and interpret terms and symbols commonly used on blueprints. (DOK2)
5. Demonstrate the use and maintenance of various hand and power tools found in the industrial maintenance and HVAC trade. (CONTREN Module: 00101-04, 00103-04, 00104-04, and 40102-07) (DOK 3)
 - a. Identify and discuss the proper safe use of common hand and power tools. (DOK1)

- b. Select and demonstrate the use of tools, and explain the procedures for maintaining hand and power tools. (DOK3)

Unit 3: Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)

1. The student will research and distinguish job opportunities in the industrial maintenance field and then reflect upon the importance of the industrial maintenance mechanic's role in the modern manufacturing and service industry (CONTREN: 00108-04 and 40101-07) (DOK 2)
 - a. Describe employment opportunities in the industrial maintenance profession. (DOK2)
2. Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. (CONTREN: 00103-04, 00104-04, and 40102-07) (DOK 2)
 - a. Illustrate the use of tools used in the industrial maintenance profession. (DOK2)
 - b. Identify and use common hand and power tools used in the industrial maintenance trade. (DOK2)
3. Identify various fasteners and anchors found in the industrial and HVAC trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application (CONTREN Module: 40103-07 Fasteners and Anchors). (DOK2)
 - a. Identify and install threaded fasteners, non-threaded fasteners, and anchors. (DOK2)
 - b. Identify various grades of bolt hardness. (DOK1)
4. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (CONTREN Module: 40104-07 Oxy-Fuel Cutting) (DOK 2)
 - a. Identify and explain the use of oxy-fuel cutting equipment. (DOK1)
 - b. Demonstrate how to use an oxy-fuel torch. (DOK2)
 - c. Perform oxy-fuel cutting (DOK2):
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing

Unit 4: Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)

1. Identify and explain heating, ventilation, and air-conditioning systems, HVAC environmental law, and job opportunities that are available in the HVAC profession. (CONTREN Module: 03101-07 Introduction to HVAC) (DOK 2)
 - a. Explain the basic principles of heating, ventilating, and air-conditioning. (DOK2)
 - b. Describe what the Clean Air Act means to the HVAC trade. (DOK1)
 - c. Identify the types of schedules/ drawings used in the HVAC trade. (DOK1)
2. Demonstrate the safe use and routine maintenance of hand and power tools used in the HVAC trade. (CONTREN Module: 00103-04, 00104-04, & 040102-07) (DOK2).

- a. Demonstrate the safe use and maintenance of hand and power tools used in HVAC. (DOK2)
3. Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment. (CONTREN Module: 03103-07 Copper and Plastic Piping) (DOK 2)
 - a. Discuss and demonstrate how to use copper tubing in HVAC. (DOK2)
 - b. Discuss and demonstrate how to use plastic tubing in HVAC. (DOK2)
4. Prepare and solder copper piping systems in various industrial and HVAC applications and properly clean, install fittings, and braze piping (silver solder). (CONTREN Module: 40104-07 and 03104-07) (DOK2)
 - a. Solder copper pipe in HVAC. (DOK2)
 - b. Braze copper pipe in HVAC. (DOK2)
5. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. (CONTREN Module: 03106-07, 40203-08, 03206-07, and 03207-07) (DOK 2)
 - a. Describe how voltage, current, resistance, and power are mathematically related. (DOK2)
 - b. Describe the difference between series and parallel circuits, and calculate loads in each. (DOK2)
 - c. Describe the purpose and operation of the various electrical components used in equipment. (DOK2)

Unit 5: Orientation and Safety (Review and Reinforcement)

1. Describe local program and vocational/career technical center policies and procedures. (CONTREN Modules: 00107-04 and 00108-04) (DOK 1)
 - a. Describe local program and vocational/career technical center policies and procedures. (DOK1)
2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (CONTREN Modules: 00108-04, 40101-07, and 03103-07) (DOK 2)
 - a. Describe employer expectations in the workplace. (DOK2)
3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (CONTREN Modules: 00107-04 and 00108-07) (DOK 2)
 - a. Demonstrate effective team-building and leadership skills. (DOK1)
 - b. Demonstrate through practice appropriate work ethics. (DOK2)
4. Describe general safety rules for working in a shop/lab and industry. (CONTREN Modules: 00101-04) (DOK 1)
 - a. Discuss safety issues and prevention associated with the installation and service shop area. (DOK1)
 - b. Explain fire safety and prevention in the workplace. (DOK1)

Unit 6: Trade Math, Ferrous Metal Piping Practice, Introduction to Cooling, and Introduction to Heating

1. Identify proper math to use for problem solving; use English and metric measurement; use powers, algebra, and geometric calculation to solve for HVAC problems; and convert Fahrenheit to Celsius. (CONTREN Module: 03102-07) (DOK 2)
 - a. Demonstrate how to calculate mathematic problems found in the HVAC area. (DOK2)
2. Recognize types and sizes of ferrous metal piping and pipe fittings, and also recognize and use tools used to cut, ream, and thread ferrous pipe in the HVAC application. (CONTREN Module: 03105-07) (DOK 2).
 - a. Explain the uses of ferrous metal pipes in the HVAC trade. (DOK2)
3. Explain the basic theory of cooling systems, heat transfer, trade terms, refrigerants, components of the cooling system, controls, and proper piping of the cooling system. (CONTREN Module: 03107-07) (DOK 2)
 - a. Explain how an HVAC system removes heat from an air-conditioned area of an HVAC system. (DOK2)
 - b. Identify the major components, accessories, and control devices available for cooling systems, and explain how each works. (DOK2)
4. Explain methods of heat transfer and characteristics of combustion, identify types of fuels and types of furnaces and components of the electric and gas furnace, identify and safely use meters in gas measurement, and perform maintenance on electric and gas furnaces. (CONTREN Modules: 03108-07)(DOK 2)
 - a. Explain how an HVAC heating system operates. (DOK2)
 - b. Describe how an electric furnace works. (DOK1)
 - c. With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement. (DOK2)

Unit 7: Air Distribution Systems, Leak Detection Evacuation Recovery and Charging, Alternating Current, and Basic Electronics

1. The student will understand the general practices of designing and installing HVAC duct and piping systems (CONTREN Modules: 03109-07) (DOK 2).
 - a. Discuss and explain the patterns of air flow and pressures in an HVAC duct. (DOK2)
 - b. Identify types of duct systems, and explain where each is used in installation and service applications. (DOK2)
2. The student will identify leaks in an HVAC system and perform the proper steps to repair the leak restoring the unit to operation. (CONTREN Modules: 03205-07) (DOK 2)
 - a. Define and perform a leak test on an HVAC system. (DOK2)
 - b. Use nitrogen to purge a system and charge refrigerant into a system by the following methods (DOK2)
 - Weight
 - Superheat
 - Subcooling
 - Charging pressure

3. Gain an understanding of the safe operation of electrical transformers, motors, and single- and three-phase HVAC devices. (CONTREN Modules: 03206-07) (DOK 2)
 - a. Explain and demonstrate the safe operation of various types of transformers. (DOK2)
 - b. Describe the types of capacitors and motors found in the HVAC unit. (DOK1)
 - c. State and demonstrate the safety precautions that must be followed when working with electrical equipment and testing AC components, including capacitors, transformers, and motors. (DOK1)
4. Explain and apply basic electrical theory to HVAC applications and how to troubleshoot common electronic devices found in HVAC systems. (CONTREN Modules: 03207-07)(DOK 2)
 - a. Explain basic electronic theory of semiconductors, and test the operation of various semiconductor devices such as resistors, diodes, LEDs, thermistors, cad cells, and photo diodes. Explain how these devices are used in power and control circuits. (DOK2)

Heating Ventilation and Air Conditioning Competency Profile

Program CIP: 47.0201

Unit 1: Orientation and Safety

- _____ 1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
- _____ 2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (DOK 2)
- _____ 3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2)
- _____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)

Unit 2: Math, Introduction to Blueprints, and Hand and Power Tools

- _____ 1. Apply the four basic math skills with whole numbers, fractions, and percents. (DOK 1)
- _____ 2. Perform basic mathematical calculations related to industrial maintenance shop operations. (DOK 1)
- _____ 3. Identify and perform functions using various measuring tools and instruments. (DOK 2)
- _____ 4. Read, analyze, and design a blueprint. (DOK 2)
- _____ 5. Demonstrate the use and maintenance of various hand and power tools found in the industrial maintenance and HVAC trade. (DOK 3)

Unit 3: Orientation to the Trade, Tools of the Trade, Fasteners and Anchors, and Oxy-Fuel Cutting (IM)

- _____ 1. The student will research and distinguish job opportunities in the industrial maintenance field and then reflect upon the importance of the industrial maintenance mechanic's role in modern manufacturing and service industry. (DOK 2)
- _____ 2. Identify and use tools found in the industrial maintenance trade, describe how each is used, and discuss proper care and maintenance of the tools. (DOK 2)
- _____ 3. Identify various fasteners and anchors found in the industrial and HVAC trade, how to install and remove fasteners and anchors, and how to select the correct fastener or anchor for an application. (DOK 2)
- _____ 4. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (DOK 2)

Unit 4: Introduction to HVAC, Tools of the Trade (HVAC), Copper and Plastic Piping, Soldering and Brazing, and Basic Electricity (IM)

- _____ 1. Identify and explain heating, ventilation, and air-conditioning systems, HVAC environmental law, and job opportunities that are available in the HVAC profession. (DOK 2)
- _____ 2. Demonstrate the safe use and routine maintenance of hand and power tools used in the HVAC trade. (DOK 2)
- _____ 3. Identify and discuss the tools used in the piping trade, discuss the materials and methods of connecting piping systems, and perform copper and plastic piping tasks found in the industrial maintenance and HVAC environment. (DOK 2)
- _____ 4. Prepare and solder copper piping systems in various industrial and HVAC applications and properly clean, install fittings, and braze piping (silver solder). (DOK 2)
- _____ 5. Identify electrical safety hazards, demonstrate safety around circuits and equipment, describe basic electricity laws, interpret electrical drawings and schematics, and demonstrate wiring basic electrical circuits. (DOK 2)

Unit 5: Orientation and Safety (Review and Reinforcement)

- _____ 1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
- _____ 2. Describe employment opportunities and responsibilities of the industrial and HVAC mechanic. (DOK 2)
- _____ 3. Explore leadership skills and personal development opportunities provided for students by student organizations to include SkillsUSA. (DOK 2)
- _____ 4. Describe general safety rules for working in a shop/lab and industry. (DOK 1)

Unit 6: Trade Math, Ferrous Metal Piping Practice, Introduction to Cooling, and Introduction to Heating

- _____ 1. Identify proper math to use for problem solving; use English and metric measurement; use powers, algebra, and geometric calculation to solve for HVAC problems; and convert Fahrenheit to Celsius. (DOK 2)
- _____ 2. Recognize types and sizes of ferrous metal piping and pipe fittings, and also recognize and use tools used to cut, ream, and thread ferrous pipe in the HVAC application. (DOK 2)
- _____ 3. Explain the basic theory of cooling systems, heat transfer, trade terms, refrigerants, components of the cooling system, controls, and proper piping of the cooling system. (DOK 2)
- _____ 4. Explain methods of heat transfer and characteristics of combustion, identify types of fuels and types of furnaces and components of the electric and gas furnace, identify and safely use meters in gas measurement, and perform maintenance on electric and gas furnaces. (DOK 2)

Unit 7: Air Distribution Systems, Leak Detection Evacuation Recovery and Charging, Alternating Current, and Basic Electronics

- _____ 1. The student will understand the general practices of designing and installing HVAC duct and piping systems. (DOK 2)
- _____ 2. The student will identify leaks in an HVAC system and perform the proper steps to repair the leak restoring the unit to operation. (DOK 2)
- _____ 3. Gain an understanding of the safe operation of electrical transformers, motors, and single- and three-phase HVAC devices. (DOK 2)
- _____ 4. Explain and apply basic electrical theory to HVAC applications and how to troubleshoot common electronic devices found in HVAC systems. (DOK 2)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

16. Using 21st century skills to understand and address global issues
17. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
18. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

16. Knowing how to make appropriate personal economic choices
17. Understanding the role of the economy in society
18. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

16. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
17. Exercising the rights and obligations of citizenship at local, state, national, and global levels
18. Understanding the local and global implications of civic decisions

CS4 Health Literacy

26. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
27. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
28. Using available information to make appropriate health-related decisions
29. Establishing and monitoring personal and family health goals
30. Understanding national and international public health and safety issues

CS5 Environmental Literacy

21. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
22. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
23. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
24. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

16. Think Creatively
17. Work Creatively with Others

- 18. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 21. Reason Effectively
 - 22. Use Systems Thinking
 - 23. Make Judgments and Decisions
 - 24. Solve Problems
- CS8 Communication and Collaboration**
 - 11. Communicate Clearly
 - 12. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 11. Access and Evaluate Information
 - 12. Use and Manage Information
- CS10 Media Literacy**
 - 11. Analyze Media
 - 12. Create Media Products
- CS11 ICT Literacy**
 - 6. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 11. Adapt to change
 - 12. Be Flexible
- CS13 Initiative and Self-Direction**
 - 16. Manage Goals and Time
 - 17. Work Independently
 - 18. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 11. Interact Effectively with others
 - 12. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 11. Manage Projects
 - 12. Produce Results
- CS16 Leadership and Responsibility**
 - 11. Guide and Lead Others
 - 12. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

6. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- jj. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- kk. Explain the causes and characteristics of tides. (DOK 1)
- ll. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- mm. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- nn. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- oo. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
- Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
- pp. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
3. **Apply an understanding of the diverse organisms found in aquatic environments.**
- ee. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
- ff. Research, calculate, and interpret population data. (DOK 2)
- gg. Research and compare reproductive processes in aquatic organisms. (DOK 2)
- hh. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
- ii. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
- jj. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
- tt. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
- uu. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
- vv. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- f. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- ww. Formulate questions that can be answered through research and experimental design. (DOK 3)
- xx. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- yy. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- zz. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- aaa. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- bbb. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- jj. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- kk. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- ll. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- mm. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- nn. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- oo. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
 - ATP function
- pp. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- p. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- q. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- r. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- u. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- v. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- w. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- x. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- u. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- v. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- w. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - x. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- z. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - aa. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - bb. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - cc. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - dd. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - kk. Clarify research questions and design laboratory investigations. (DOK 3)
 - ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- u. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - v. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - w. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - x. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- z. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - aa. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - bb. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- cc. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- dd. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- tt. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- uu. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- vv. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- ww. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- xx. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- yy. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- zz. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- aaa. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- bbb. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- k. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- l. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- z. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- aa. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- bb. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- cc. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- dd. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- ee. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- ff. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- gg. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- hh. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- ii. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- jj. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- u. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- v. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- w. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- x. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- u. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- v. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- w. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- x. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- kk. Clarify research questions and design laboratory investigations. (DOK 3)
- ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

- jj. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)
- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
 - Substances and mixtures
 - Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them
- kk. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)
- ll. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)
- Properties and interactions of the three fundamental particles of the atom
 - Laws of conservation of mass, constant composition, definite proportions, and multiple proportions
- mm. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)
- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
 - The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process
- nn. Compare the properties of compounds according to their type of bonding. (DOK 1)
- Covalent, ionic, and metallic bonding
 - Polar and nonpolar covalent bonding
 - Valence electrons and bonding atoms
- oo. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)
- pp. Develop a three-dimensional model of molecular structure. (DOK 2)
- Lewis dot structures for simple molecules and ionic compounds
 - Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

- u. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- v. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations

- Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- w. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- x. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
- 4. Analyze the relationship between microscopic and macroscopic models of matter.**
- u. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- v. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- w. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- x. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
- 5. Compare factors associated with acid/base and oxidation/reduction reactions.**
- p. Analyze and explain acid/base reactions. (DOK 2)

- Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- q. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
- r. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- oo. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

ee. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)

- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

ff. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)

gg. Apply principles of geometry and hybridization to organic molecules. (DOK 2)

- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

hh. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)

ii. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)

jj. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)

- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

p. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)

- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

q. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)

- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

r. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.

E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- u. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- v. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- w. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- x. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
 - How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- oo. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
 - Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
 - pp. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
 - qq. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
 - rr. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
 - ss. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
 - tt. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
 - Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
 - uu. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
 - vv. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
- 4. Demonstrate an understanding of earth systems relating to weather and climate.**
- z. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
 - Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
 - aa. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
 - bb. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
 - cc. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - dd. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- u. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
 - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- v. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- w. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
 - Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- x. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- kk. Formulate questions that can be answered through research and experimental design. (DOK 3)

- ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
 - nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
 - oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
- 2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.**
- jj. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
 - kk. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
 - ll. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
 - mm. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
 - nn. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
 - oo. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
 - pp. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)
- 3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**
- p. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
 - q. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

- r. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- kk. Clarify research questions and design laboratory investigations. (DOK 3)
- ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- jj. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- kk. Describe how organic components are integral to biochemical processes. (DOK 2)
- ll. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- mm. Explain the significance of the discovery of nucleic acids. (DOK 1)
- nn. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- oo. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- pp. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- jj. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)
- kk. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- ll. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- mm. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- nn. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- oo. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- pp. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- kk. Formulate questions that can be answered through research and experimental design. (DOK 3)

- ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
 - nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
 - oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
 - pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
- ddd. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
 - eee. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
 - fff. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
 - ggg. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
 - hhh. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
 - iii. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
 - jjj. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
 - kkk. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
 - lll. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
 - mmm. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
 - nnn. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- kk. Identify questions that can be answered through scientific investigations. (DOK 3)
- ll. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- mm. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- nn. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- pp. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- z. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- aa. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)

- Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- bb. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- cc. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- dd. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- u. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- v. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
- w. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
- x. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- u. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
- v. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
- w. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)

- x. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
 - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
- 5. Investigate and apply principles of physical and chemical changes in matter.**
- p. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
 - q. Balance chemical equations. (DOK 2)
 - r. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. Investigate and apply principles of physical and chemical changes in matter.

- jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- kk. Clarify research questions, and design laboratory investigations. (DOK 3)
- ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Develop an understanding of concepts related to forces and motion.

- u. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
 - Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- v. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- w. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- x. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
 - Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
 - z. Explain and apply the conservation of energy and momentum. (DOK 2)
 - Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
 - aa. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
 - bb. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
 - cc. Investigate and summarize the principles of thermodynamics. (DOK 2)
 - How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
 - dd. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**
 - z. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
 - Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.

- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - aa. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - bb. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - cc. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - dd. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- p. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
 - q. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - r. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- k. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - l. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

- SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- jj. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- kk. Clarify research questions, and design laboratory investigations. (DOK 3)
- ll. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)

- mm. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
- nn. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- oo. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- pp. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

- ee. Describe the characteristics of the electromagnetic spectrum.
- ff. Using images and graphs, interpret the absorption/reflection spectrum.
- gg. Distinguish between passive vs. active sensor systems.
- hh. Analyze the effects of changes in spatial, temporal, and spectral resolution.
- ii. Analyze the effects on images due to changes in scale.
- jj. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- jj. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- kk. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ll. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- mm. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- nn. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- oo. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- pp. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- u. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- v. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- w. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- x. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenetic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- z. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- aa. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- bb. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- cc. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- dd. Contrast food chains and food webs. (DOK 2)
- 4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.**

- k. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- l. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

Industry Standards

CONTREN CORE

SAF – Basic Safety

- Explain the role that safety plays in the construction crafts.
- Describe the meaning of jobsite safety.
- Describe the characteristics of a competent person and a qualified person.
- Explain the appropriate safety precautions to take around common jobsite hazards.
- Demonstrate the use and care of appropriate personal protective equipment (PPE).
- Properly don and remove personal protective equipment (safety goggles, hard hat, and personal fall protection).
- Follow the safety procedures required for lifting heavy objects.
- Describe safe behavior on and around ladders and scaffolds.
- Explain the importance of Hazard Communications (HazCom) and material safety data sheets (MSDSs).
- Describe fire prevention and firefighting techniques.
- Define safe work procedures to use around electrical hazards.

MAT – Introduction to Construction Math

- Add, subtract, multiply, and divide whole numbers, with and without a calculator.
- Use a standard ruler and a metric ruler to measure.
- Add, subtract, multiply, and divide fractions.
- Add, subtract, multiply, and divide decimals, with and without a calculator.
- Convert decimals to percentages and percentages to decimals.
- Convert fractions to decimals and decimals to fractions.
- Explain what the metric system is and how it is important in the construction trade.
- Recognize and use metric units of length, weight, volume, and temperature.
- Recognize some of the basic shapes used in the construction industry, and apply basic geometry to measure them.

HTO – Introduction to Hand Tools

- Recognize and identify some of the basic hand tools used in the construction trade.
- Use hand tools safely.
- Describe the basic procedures for taking care of hand tools.

PTO – Introduction to Power Tools

- Identify power tools commonly used in the construction trades.
- Use power tools safely.
- Explain how to maintain power tools properly.

BLU – Introduction to Blueprints

- Recognize and identify basic blueprint terms, components, and symbols.
- Relate information on blueprints to actual locations on the print.
- Recognize different classifications of drawings.
- Interpret and use drawing dimensions.

RIG – Basic Rigging

- Identify and describe the use of slings and common rigging hardware.
- Describe basic inspection techniques and rejection criteria used for slings and hardware.
- Describe basic hitch configurations and their proper connections.
- Describe basic load-handling safety practices.
- Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

COM – Basic Communication Skills

- Demonstrate the ability to interpret information and instructions presented in both written and verbal form.
- Demonstrate the ability to communicate effectively in on-the-job situations using written and verbal skills.

EMP – Basic Employability Skills

- Explain the construction industry, the role of the companies that make up the industry, and the role of individual professionals in the industry.
- Demonstrate critical-thinking skills and the ability to solve problems using those skills.
- Demonstrate knowledge of computer systems, and explain common uses for computers in the construction industry.
- Demonstrate effective relationship skills with teammates and supervisors, the ability to work on a team, and appropriate leadership skills.
- Be aware of workplace issues such as sexual harassment, stress, and substance abuse.

CONTREN INDUSTRIAL MAINTENANCE TECHNICIAN

LEVEL ONE

OTI – Orientation to the Trade

- Describe the types of work performed by industrial maintenance craft workers.
- Identify career opportunities available to industrial maintenance craft workers.
- Explain the purpose and objectives of an apprentice training program.
- Explain the responsibilities and characteristics of a good industrial maintenance craft worker.
- Explain the importance of safety in relation to industrial maintenance craft workers.
- Explain the role of NCCER in the training process.

TTI – Tools of the Trade

- Explain the purpose of each of the tools commonly used by industrial maintenance craft workers.
- Describe how to maintain each of the tools used by industrial maintenance craft workers.
- Demonstrate the proper use and basic maintenance of selected industrial maintenance tools.

FAN – Fasteners and Anchors

- Identify and explain the use of threaded fasteners.
- Identify and explain the use of non-threaded fasteners.
- Identify and explain the use of anchors.
- Select the correct fasteners and anchors for given applications.
- Install fasteners and anchors.

OXC – Oxy-Fuel Cutting

- Identify and explain the use of oxy-fuel cutting equipment.
- State the safety precautions for using oxy-fuel equipment.
- Set up oxy-fuel cutting equipment.
- Light and adjust an oxy-fuel torch.
- Shut down oxy-fuel cutting equipment.
- Disassemble oxy-fuel cutting equipment.
- Change empty cylinders.
- Perform oxy-fuel cutting:
 - Straight line and square shapes
 - Piercing and slot cutting
 - Bevels
 - Washing
- Apply a rosebud flame to remove frozen components (also for preheat and expanding larger fittings).
- Operate a motorized, portable oxy-fuel gas cutting machine.

GPI – Gaskets and Packing

- Identify the various types of gaskets, and explain their uses.
- Identify the various types of gasket materials, and explain their applications.
- Lay out, cut, and install a flange gasket.
- Describe the use of O-rings.
- Explain the importance of selecting the correct O-ring for an application.
- Select an O-ring for a given application, and install it.
- Describe the uses and methods of packing.

TMI – Craft-Related Mathematics

- Identify and explain the use of special measuring devices.
- Use tables of weights and measurements.
- Use formulas to solve basic problems.

- Solve area problems.
- Solve volume problems.
- Solve circumference problems.
- Solve right triangles using the Pythagorean theorem.

CDI – Construction Drawings

- Explain the basic layout of a blueprint.
- Describe the information included in the title block of a blueprint.
- Identify the types of lines used on blueprints.
- Identify common symbols used on blueprints.
- Understand the use of architect's and engineer's scales.
- Demonstrate the use of an architect's scale.

PAD – Pumps and Drivers

- Identify and explain centrifugal pumps.
- Identify and explain rotary pumps.
- Identify and explain reciprocating pumps.
- Identify and explain metering pumps.
- Identify and explain vacuum pumps.
- Explain net positive suction head and cavitation.
- Identify types of drivers.

ITV – Introduction to Valves

- Identify types of valves that start and stop flow.
- Identify types of valves that regulate flow.
- Identify valves that relieve pressure.
- Identify valves that regulate the direction of flow.
- Explain how to properly store and handle valves.
- Explain valve locations and positions.

ITE – Introduction to Test Equipment

- Explain the operation of and describe the following pieces of test equipment:
 - Tachometer
 - Pyrometers
 - Multimeters
 - Automated diagnostics tools
 - Wiggy voltage tester
 - Stroboscope
- Explain how to read and convert from one scale to another using the above test equipment.
- Define frequency, and explain the use of a frequency meter.

MHR – Material Handling and Hand Rigging

- Identify and describe the uses of common rigging hardware and equipment.
- Inspect common rigging equipment.
- Select, use, and maintain special rigging equipment, including the following:
 - Jacks
 - Block and tackle
 - Chain hoists
 - Come-alongs
- Tie knots used in rigging.
- Use and understand the correct hand signals to guide a crane operator.
- Identify basic rigging and crane safety procedures.

MSE – Mobile and Support Equipment

- State the safety precautions associated with the use of motor-driven equipment in industrial plants.
- Explain the operation and applications of the following motor-driven equipment commonly used in industrial plants:
 - Portable generators
 - Air compressors
 - Aerial lifts
 - Forklifts
 - Mobile cranes
- Operate and perform preventive maintenance on the following equipment:
 - Portable generators
 - Air compressors
 - Aerial lifts

LUB – Lubrication

- Explain OSHA hazard communication as pertaining to lubrication.
- Read and interpret a material data safety sheet (MSDS).
- Explain the EPA hazardous waste control program.
- Explain lubricant storage.
- Explain lubricant classification.
- Explain lubricant film protection.
- Explain properties of lubricants.
- Explain properties of greases.
- Explain how to select lubricants.
- Identify and explain types of additives.
- Identify and explain types of lubricating oils.
- Identify and use lubrication equipment to apply lubricants.
- Read and interpret a lubrication chart.

LEVEL TWO

NEC – Introduction to the National Electrical Code

- Explain the purpose and history of the National Electrical Code (NEC).
- Describe the layout of the NEC.
- Explain how to navigate the NEC.
- Describe the purpose of the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA).
- Explain the role of nationally recognized testing laboratories.

ETO – Electrical Theory

- Define voltage, and identify the ways in which it can be produced.
- Explain the difference between conductors and insulators.
- Define the units of measurement that are used to measure the properties of electricity.
- Identify the meters used to measure voltage, current, and resistance.
- Explain the basic characteristics of series and parallel circuits.
- Use Kirchhoff's current law to calculate the total and unknown currents in parallel and series-parallel circuits.
- Use Kirchhoff's voltage law to calculate voltage drops in series, parallel, and series-parallel circuits.
- Use the formula for Ohm's law to calculate voltage, current, and resistance.

ALT – Alternating Current

- Calculate the peak and effective voltage or current values for an AC waveform.
- Calculate the phase relationship between two AC waveforms.
- Describe the voltage and current phase relationship in a resistive AC circuit.
- Describe the voltage and current transients that occur in an inductive circuit.
- Define inductive reactance, and state how it is affected by frequency.
- Describe the voltage and current transients that occur in a capacitive circuit.
- Define capacitive reactance, and state how it is affected by frequency.
- Explain the relationship between voltage and current in the following types of AC circuits:
 - RL circuit
 - RC circuit
 - LC circuit
 - RLC circuit
- Explain the following terms as they relate to AC circuits:
 - True power
 - Apparent power
 - Reactive power
 - Power factor
- Explain basic transformer action.

HBE – Hand Bending

- Identify the methods for hand bending and installing conduit.
- Calculate conduit bends.
- Make 90° bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.
- Cut, ream, and thread conduit.

CON – Conductor Terminations and Splices

- Describe how to make a sound conductor termination.
- Prepare cable ends for terminations and splices, and connect the ends using lugs or connectors.
- Train cable at termination points.
- Describe the National Electrical Code requirements for making cable terminations and splices.
- Demonstrate crimping techniques.
- Select the proper lug or connector for the job.

LEVEL THREE

HPC – Hydraulic and Pneumatic Controls

- Explain hydraulic system safety.
- Explain the principles of hydraulics.
- Identify and explain hydraulic fluids.
- Identify and explain hydraulic system parts.
- Identify and explain hydraulic pumps.
- Identify and explain hydraulic motors.
- Explain pneumatic safety.
- Explain the physical characteristics of gases.
- Explain compressing gases.
- Explain the pneumatic transmission of energy.
- Explain the principles of compressor operation.
- Identify and explain types of compressors.
- Explain compressed-air treatment.
- Identify and explain pneumatic system components and symbols.

CONTREN HVAC

LEVEL ONE

INT – Introduction to HVAC

- Explain the basic principles of heating, ventilating, and air-conditioning.
- Identify career opportunities available to people in the HVAC trade.
- Explain the purpose and objectives of an apprentice training program.
- Describe how certified apprentice training can start in high school.

- Describe what the Clean Air Act means to the HVAC trade.
- Describe the types of regulatory codes encountered in the HVAC trade.
- Identify the types of schedules/drawings used in the HVAC trade.

TMH – Trade Mathematics

- Identify similar units of measurement in both the inch–pound (English) and metric systems, and state which units are larger.
- Convert measured values in the inch–pound system to equivalent metric values and vice versa.
- Express numbers as powers of ten.
- Determine the powers and roots of numbers.
- Solve basic algebraic equations.
- Identify various geometric figures.
- Use the Pythagorean theorem to make calculations involving right triangles.
- Convert decimal feet to feet and inches and vice versa.
- Calculate perimeter, area, and volume.
- Convert temperature values between Celsius and Fahrenheit.

CPP – Copper and Plastic Piping Practices

- State the precautions that must be taken when installing refrigerant piping.
- Select the right tubing for a job.
- Cut and bend copper tubing.
- Safely join tubing by using flare and compression fittings.
- Determine the kinds of hangers and supports needed for refrigerant piping.
- State the basic safety requirements for pressure-testing a system once it has been installed.
- Identify types of plastic pipe, and state their uses.
- Cut and join lengths of plastic pipe.

SBR – Soldering and Brazing

- Assemble and operate the tools used for soldering.
- Prepare tubing and fittings for soldering.
- Identify the purposes and uses of solder and solder fluxes.
- Solder copper tubing and fittings.
- Assemble and operate the tools used for brazing.
- Prepare tubing and fittings for brazing.
- Identify the purposes and uses of filler metals and fluxes used for brazing.
- Braze copper tubing and fittings.
- Identify the inert gases that can be used safely to purge tubing when brazing.

FMP – Ferrous Metal Piping Practices

- Identify the types of ferrous metal pipes.
- Measure the sizes of ferrous metal pipes.

- Identify the common malleable iron fittings.
- Cut, ream, and thread ferrous metal pipe.
- Join lengths of threaded pipe together, and install fittings.
- Describe the main points to consider when installing pipe runs.
- Describe the methods used to join grooved piping.

BEL – Basic Electricity

- State how electrical power is distributed.
- Describe how voltage, current, resistance, and power are related.
- Use Ohm’s law to calculate the current, voltage, and resistance in a circuit
- Use the power formula to calculate how much power is consumed by a circuit.
- Describe the difference between series and parallel circuits, and calculate loads in each.
- Describe the purpose and operation of the various electrical components used in HVAC equipment.
- State and demonstrate the safety precautions that must be followed when working on electrical equipment.
- Make voltage, current, and resistance measurements using electrical test equipment.
- Read and interpret common electrical symbols.

ITC – Introduction to Cooling

- Explain how heat transfer occurs in a cooling system, demonstrating an understanding of the terms and concepts used in the refrigeration cycle.
- Calculate the temperature and pressure relationships at key points in the refrigeration cycle.
- Under supervision, use temperature- and pressure-measuring instruments to make readings at key points in the refrigeration cycle.
- Identify commonly used refrigerants, and demonstrate the proper procedures for handling these refrigerants.
- Identify the major components of a cooling system, and explain how each type works.
- Identify the major accessories available for cooling systems, and explain how each works.
- Identify the control devices used in cooling systems, and explain how each works.
- State the correct methods to be used when piping a refrigeration system.

ITH – Introduction to Heating

- Explain the three methods by which heat is transferred, and give an example of each.
- Describe how combustion occurs, and identify the byproducts of combustion.
- Identify various types of fuels used in heating.
- Identify the major components and accessories of an induced draft and condensing gas furnace, and explain the function of each component.
- State the factors that must be considered when installing a furnace.
- Identify the major components of a gas furnace, and describe how each works.

- With supervision, use a manometer to measure and adjust manifold pressure on a gas furnace.
- Identify the major components of an oil furnace, and describe how each works.
- Describe how an electric furnace works.
- With supervision, perform basic furnace preventive maintenance procedures such as cleaning and filter replacement.

ADS – Air Distribution Systems

- Describe the airflow and pressures in a basic forced-air distribution system.
- Explain the differences between propeller and centrifugal fans and blowers.
- Identify the various types of duct systems, and explain why and where each type is used.
- Demonstrate or explain the installation of metal, fiberboard, and flexible duct.
- Demonstrate or explain the installation of fittings and transitions used in duct systems.
- Demonstrate or explain the use and installation of diffusers, registers, and grilles used in duct systems.
- Demonstrate or explain the use and installation of dampers used in duct systems.
- Demonstrate or explain the use and installation of insulation and vapor barriers used in duct systems.
- Identify instruments used to make measurements in air systems, and explain the use of each instrument.
- Make basic temperature, air pressure, and velocity measurements in an air distribution system.

ACS – Commercial Airside Systems

- Identify the differences in types of commercial all-air systems.
- Identify the type of building in which a particular type of system is used.
- Explain the typical range of capacities for a commercial air system.

LEVEL TWO

LDE – Leak Detection, Evacuation, Recovery, and Charging

- Identify the common types of leak detectors, and explain how each is used.
- Perform leak detection tests using selected methods.
- Identify the service equipment used for evacuating a system, and explain why each item of equipment is used.
- Perform system evacuation and dehydration.
- Identify the service equipment used for recovering refrigerant from a system and for recycling the recovered refrigerant, and explain why each item of equipment is used.
- Perform a refrigerant recovery.
- Evacuate a system to a deep vacuum.
- Identify the service equipment used for charging refrigerant into a system, and explain why each item of equipment is used.
- Use nitrogen to purge a system.

- Charge refrigerant into a system by the following methods:
 - Weight
 - Superheat
 - Subcooling
 - Charging pressure chart

ALT – Alternating Current

- Describe the operation of various types of transformers.
- Explain how alternating current is developed, and draw a sine wave.
- Identify single-phase and three-phase wiring arrangements.
- Explain how phase shift occurs in inductors and capacitors.
- Describe the types of capacitors and their applications.
- Explain the operation of single-phase and three-phase induction motors.
- Identify the various types of single-phase motors and their applications.
- State and demonstrate the safety precautions that must be followed when working with electrical equipment.
- Test AC components, including capacitors, transformers, and motors.

BAE – Basic Electronics

- Explain the basic theory of electronics and semiconductors.
- Explain how various semiconductor devices such as diodes, LEDs, and photo diodes work and how they are used in power and control circuits.
- Identify different types of resistors, and explain how their resistance values can be determined.
- Describe the operation and function of thermistors and cad cells.
- Test semiconductor components.
- Identify the connectors on a personal computer.

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Digital Media Technology Executive Summary.....	479
Course Outlines.....	482
Digital Media Technology I Competencies and Objectives	487
Digital Media Technology II Competencies and Objectives	491
Digital Media Technology III Competencies and Objectives.....	496
Digital Media Technology IV Competencies and Objectives	497
Digital Media Technology I Competency Profile.....	498
Digital Media Technology II Competency Profile	499
Digital Media Technology III Competency Profile	501
Digital Media Technology IV Competency Profile.....	502
Appendix A: 21st Century Skills Standards	503
Appendix B: MS Academic Standards	505
Appendix C: ACT College Readiness Standards.....	535
Appendix D: Pathway Content Standards.....	550
Appendix E: National Educational Technology Standards for Students	554

Digital Media Technology Executive Summary

Program Description

This program is designed for students who wish to develop, design, and implement projects in the fast growing field of digital media. The program emphasizes the techniques and tools used in digital media and the creative design or content of such media. Both theoretical learning and activity-based learning are provided for students who wish to develop and enhance their competencies and skills. The course focuses on the basic areas of computer graphics, multimedia, and animation. Exposure to state-of-the-art equipment is given through advice by experts from industry. The comprehensive project component provides practical experience toward developing a portfolio of work.

Industry Certification

Research with Mississippi industry suggests that this curriculum should be written to the Adobe Certified Associate Certification. This exam assesses the foundation of digital communication skills students need to create effective communication using digital media tools. This certification was developed after a group of industries met with educators to design the entry-level skill industry standards for Web communication, rich media communication, and visual communication. Additionally, the Final Cut Pro 6.0 is the recognized industry software for video production. The Final Cut Express 4.0 software is a more inexpensive software package that has the same interface as Final Cut Pro 6.0. It is recommended that this curriculum meets the Final Cut Pro Level 1 Certification.

Assessment

Students will be assessed using the Digital Media Technology test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the STEM instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

An eligible student will have completed the ninth grade and will have an overall B average. Prior to being enrolled in the course, a behavior reference must be obtained from an academic technology teacher.

Proposed Applied Academic Credit

The academic credit is still pending for this curriculum.

Licensure Requirements

The 987 licensure is needed to teach the Digital Media Technology program. The requirements for the 987 licensure endorsement are listed below:

- 987– Digital Media Technology
1. Applicants with associate’s degrees must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
 2. Applicants with bachelor’s or higher degrees must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
 3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
 4. Applicant must complete the individualized professional development plan (PDP) requirements of the VIP or REP prior to the expiration date of the three-year vocational license.
 5. Applicants must possess a Final Cut Pro Level 1 Certification.
 6. Applicants must possess an Adobe Certified Associate Certification in each of the following areas: Web Communication, Rich Media Communication, and Visual Communication.
 7. Applicants must successfully complete an MDE-approved computer literacy certification exam.
 8. Applicants must successfully complete certification for an online learning workshop, module, or course that is approved by the MDE.
 9. Applicants must successfully complete a Digital Media Technology certification workshop, module, or course that is approved by the MDE.

Note: If an applicant meets all requirements listed above, that applicant will be issued a 987 endorsement—a 5-year license. If an applicant does not meet **all** requirements, the applicant will be issued a 3-year endorsement license, and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows for local school districts to meet student needs and scheduling demands. The first option groups units into four one-Carnegie-unit courses. The second option groups units into two two-Carnegie-unit courses. A discussion of each option is listed below.

Introduction to Photography and Graphic Design and Web Design and Media Rich Content courses introduce students to the principles and skills associated with graphic and print production and Web site development as it is related to meeting the needs of clients and producing graphic design products. Video Production and the Directed Individual Project courses concentrate on video production, a directed individual project, and portfolio finalization. These courses must be taken in sequential order.

Option 1

By following this course of study for Digital Media Technology, the students will progress through a series of four one-credit courses that should be completed in the following sequence:

1. Introduction to Photography and Graphic Design (Course Code: 994102)
2. Web Design and Media Rich Content (Course Code: 994103)
3. Video Production (Course Code: 994104)
4. Directed Individual Project (Course Code: 994105)

Course Description: Introduction to Photography and Graphic Design includes the foundation skills necessary in the digital media industry. Content such as safety, ethical issues and production, photography, graphic design, and print production will be offered to students. This is a one-Carnegie-unit course.

Course Description: Web Design and Media Rich Content emphasizes real-world, hands-on practice. Content related to Web design, building a basic client Web site, media rich content for Web design, and planning a digital narrative and creating a script will be offered to students. This one-Carnegie-unit course should only be taken after students successfully pass Introduction to Photography and Graphic Design (Course Code: 994102).

Course Description: Video Production focuses on career opportunities in audio and video technology, production systems, production process, and video and audio production. This one-Carnegie-unit course should only be taken after students successfully pass Web Design and Media Rich Content (Course Code: 994103).

Course Description: The Directed Individual Project is a culminating course that gives students the opportunity to produce a final video project that incorporates the skill and knowledge learned in the Video Production course, giving the students the chance to showcase what they have learned and accomplished. Upon the completion of this course, the students will have also put

the finishing touches on a digital portfolio that is cumulative of their work throughout all semesters of Digital Media Technology. This is a one-Carnegie-unit course and should be taken after students successfully pass Introduction to Photography and Graphic Design (Course Code: 994102), Web Design and Media Rich Content (Course Code: 994103), and Video Production (Course Code: 994104).

Introduction to Photography and Graphic Design (One Carnegie Unit) - Course Code: 994102

Unit	Title	Hours
1	Introduction, Safety, and Orientation	10
2	Ethical Content and Production	20
3	Photography	25
4	Graphic Design and Print Production	85
		140

Web Design and Media Rich Content (One Carnegie Unit) - Course Code: 994103

Unit	Title	Hours
5	Introduction to Web Design	30
6	Building a Basic Client Web Site	20
7	Media Rich Content for Web Design	55
8	Planning a Digital Narrative and Creating a Script	35
		140

Video Production (One Carnegie Unit) - Course Code: 994104

Unit	Title	Hours
9	Creating a Rough Cut	10
10	Refining a Rough Cut	35
11	Customizing and Capturing Footage	25

12	Completing the Cut	35
13	Adding Effects and Finishing Video Projects	35
		140

Directed Individual Project (One Carnegie Unit) - Course Code: 994105

Unit	Title	Hours
14	Developing Movie Ideas	15
15	Storyboarding a Movie	15
16	Producing a Movie	15
17	Lighting Elements in a Movie	15
18	Working with Audio in Movies	15
19	Creating the Perfect Camera Frame	15
20	Documentary Movies	15
21	Post-Production	35
		140

Option 2

Course Description: Digital Media Technology I encompasses the foundation skills necessary in the digital media industry. Content such as safety, ethical issues and production, photography, graphic design, and print production will be offered to students. The Web Design and Media Rich Content portion of the course emphasizes real-world, hands-on practice. Content related to Web design, building a basic client Web site, media rich content for Web design, and planning a digital narrative and creating a script will be offered to students. Students will receive two Carnegie units upon completion of the course.

Course Description: Digital Media Technology II focuses on the process of video production and editing as well as career opportunities in audio and video technology. Another component of the course is the Directed Individual Project that is a culminating assignment that gives students the opportunity to produce a final video project that incorporates the skill and knowledge learned throughout the course, giving the students the chance to showcase what they have learned and accomplished. Also upon completion of this course, the students will have also put the finishing

touches on a digital portfolio that is cumulative of their work throughout their study of Digital Media Technology.

Digital Media Technology I (Two Carnegie Unit) - Course Code: 994100

Unit	Title	Hours
1	Introduction, Safety, and Orientation	10
2	Ethical Content and Production	20
3	Photography	25
4	Graphic Design and Print Production	85
5	Introduction to Web Design	30
6	Building a Basic Client Web Site	20
7	Media Rich Content for Web Design	55
8	Planning a Digital Narrative and Creating a Script	35
		280

Digital Media Technology II (Two Carnegie Unit) - Course Code: 994101

Unit	Title	Hours
9	Career Opportunities in Audio and Video Technology	10
10	Production Systems	35
11	Production Process	25
12	Video Production	35
13	Audio Production	35
14	Directed Individual Project	130
15	Portfolio Preparation	10
		280

Digital Media Technology I Competencies and Objectives

Unit 1: Introduction, Safety, and Orientation

1. Identify course expectations, school policies, program policies, and safety procedures related to Digital Media Technology (DMT).
 - a. Identify course expectations, school policies, and program policies related to Digital Media Technology (DMT). (DOK 1)
 - b. Apply safety procedures in the computer classroom and lab. (DOK 2)
2. Explore personality development, leadership, and teamwork in relation to the classroom environment, interpersonal skills, and others. (DOK 1)
 - a. Identify potential influences that shape the personality development including personality traits, heredity, and environment. (DOK 1)
 - b. Develop a report on how personality traits affect teamwork and leadership skills. (DOK 2)
 - c. Identify forces that shape personality development including personality traits, heredity, and environment. (DOK 1)
 - d. Develop effective leadership, decision-making, and communication skills. (DOK 2)

Unit 2: Ethical Content and Production

1. Research copyright rules, regulations, and issues related to graphics and images produced by others and original work, and adhere to those rules and regulations when developing work. (DOK 2)
 - a. Define terms related to copyright rules, regulations, and issues related to graphics and images produced by others and original work. (DOK 1)
 - b. Research copyright laws related to graphics, images, and other original work. (DOK 2)
 - c. Give examples of copyright violations related to trademark, symbols, length of time, and public domain. (DOK 2)
 - d. Prepare images and video for Web and print that meet copyright guidelines. (DOK 2)
2. Research online content, and evaluate content bias, currency, and source. (DOK 1)
 - a. Determine how to search for information online. (DOK 1)
 - b. Correlate information with multiple sources. (DOK 2)
3. Define and abide by the journalistic code of ethics. (DOK 2)
 - a. Define terms related to the journalistic code of ethics. (DOK 1)
 - b. Identify the similarities and differences between news and advertisement. (DOK 2)
 - c. Compare and contrast news and opinions, and determine the benefits and dangers of reporting non-biased information. (DOK 2)
 - d. Demonstrate the ability to avoid conflicts of interest, bribery, and knowledge of personal political and economic interests. (DOK 3)
 - e. Maintain confidentiality of sources, and avoid anonymous sources when possible. (DOK 1)
 - f. Demonstrate proper use of pictures, sounds bites, and quotations. (DOK 2)

- g. Discuss plagiarism and the consequences of plagiarizing. (DOK 1)
- h. Demonstrate standards for factual reporting. (DOK 2)
- i. Demonstrate an understanding of libel and slander, privacy rights, and a publisher's obligation to defend a reporter against any libel suit filed against him or her. (DOK 2)
- j. Describe the principle of harm limitation. (DOK 1)

Unit 3: Photography

1. Demonstrate proficiency in the setup, operation, and troubleshooting of a graphic design computer. (DOK 2)
 - a. Demonstrate proficiency in the setup and maintenance of a graphic computer system. (DOK 2)
 - b. Manipulate a window by using application software functions and keyboard shortcuts. (DOK 1)
 - c. Demonstrate knowledge of an electronic file management system and folder management. (DOK 2)
2. Explain photography and graphic design elements. (DOK 1)
 - a. Identify safety and proper use of equipment related to photography. (DOK 1)
 - b. Identify the basic components of a digital camera and photography-related terms. (DOK 1)
3. Complete a photography project that meets the needs of an audience. (DOK 2)
 - a. Explore image composition and elements of visual design through photography. (DOK 2)
 - b. Distinguish file type per job needed. (DOK 1)
 - c. Use digital cameras to learn the basics of photography. (DOK 2)
 - d. Identify and produce portrait photographs, art photographs (objects in the classroom), and landscape photographs. (DOK 2)
 - e. Use photo manipulation to investigate the potential of color enhancement and retouching. (DOK 2)
 - f. Compare and contrast the advantages of manipulating a saved copy of an image in various formats. (DOK 3)
4. Use photo editing software to create and edit a product for a customer. (DOK 3)
 - a. Identify terminology related to the photo editing software. (DOK 1)
 - b. Demonstrate how to open and save an image from a digital camera and an image from a scanner in photo editing software. (DOK 2)
 - c. Apply the following tools of photo editing software (DOK 2):
 - Histogram
 - Levels
 - Curves
 - Brightness
 - Auto color correction
 - Clone stamp
 - Lasso
 - Magic wand

- Crop
 - Image
 - Canvas size
 - Transform
- d. Determine proper resolution for printing an 8-in. by 10-in. photograph on the designated size of paper using photo editing software. (DOK 2)
 - e. Use Photomerge to create panoramic images. (DOK 3)

Unit 4: Graphic Design and Print Production

1. Apply color theory and design principles. (DOK 2)
 - a. Discuss the types of design principles, and have students define design principle terms. (DOK 1)
 - b. Understand the importance of color management, and explain why color variations occur between devices. (DOK 2)
 - c. Demonstrate use of selection, drawing, and painting tools in appropriate graphic design software. (DOK 2)
 - d. Discuss possible canvas sizes for logos, and demonstrate the options that can be altered. (DOK 2)
 - e. Understand and incorporate image-optimization (vector and bitmap) strategies and file formats. (DOK 2)
 - f. Identify aspects of redesign and its importance in the design process. (DOK 1)
2. Understand typography and layout design. (DOK 1)
 - a. Understand typography concepts for use in planning and designing in graphic design. (DOK 1)
 - b. Discuss how tone, audience, and purpose impact design and readability. (DOK 1)
 - c. Explore resizing and cropping images. (DOK 1)
 - d. Demonstrate layout in graphic software. (DOK 2)
 - e. Demonstrate importing files into graphic software. (DOK 2)
3. Apply design principles and techniques in the creation of an advertisement. (DOK 3)
 - a. Understand design principles and techniques for use in planning, designing, and producing an advertisement. (DOK 3)
 - b. Introduce aspects of project management and how to work with clients. (DOK 2)
 - c. Plan and design an advertisement. (DOK 3)
 - d. Build an advertisement. (DOK 3)
 - e. Understand the process of reviewing and redesigning an advertisement. (DOK 3)
4. Utilize advanced image manipulation and page layout to create a brochure. (DOK 3)
 - a. Demonstrate advanced image manipulation techniques. (DOK 2)
 - b. Demonstrate advanced layout techniques. (DOK 2)
5. Create a newsletter layout with advanced editing. (DOK 3)
 - a. Identify standard newsletter publishing practices, and cite sources. (DOK 1)
 - b. Examine newsletters to identify the following elements: (DOK 1)
 - Nameplate
 - Content (and number of articles or entries)
 - Table of contents

- Masthead
 - Titles and headers
 - Page numbers
 - Bylines
 - Continuation lines
 - Pull quotes
 - End signs
 - Photos/illustrations
 - Mailing panels
- c. Discuss the concept of working as a team and roles in newsletter production. (DOK 2)
 - d. Design, build, and review a newsletter. (DOK 3)
 - e. Present the finished newsletter to an audience. (DOK 2)
6. Research careers, and develop a professional portfolio. (DOK 3)
 - a. Research career areas in design and/or print production. (DOK 1)
 - b. Identify the purpose of a portfolio as it relates to career planning. (DOK 2)
 - c. Construct a portfolio. (DOK 3)
 - d. Present a portfolio. (DOK 2)

Digital Media Technology II Competencies and Objectives

Unit 5: Introduction to Web Design

1. Identify the components of Web design application software. (DOK 1)
 - a. Research key vocabulary terms, and illustrate terminology used with Web design applications. (DOK 1)
 - b. Identify the basic components of a Web design application screen. (DOK 1)
 - c. Research certification requirements for a Web specialist. (DOK 1)
 - d. Identify the elements of the graphic design software interface. (DOK 1)
 - e. Demonstrate knowledge of best practices for designing a Web site, such as maintaining consistency, separating content from design, and using standard fonts and Web-safe fonts. (DOK 2)
 - f. Demonstrate knowledge of page layout design elements and principles, and organize content consistently. (DOK 2)
2. Demonstrate skills needed for planning and creating a home page. (DOK 3)
 - a. Research key vocabulary terms related to planning and creating a home page. (DOK 1)
 - b. Plan and create a detailed storyboard for the home page of a portfolio. (DOK 2)
 - c. Incorporate principles of good user interface design on a home page. (DOK 3)
3. Demonstrate knowledge of best practices for designing Web sites, such as maintaining consistency, separating content from design, and using standard fonts and Web-safe colors. (DOK 2)
 - a. Research key vocabulary terms, and illustrate terminology used with creating content pages. (DOK 1)
 - b. Demonstrate knowledge of designing a Web site. (DOK 2)
 - c. Make design decisions such as colors, layout, and structuring navigation through Web sites. (DOK 2)
4. Demonstrate proficiency linking Web content using hyperlinks, e-mail links, and named anchors. (DOK 2)
 - a. Identify key vocabulary terms related to linking pages. (DOK 1)
 - b. Demonstrate adding links using the Properties pane. (DOK 2)
 - c. Create links using the Hyperlink dialog box. (DOK 2)
 - d. Demonstrate three methods for using the property inspector to create links from text or an image to another document. (DOK 2)
5. Demonstrate knowledge of Web site accessibility standards that address the needs of people with visual and motor impairments. (DOK 2)
 - a. Identify terminology and techniques associated with ensuring usability and accessibility. (DOK 1)
 - b. Demonstrate the ability to use visual clues about navigation, structure, and organization. (DOK 2)
 - c. Demonstrate text-formatting guidelines that improve Web site readability. (DOK 2)
6. Demonstrate how to insert a graphical navigation bar created in a separate program. (DOK 2)

- a. Identify terminology and techniques associated with ensuring usability and accessibility. (DOK 1)
 - b. Demonstrate how to create three-state buttons and how to set the active area for a button using a multimedia authoring program. (DOK 2)
 - c. Demonstrate how to export a navigation bar from a different application. (DOK 2)
 - d. Demonstrate how to use roundtrip editing to edit images with different software. (DOK 2)
7. Produce Web site designs that work equally well on various operating systems and browser versions. (DOK 3)
 - a. Identify terminology and techniques associated with ensuring quality assurance. (DOK 1)
 - b. Conduct a quality assurance test on the students' electronic portfolios. (DOK 3)
 - c. Demonstrate how to conduct a technical and functional usability test. (DOK 2)
 8. Identify techniques and methods for basic usability tests and collecting site feedback. (DOK 2)
 - a. Identify terminology and techniques associated with ensuring usability and accessibility. (DOK 1)
 - b. Demonstrate methods for collecting site visitor feedback and site evaluation information. (DOK 2)
 - c. Identify characteristics of what a usability observation looks for. (DOK 2)
 9. Demonstrate knowledge of using and managing assets, links, and files to publish and update site files to a remote server. (DOK 2)
 - a. Identify key terminology and techniques associated with publishing a Web site. (DOK 1)
 - b. Demonstrate how to set up a remote site. (DOK 2)
 - c. Demonstrate how to use the Web browser to open newly published sites. (DOK 2)
 - d. Identify how to navigate each page to ensure all files were successfully published and are valid and reliable. (DOK 3)
 10. Use basic HTML tags to set up an HTML document, format text, add links, create tables, and build ordered and unordered lists. (DOK 2)
 - a. Identify terminology and techniques associated with Hyper Text Markup Language (HTML). (DOK 1)
 - b. Demonstrate how to locate the code view and create tags using the Web browser. (DOK 2)

Unit 6: Building a Basic Client Web Site

1. Gather information and data as it pertains to the development of a client Web site. (DOK 2)
 - a. Define the scope of the project and related terms. (DOK 1)
 - b. Identify the phases of a client Web site project to build a common class understanding and agreement for each phase and task (i.e., goals, target audience, content, and delivery requirements for the Web site). (DOK 1)
 - c. Interview clients to identify the goals and audience, the design and technical (delivery) requirements, and the main content. (DOK 2)

- d. Write a brief design document incorporating information from clients. (DOK 2)
2. Utilize the phases involved in planning a client Web site in order to effectively meet the client's needs. (DOK 2)
 - a. Discuss the project phases again in the context of the client Web sites. (DOK 2)
 - b. Define a project plan for a client Web site project. (DOK 2)
3. Use an effective and functional structure in creating a client Web site. (DOK 3)
 - a. Build a flowchart for the client site (screen view, flowchart, and information organization). (DOK 2)
 - b. Present the flowchart to the client. (DOK 2)
 - c. Create screen views of the home page and sample content page for the client site. (DOK 3)
4. Apply techniques of design to create a suitable client Web site. (DOK 3)
 - a. Create design comps of a home page and a sample content page to show different looks. (DOK 3)
5. Utilize client feedback to improve a design concept. (DOK 3)
 - a. Define the terms *active listening* and *production storyboard*. (DOK 1)
 - b. Use active listening skills during the client review. (DOK 1)
 - c. Revise design comps, and present revised design comps to the client. (DOK 3)
 - d. Create production storyboards for client Web site. (DOK 3)
6. Utilize cascading style sheets to ensure consistency of style and theme. (DOK 2)
 - a. Define key terms related to cascading style sheets. (DOK 1)
 - b. Create a style sheet for use with the client Web site. (DOK 2)
7. Develop a final product for the client utilizing all design phases, feedback, and peer collaboration. (DOK 3)
 - a. Work collaboratively to build a client Web site. (DOK 3)
 - b. Use templates and libraries to build consistent Web pages. (DOK 2)
 - c. Apply cascading style sheets to templates. (DOK 2)
 - d. Discuss and demonstrate library features as they relate to templates. (DOK 2)
 - e. Create a Web site using templates. (DOK 3)
8. Test the Web site for usability and accessibility. (DOK 2)
 - a. Conduct a technical test on a client Web site, and compile a bug list. (DOK 2)
 - b. Conduct a usability test on a client Web site. (DOK 2)
 - c. Compile the results of technical testing and usability testing of a client Web site, make necessary revisions, and add the client site to an electronic portfolio. (DOK 2)
9. Compose a marketing plan to publicize the client Web site. (DOK 3)
 - a. Create a basic marketing plan for the client Web site. (DOK 3)
 - b. Present a Web site and marketing plan to the client. (DOK 2)

Unit 7: Media Rich Content for Web Design

1. Apply media rich concepts in order to enhance a Web site. (DOK 2)
 - a. Identify parts of a rich media software program workspace, including the following (DOK 1):
 - Timeline
 - Frames

- Layers
 - The stage
 - Scenes
 - Tools
 - Panels
 - Property inspector
 - Symbols
 - Instances
 - Libraries
- b. Create an interactive animated movie that incorporates motion and shape tweens, sound, and buttons. (DOK 3)
 2. Examine the properties and benefits of Adobe Flash software. (DOK 1)
 - a. Identify the use of technical elements such as tweens, images, text animations, actions, and sound in Adobe Flash CS3 movies and ads on the Web. (DOK 1)
 3. Incorporate video and multimedia elements into Web design. (DOK 3)
 - a. Examine Web sites that incorporate Flash video. (DOK 1)
 - b. Appropriately incorporate video in a Flash document for use on a Web site. (DOK 3)
 - c. Identify challenges with using video on the Web and the ways in which Flash video addresses these challenges and improves user experience. (DOK 2)
 4. Utilize motion tweens to enhance the user experience. (DOK 2)
 - a. Examine Web sites that use masking and path animation techniques. (DOK 1)
 - b. Build mask effects and path animations involving advanced motion tweens. (DOK 2)
 - c. Identify how masking and path animations can be used to enhance user experience on the Web. (DOK 2)

Unit 8: Planning a Digital Narrative and Creating a Script

1. Utilize effects and film techniques to make a story more effective. (DOK 2)
 - a. Examine online examples that use various Adobe Flash CS3 techniques. (DOK 1)
 - b. Work with custom colors and gradients in Flash. (DOK 1)
 - c. Develop transition effects built through motion, shape, and text tweening in preparation for enhancing a narrative. (DOK 2)
 - d. Build filmmaking effects involving advanced motion and shape tweens. (DOK 2)
2. Compose a digital narrative and script in order to effectively communicate through multimedia. (DOK 3)
 - a. Plan and design a narrative to effectively communicate a message. (DOK 3)
 - b. Write a script for a digital narrative. (DOK 2)
 - c. Peer critique narrative scripts, considering audience and time frame. (DOK 2)
3. Design an animation storyboard in order to plan and organize a digital narrative. (DOK 3)
 - a. Create an animation storyboard. (DOK 3)
 - b. Develop techniques for an effective animation storyboard. (DOK 2)
4. Produce a digital narrative from a peer-created storyboard. (DOK 2)
 - a. Import optimized images and self-recorded audio into Adobe Flash CS3. (DOK 2)
 - b. Produce a digital narrative from a flowchart and animation storyboard. (DOK 2)

5. Prepare a digital narrative for publishing by collecting feedback and editing accordingly. (DOK 2)
 - a. Conduct a peer review of a digital narrative. (DOK 2)
 - b. Incorporate peer-suggested changes into a digital narrative. (DOK 2)
 - c. Publish a digital narrative as an HTML document. (DOK 2)

Digital Media Technology III Competencies and Objectives

Unit 9: Creating a Rough Cut

1. Edit, build, and finish a rough cut of a video using video editing software. (DOK 3)
 - a. Identify and navigate the video editing software interface. (DOK 4)
 - b. Demonstrate basic editing skills in video editing software. (DOK 2)
 - c. Construct a rough cut. (DOK 3)
 - d. Finish a rough cut. (DOK 3)

Unit 10: Refining a Rough Cut

1. Demonstrate the techniques involved trimming clip duration, refining edit points, and refining the editing process. (DOK 2)
 - a. Demonstrate the ability to trim a clip to make it shorter or longer in length. (DOK 2)
 - b. Demonstrate the ability to refine edit points using Slip, Roll, and Slide tools. (DOK 2)
 - c. Refine the editing process in order to organize overall workflow. (DOK 2)

Unit 11: Customizing and Capturing Footage

1. Demonstrate the methods for customizing video editing software and capturing and transferring footage. (DOK 2)
 - a. Customize, change, or add metadata throughout the editing process. (DOK 2)
 - b. Capture and transfer footage. (DOK 2)

Unit 12: Completing the Cut

1. Demonstrate the process of applying transitions, mixing audio tracks, and creating titles. (DOK 2)
 - a. Apply transitions to your video to enhance how it moves from one clip to the next. (DOK 2)
 - b. Mix multiple audio tracks into one balanced, overall sound. (DOK 2)
 - c. Add titles to existing sequences. (DOK 2)

Unit 13: Adding Effects and Finishing Video Projects

1. Demonstrate the techniques to change motion properties, apply filters, and export video projects. (DOK 2)
 - a. Change the motion properties of a clip. (DOK 2)
 - b. Apply filters to create visual attractiveness and to correct or improve aspects of an image. (DOK 2)
 - c. Finish and output a project. (DOK 2)

Digital Media Technology IV Competencies and Objectives

Unit 14: Preparing Electronic Portfolios

1. Plan and create an electronic portfolio detailing the culmination of several digital, audio, and video projects. (DOK 4)
 - a. Plan and create a detailed project that includes all of the digital, audio, and video skills learned in this course. (DOK 4)

Digital Media Technology I Competency Profile

Program CIP: 09.0702

Unit 1: Introduction, Safety, and Orientation

- _____ 1. Identify course expectations, school policies, program policies, and safety procedures related to Digital Media Technology (DMT).
- _____ 2. Explore personality development, leadership, and teamwork in relation to the classroom environment, interpersonal skills, and others. (DOK 1)

Unit 2: Ethical Content and Production

- _____ 1. Research copyright rules, regulations, and issues related to graphics and images produced by others and original work, and adhere to those rules and regulations when developing work. (DOK 2)
- _____ 2. Research online content, and evaluate content bias, currency, and source. (DOK 1)
- _____ 3. Define and abide by the journalistic code of ethics. (DOK 2)

Unit 3: Photography

- _____ 1. Demonstrate proficiency in the setup, operation, and troubleshooting of a graphic design computer. (DOK 2)
- _____ 2. Explain photography and graphic design elements. (DOK 1)
- _____ 3. Complete a photography project that meets the needs of an audience. (DOK 2)
- _____ 4. Use photo editing software to create and edit a product for a customer. (DOK 3)

Unit 4: Graphic Design and Print Production

- _____ 1. Apply color theory and design principles. (DOK 2)
- _____ 2. Understand typography and layout design. (DOK 1)
- _____ 3. Apply design principles and techniques in the creation of an advertisement. (DOK 3)
- _____ 4. Utilize advanced image manipulation and page layout to create a brochure. (DOK 3)
- _____ 5. Create a newsletter layout with advanced editing. (DOK 3)
- _____ 6. Research careers and develop a professional portfolio. (DOK 3)

Digital Media Technology II Competency Profile

Unit 5: Introduction to Web Design

- _____ 1. Identify the components of Web design application software. (DOK 1)
- _____ 2. Demonstrate skills needed for planning and creating a home page. (DOK 3)
Demonstrate knowledge of best practices for designing Web sites, such as maintaining consistency, separating content from design, and using standard
- _____ 3. fonts and Web-safe colors. (DOK 2)
- _____ 4. Demonstrate proficiency linking Web content using hyperlinks, e-mail links, and named anchors. (DOK 2)
- _____ 5. Demonstrate knowledge of Web site accessibility standards that address the needs of people with visual and motor impairments. (DOK 2)
- _____ 6. Demonstrate how to insert a graphical navigation bar created in a separate program. (DOK 2)
- _____ 7. Produce Web site designs that work equally well on various operating systems and browser versions. (DOK 3)
- _____ 8. Identify techniques and methods for basic usability tests and collecting site feedback. (DOK 2)
- _____ 9. Demonstrate knowledge of using and managing assets, links, and files to publish and update site files to a remote server. (DOK 2)
- _____ 10. Use basic HTML tags to set up an HTML document, format text, add links, create tables, and build ordered and unordered lists. (DOK 2)

Unit 6: Building a Basic Client Web Site

- _____ 1. Gather information and data as it pertains to the development of a client Web site. (DOK 2)
- _____ 2. Utilize the phases involved in planning a client Web site in order to effectively meet the client's needs. (DOK 2)
- _____ 3. Use an effective and functional structure in creating a client Web site. (DOK 3)
- _____ 4. Apply techniques of design to create a suitable client Web site. (DOK 3)
- _____ 5. Utilize client feedback to improve a design concept. (DOK 3)
- _____ 6. Utilize cascading style sheets to ensure consistency of style and theme. (DOK 2)
- _____ 7. Develop a final product for the client utilizing all design phases, feedback, and peer collaboration. (DOK 3)
- _____ 8. Test the Web site for usability and accessibility. (DOK 2)
- _____ 9. Compose a marketing plan to publicize the client Web site. (DOK 3)

Unit 7: Media Rich Content for Web Design

- _____ 1. Apply media rich concepts in order to enhance a Web site. (DOK 2)
- _____ 2. Examine the properties and benefits of Adobe Flash software. (DOK 1)
- _____ 3. Incorporate video and multimedia elements into Web design. (DOK 3)
- _____ 4. Utilize motion tweens to enhance the user experience. (DOK 2)

Unit 8: Planning a Digital Narrative and Creating a Script

- _____ 1. Utilize effects and film techniques to make a story more effective. (DOK 2)
Compose a digital narrative and script in order to effectively communicate
- _____ 2. through multimedia. (DOK 3)
Design an animation storyboard in order to plan and organize a digital
- _____ 3. narrative. (DOK 3)
- _____ 4. Produce a digital narrative from a peer-created storyboard. (DOK 2)
Prepare a digital narrative for publishing by collecting feedback and editing
- _____ 5. accordingly. (DOK 2)

Digital Media Technology III Competency Profile

Unit 9: Creating a Rough Cut

Edit, build, and finish a rough cut of a video using video editing software.

- _____ 1. (DOK 3)

Unit 10: Refining a Rough Cut

Demonstrate the techniques involved trimming clip duration, refining edit

- _____ 1. points, and refining the editing process. (DOK 2)

Unit 11: Customizing and Capturing Footage

Demonstrate the methods for customizing video editing software and

- _____ 1. capturing and transferring footage. (DOK 2)

Unit 12: Completing the Cut

Demonstrate the process of applying transitions, mixing audio tracks, and

- _____ 1. creating titles. (DOK 2)

Unit 13: Adding Effects and Finishing Video Projects

Demonstrate the techniques to change motion properties, apply filters, and

- _____ 1. export video projects. (DOK 2)

Digital Media Technology IV Competency Profile

Unit 14: Preparing Electronic Portfolios

- _____ 1. Plan and create an electronic portfolio detailing the culmination of several digital, audio, and video projects. (DOK 4)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

19. Using 21st century skills to understand and address global issues
20. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
21. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

19. Knowing how to make appropriate personal economic choices
20. Understanding the role of the economy in society
21. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

19. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
20. Exercising the rights and obligations of citizenship at local, state, national, and global levels
21. Understanding the local and global implications of civic decisions

CS4 Health Literacy

31. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
32. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
33. Using available information to make appropriate health-related decisions
34. Establishing and monitoring personal and family health goals
35. Understanding national and international public health and safety issues

CS5 Environmental Literacy

25. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
26. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
27. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
28. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

19. Think Creatively
20. Work Creatively with Others

- 21. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 25. Reason Effectively
 - 26. Use Systems Thinking
 - 27. Make Judgments and Decisions
 - 28. Solve Problems
- CS8 Communication and Collaboration**
 - 13. Communicate Clearly
 - 14. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 13. Access and Evaluate Information
 - 14. Use and Manage Information
- CS10 Media Literacy**
 - 13. Analyze Media
 - 14. Create Media Products
- CS11 ICT Literacy**
 - 7. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 13. Adapt to change
 - 14. Be Flexible
- CS13 Initiative and Self-Direction**
 - 19. Manage Goals and Time
 - 20. Work Independently
 - 21. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 13. Interact Effectively with others
 - 14. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 13. Manage Projects
 - 14. Produce Results
- CS16 Leadership and Responsibility**
 - 13. Guide and Lead Others
 - 14. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

7. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- qq. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- rr. Explain the causes and characteristics of tides. (DOK 1)
- ss. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- tt. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- uu. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- vv. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
- Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
- ww. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
3. **Apply an understanding of the diverse organisms found in aquatic environments.**
- kk. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
- ll. Research, calculate, and interpret population data. (DOK 2)
- mm. Research and compare reproductive processes in aquatic organisms. (DOK 2)
- nn. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
- oo. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
- pp. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
- ccc. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
- ddd. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
- eee. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

BIOI 1	Apply inquiry-based and problem-solving processes and skills to scientific investigations.
BIOI 2	Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
BIOI 3	Investigate and evaluate the interaction between living organisms and their environment.
BIOI 4	Analyze and explain the structures and function of the levels of biological organization.
BIOI 5	Demonstrate an understanding of the molecular basis of heredity.
BIOI 6	Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- g. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- fff. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- qq. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- rr. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- ss. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- tt. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- uu. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- vv. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
 - ATP function
- ww. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- s. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- t. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- u. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- y. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- z. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- aa. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- bb. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- y. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- z. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- aa. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - bb. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- ee. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - ff. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - gg. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - hh. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - ii. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - rr. Clarify research questions and design laboratory investigations. (DOK 3)
 - ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- y. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - z. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - aa. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - bb. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- ee. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - ff. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - gg. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- hh. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- ii. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- ccc. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- ddd. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- eee. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- fff. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- ggg. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- hhh. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- iii. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- jjj. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- kkk. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- m. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- n. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- ee. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- ff. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- gg. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- hh. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- ii. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- kk. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- ll. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- mm. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- nn. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- oo. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- pp. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- y. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- z. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- aa. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- bb. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- y. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- z. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- aa. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- bb. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- rr. Clarify research questions and design laboratory investigations. (DOK 3)
- ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

qq. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)

- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

rr. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)

ss. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)

- Properties and interactions of the three fundamental particles of the atom
- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

tt. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)

- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

uu. Compare the properties of compounds according to their type of bonding. (DOK 1)

- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

vv. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

ww. Develop a three-dimensional model of molecular structure. (DOK 2)

- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

y. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

z. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)

- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- aa. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- bb. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
- 4. Analyze the relationship between microscopic and macroscopic models of matter.**
- y. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- z. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- aa. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- bb. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements

- Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- s. Analyze and explain acid/base reactions. (DOK 2)
 - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
 - t. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
 - u. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- vv. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

- kk. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)

- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

- ll. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)

- mm. Apply principles of geometry and hybridization to organic molecules. (DOK 2)

- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

- nn. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)

- oo. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)

- pp. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)

- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

- s. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)

- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

- t. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)

- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

- u. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.
- E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- y. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- z. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- aa. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

- bb. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere
3. **Discuss factors which are used to explain the geological history of earth.**
- ww. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
- xx. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
- yy. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
- zz. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
- aaa. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
- bbb. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
- ccc. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
- ddd. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
4. **Demonstrate an understanding of earth systems relating to weather and climate.**
- ee. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
- ff. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
- gg. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

- hh. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
 - ii. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting
- 5. Apply an understanding of ecological factors to explain relationships between earth systems.**
- y. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
 - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
 - z. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
 - aa. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
 - Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
 - bb. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols

- Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
- 2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.**
- qq. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
- rr. Explain the flow of matter and energy in ecosystems. (DOK 2)
- Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
- ss. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- tt. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
- How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
- uu. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- vv. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- ww. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)
- 3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**
- s. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

- t. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
- u. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- rr. Clarify research questions and design laboratory investigations. (DOK 3)
- ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- qq. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- rr. Describe how organic components are integral to biochemical processes. (DOK 2)
- ss. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
 - Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- tt. Explain the significance of the discovery of nucleic acids. (DOK 1)
- uu. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- vv. Cite examples to compare the consequences of the different types of mutations. (DOK 1)
- ww. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- qq. Cite evidence that supports the significance of Mendel’s concept of “particulate inheritance” to explain the understanding of heredity. (DOK 1)
- rr. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
 - Chromosomal theory of inheritance
- ss. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- tt. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- uu. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- vv. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- ww. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

- rr. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

- ooo. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- ppp. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- qqq. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- rrr. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- sss. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- ttt. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- uuu. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- vvv. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- www. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
- xxx. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)

- yyy. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- rr. Identify questions that can be answered through scientific investigations. (DOK 3)
- ss. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- tt. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- uu. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ww. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- ee. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)

- ff. Explain the connection between force, work, and energy. (DOK 2)
 - Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)
 - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- gg. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- hh. Draw and assess conclusions about charges and electric current. (DOK 2)
 - Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- ii. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
 - y. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
 - z. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
 - aa. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
 - The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
 - bb. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
 - y. Cite evidence to summarize the atomic theory. (DOK 1)
 - Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
 - z. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
 - aa. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)

- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectrosopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)
- bb. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
- 5. Investigate and apply principles of physical and chemical changes in matter.**
- s. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
- t. Balance chemical equations. (DOK 2)
- u. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

- 1. Investigate and apply principles of physical and chemical changes in matter.**
- qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- rr. Clarify research questions, and design laboratory investigations. (DOK 3)
- ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

- vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Develop an understanding of concepts related to forces and motion.

- y. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- z. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- aa. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- bb. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves

3. Develop an understanding of concepts related to work and energy.

- ee. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
- ff. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- gg. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- hh. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
- ii. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. Discuss the characteristics and properties of light and sound.

- ee. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
 - Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.
 - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
- ff. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
- gg. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
- hh. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
- ii. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. Apply an understanding of magnetism, electric fields, and electricity.

- s. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
- t. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
- u. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. Analyze and explain concepts of nuclear physics.

- m. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
- n. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

- SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- qq. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- rr. Clarify research questions, and design laboratory investigations. (DOK 3)
- ss. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
- tt. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
- uu. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- vv. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ww. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

- kk. Describe the characteristics of the electromagnetic spectrum.
- ll. Using images and graphs, interpret the absorption/reflection spectrum.
- mm. Distinguish between passive vs. active sensor systems.
- nn. Analyze the effects of changes in spatial, temporal, and spectral resolution.
- oo. Analyze the effects on images due to changes in scale.
- pp. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- qq. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- rr. Formulate questions that can be answered through research and experimental design. (DOK 3)

- ss. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- tt. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- uu. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- vv. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ww. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of levels of organization and animal classification.

- y. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
 - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- z. Identify and describe characteristics of the major phyla. (DOK 1)
 - Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- aa. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- bb. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
 - Phylogenic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.

- ee. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- ff. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
 - Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- gg. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)

- hh. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- ii. Contrast food chains and food webs. (DOK 2)
4. **Demonstrate an understanding of the principles of animal genetic diversity and evolution.**
- m. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- n. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.

- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.

- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.
- Multiply two binomials.*
- Solve real-world problems using first-degree equations.

- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.

- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†
- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.
- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.

- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.

- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.
- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.

- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer's position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer's position
 - Providing some response to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer's position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.
- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.
- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:

- Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
- Using simple vocabulary
- Using simple sentence structure
- Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
- Using simple but appropriate vocabulary
- Using a little sentence variety, though most sentences are simple in structure
- Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
- Using appropriate vocabulary
- Using some varied kinds of sentence structures to vary pace
- Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
- Using some precise and varied vocabulary
- Using several kinds of sentence structures to vary pace and to support meaning
- Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
- Using precise and varied vocabulary
- Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

Adobe Certified Associate Standards

Web Communication

AWC 1 Setting project requirements

- AWC 1.1 Identify the purpose, audience, and audience needs for a Web site.
- AWC 1.2 Identify Web page content that is relevant to the Web site purpose and appropriate for the target audience.
- AWC 1.3 Demonstrate knowledge of standard copyright rules (related terms, obtaining permission, and citing copyrighted material).
- AWC 1.4 Demonstrate knowledge of Web site accessibility standards that address the needs of people with visual and motor impairments.
- AWC 1.5 Make Web site development decisions based on your analysis and interpretation of design specifications.
- AWC 1.6 Understand project management tasks and responsibilities.

AWC 2 Planning site design and page layout

- AWC 2.1 Demonstrate general and Dreamweaver-specific knowledge of best practices for designing a Web site, such as maintaining consistency, separating content from design, using standard fonts and Web-safe colors, and utilizing visual hierarchy.
- AWC 2.2 Produce Web site designs that work equally well on various operating systems and browser versions/configurations.
- AWC 2.3 Demonstrate knowledge of page layout design concepts and principles.
- AWC 2.4 Identify basic principles of Web site usability, readability, and accessibility.
- AWC 2.5 Demonstrate knowledge of flowcharts, storyboards, and wireframes to create Web pages and a site map (site index) that maintain the planned Web site hierarchy.
- AWC 2.6 Communicate with others (such as peers and clients) about design and content plans.

AWC 3 Understanding the Adobe Dreamweaver CS4 interface

- AWC 3.1 Identify elements of the Dreamweaver interface.
- AWC 3.2 Use the Insert bar.
- AWC 3.3 Use the Property inspector.
- AWC 3.4 Use the Assets panel.
- AWC 3.5 Use the Files panel.

AWC 4 Adding content by using Dreamweaver CS4

- AWC 4.1 Define a Dreamweaver site.
- AWC 4.2 Create, title, name, and save a Web page.
- AWC 4.3 Add text to a Web page.
- AWC 4.4 Insert images and apply alternative text on a Web page.
- AWC 4.5 Link Web content, using hyperlinks, e-mail links, and named anchors.

- AWC 4.6** Insert rich media, such as video, sound, and animation in Flash format.
- AWC 4.7** Insert navigation bars, rollover images, and buttons created in Adobe Fireworks on a Web page.
- AWC 4.8** Build image maps.
- AWC 4.9** Import tabular data to a Web page.
- AWC 4.10** Import and display a Microsoft Word or Microsoft Excel document to a Web page.
- AWC 4.11** Create forms.

AWC 5 Organizing content by using Dreamweaver CS4

- AWC 5.1** Set and modify document properties.
- AWC 5.2** Organize Web page layout with absolutely positioned div tags and CSS styles.
- AWC 5.3** Modify text and text properties.
- AWC 5.4** Modify images and image properties.
- AWC 5.5** Create Web page templates.
- AWC 5.6** Use basic HTML tags to set up an HTML document, format text, add links, create tables, and build ordered and unordered lists.
- AWC 5.7** Add head content to make a Web page visible to search engines.
- AWC 5.9** Use CSS to implement a reusable design.

AWC 6 Evaluating and maintaining a site by using Dreamweaver CS4

- AWC 6.1** Conduct basic technical tests.
- AWC 6.2** Identify techniques for basic usability tests.
- AWC 6.3** Present Web pages to others (such as team members and clients) for feedback and evaluation.
- AWC 6.4** Identify methods for collecting site feedback.
- AWC 6.5** Manage assets, links, and files for a site.
- AWC 6.6** Publish and update site files to a remote server.

Rich Media Communication

ARM 1 Setting project requirements

- ARM 1.1** Identify the purpose, audience, and audience needs for rich media content.
- ARM 1.2** Identify rich media content that is relevant to the purpose of the media in which it will be used (Web sites, mobile devices, etc.).
- ARM 1.3** Understand options for producing accessible rich media content.
- ARM 1.4** Demonstrate knowledge of standard copyright rules (related terms, obtaining permission, and citing copyrighted material).
- ARM 1.5** Understand project management tasks and responsibilities.
- ARM 1.6** Communicate with others (such as peers and clients) about design and content plans.

ARM 2 Identifying rich media design elements

- ARM 2.1** Identify general and Flash-specific best practices for designing rich media content for a Web site.
- ARM 2.2** Demonstrate knowledge of design elements and principles.

ARM 2.3 Identify general and Flash-specific techniques to create rich media elements that are accessible and readable.

ARM 2.4 Use a storyboard to produce rich media elements.

ARM 2.5 Organize a Flash document.

ARM 3 Understanding Adobe Flash CS4 Interface

ARM 3.1 Identify elements of the Flash interface.

ARM 3.2 Use the Property inspector.

ARM 3.3 Use the Timeline.

ARM 3.4 Use the Motion Editor.

ARM 3.5 Understand Flash file types.

ARM 3.6 Identify best practices for managing the file size of a published Flash document.

ARM 4 Building rich media elements by using Flash CS4

ARM 4.1 Make rich media content development decisions based on your analysis and interpretation of design specifications.

ARM 4.2 Adjust document properties.

ARM 4.3 Use Flash guides and rulers.

ARM 4.4 Use tools on the Tools panel to select, create, and manipulate graphics and text.

ARM 4.5 Import and modify graphics.

ARM 4.6 Create text.

ARM 4.7 Adjust text properties.

ARM 4.8 Create objects, and convert them to symbols, including graphics, movie clips, and buttons.

ARM 4.9 Understand symbols and the library.

ARM 4.10 Edit symbols and instances.

ARM 4.11 Create masks.

ARM 4.12 Create animations (changes in shape, position, size, color, and transparency).

ARM 4.13 Add simple controls through ActionScript 3.0.

ARM 4.14 Import and use sound.

ARM 4.15 Add and export video.

ARM 4.16 Publish Flash documents.

ARM 4.17 Make a document accessible.

ARM 5 Evaluating rich media elements

ARM 5.1 Conduct basic technical tests.

ARM 5.2 Identify techniques for basic usability tests

Visual Communication

AVC 1 Setting project requirements

AVC 1.1 Identify the purpose, audience, and audience needs for preparing image(s).

AVC 1.2 Demonstrate knowledge of standard copyright rules for images and image use.

AVC 1.3 Demonstrate knowledge of project management tasks and responsibilities.

AVC 1.4 Communicate with others (such as peers and clients) about design plans.

AVC 2 Identifying design elements when preparing images

- AVC 2.1** Demonstrate knowledge of image resolution, image size, and image file format for Web, video, and print.
- AVC 2.2** Demonstrate knowledge of design principles and image composition.
- AVC 2.3** Demonstrate knowledge of typography.
- AVC 2.4** Demonstrate knowledge of color correction using Photoshop CS4.
- AVC 2.5** Demonstrate knowledge of image generating devices, their resulting image types, and how to access resulting images in Photoshop.

AVC 3 Understanding Adobe Photoshop CS4

- AVC 3.1** Identify elements of the Photoshop CS4 user interface, and demonstrate knowledge of their functions.
- AVC 3.2** Demonstrate knowledge of layers and masks.
- AVC 3.3** Demonstrate knowledge of importing, exporting, organizing, and saving.
- AVC 3.4** Demonstrate knowledge of producing and reusing images.
- AVC 3.5** Demonstrate an understanding of and select the appropriate features and options required to implement a color management workflow.

AVC 4 Manipulating images using Adobe Photoshop CS4

- AVC 4.1** Demonstrate knowledge of working with selections and measurement.
- AVC 4.2** Use Photoshop guides and rulers.
- AVC 4.3** Transform images.
- AVC 4.4** Adjust the tonal range and correct the color of an image.
- AVC 4.5** Demonstrate knowledge of retouching and blending images.
- AVC 4.6** Demonstrate knowledge of drawing and painting.
- AVC 4.7** Demonstrate knowledge of type.
- AVC 4.8** Demonstrate knowledge of filters.

AVC 5 Publishing digital images using Adobe Photoshop CS4

- AVC 5.1** Demonstrate knowledge of preparing images for Web, print, and video.

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.
- b. Plan and manage activities to develop a solution or complete a project.

- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Culinary Arts Executive Summary	561
Course Outlines.....	563
Culinary Arts Competencies and Objectives	568
Culinary Arts Competency Profile.....	579
Appendix A: 21st Century Skills Standards	582
Appendix B: MS Academic Standards	584
Appendix C: ACT College Readiness Standards.....	614
Appendix D: Pathway Content Standards.....	628
Appendix E: National Educational Technology Standards for Students	631

Culinary Arts Executive Summary

Program Description

Culinary Arts is a pathway for students in the Human Science, Art, and Humanities career cluster. The following description is from the current Standard Course of Study, for Career–Technical Education, Mississippi Department of Education.

The Culinary Arts pathway program includes classroom and hands-on experiences that will prepare students for employment or continuing education in the foodservice industry. This program was written to incorporate the **National Restaurant Associations (NRA) ProStart** learning objectives. Any student who successfully completes this program and the mentoring requirements of the NRA can take the National ProStart Certificate of Achievement exam. This is a national certification program recognized throughout the foodservice industry. Each district should implement a maximum student number due to the size of each lab.

Industry Certification

This program was designed to articulate to postsecondary Food Production, Hotel and Restaurant Management, and Culinary Arts. Industry standards are based on the *National Restaurant Association ProStart Certification and the National Restaurant Association ServSafe Certification*.

Assessment

Students will be assessed using the Culinary Arts MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the Culinary Arts instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Culinary Arts program, the following student prerequisites are in place:

9. C or higher in English (the previous year)
10. C or higher in Math (last course taken or the instructor can specify the math)

or

11. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

12. Instructor Approval

Proposed Applied Academic Credit

The mathematics content in the Culinary Arts program is meaningful and useful to students who are entering the foodservice industry. Applied mathematics content was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn ½ applied mathematical credit that can be used for graduation requirements.

The applied academic credit has *not* been approved by the MS Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

Mississippi teacher license endorsement 972 is needed to teach the Culinary Arts pathway. Requirements for the 972 educator endorsement are listed below:

1. Applicant must have earned an AA degree or higher.
2. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
3. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
4. Applicant must complete all components of the national Prostart Certification program.
5. Applicant must successfully complete the ServSafe certification exam (updated every 5 years).
6. Applicant must successfully complete an approved computer literacy certification exam.
7. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the Mississippi Department of Education.
8. Applicant must successfully complete a Culinary Arts certification workshop, module, or course that is approved by the Mississippi Department of Education.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum provides options for local school districts to meet student needs and scheduling demands. The first option groups units into four 1-Carnegie unit courses. The second option groups units into two 2-Carnegie courses. Please see below for a description of each option.

Option 1

This option consists of four 1-credit courses that should be completed in the following sequence:

7. Orientation to Culinary Arts (Course Code: 996002)
8. Theory and Applications of Culinary Arts, Part A (Course Code: 996004)
9. Theory and Applications of Culinary Arts, Part B (Course Code: 96005)
10. Advanced Studies in Culinary Arts (Course Code: 996006)

Course Description: Orientation to Culinary Arts includes the foundation skills necessary in the foodservice industry. Content such as food safety and sanitation, equipment, safety and security, culinary foundations and math, and an introduction to the hospitality industry are included in the course. Mastery of the competencies listed in the food safety and sanitation unit will prepare the student to take the NRA's ServSafe exam to become ServSafe Food Safety certified. As of January 1, 1999, every foodservice establishment in Mississippi must have a full-time certified food manager employed in order to meet the FDA Food Code requirements. Students are encouraged to take this exam.

Course Description: Theory and Applications of Culinary Arts, Part A emphasizes real-world, hands-on practice of food preparation. Food preparation techniques included in this course include breakfast foods, dairy, and sandwiches; fruits, vegetables, salads, and garnishes; and potatoes and grains. This one-Carnegie unit course should only be taken after students successfully pass Orientation to Culinary Arts (Course Code: 995002).

Course Description: Theory and Applications of Culinary Arts, Part B emphasizes real-world, hands-on practice of food preparation. Food preparation techniques included in this course include desserts and baked goods; meat, poultry, and seafood; and stocks, sauces, and soups. This one-Carnegie unit course should only be taken after students successfully pass Theory and Applications of Culinary Arts (Course Code: 995004).

Course Description: Advanced Studies in Culinary Arts is a culminating course that places emphasis on an internship experience. While they participate in the on-the-job training, the students will use their skills that are related to management and business concepts, customer communication, and customer service. Before students can complete the Advanced Placement Culinary Arts course, they must meet the following requirements:

Score 80% or higher on the MS-CPAS2 summative assessment.

Attendance rate of 92% or better in the Orientation to Culinary Arts (Course Code: 996002) and the Theory and Applications of Culinary Arts parts A and B (Course Code: 996004 and 996005)

Find a job related to the culinary industry.

Orientation to Culinary Arts (One Carnegie Unit) - Course Code: 996002

Unit	Title	Hours
1	Introduction	10
2	Human Relations Management	25
3	Food Safety and Sanitation	30
4	Foodservice Equipment, Safety, and Security	30
5	Culinary Foundations	35
		130

Theory and Applications of Culinary Arts, Part A (One Carnegie Unit) - Course Code: 996004

Unit	Title	Hours
6	Breakfast Foods, Dairy, and Sandwiches	25
7	Fruits, Vegetables, Salads, and Garnishes	35
8	Culinary Math	25
		85

Theory and Applications of Culinary Arts, Part B (One Carnegie Unit) - Course Code: 996005

Unit	Title	Hours
9	Orientation	20
10	Hospitality Industry	30
11	Potatoes and Grains	25
12	Customer Communication and Service	25
13	Desserts and Baked Goods	25
		125

Advanced Studies in Culinary Arts (One Carnegie Unit) - Course Code: 996006

Unit	Title	Hours
14	Culinary Business Concepts	45
15	Meat, Poultry, and Seafood	25
16	Stocks, Sauces, and Soups	25
		95

Option 2

This option consists of two 2-Carnegie unit courses that should be completed in the following sequence.

1. Culinary Arts I (Course Code: 996000)
2. Culinary Arts II (Course Code: 996001)

Course Description: Culinary Arts I is the first course of the program. Food preparation techniques included in this course are breakfast foods, dairy, sandwiches, salads, garnishes, fruits, and vegetables. Management skills emphasized are basic customer service, food safety and sanitation, workplace safety and security, culinary basics, equipment, nutrition, human resources, math, and food cost control. Mastery of the competencies listed in the food safety and sanitation unit will prepare students to take the NRA's ServSafe exam to become ServSafe Food

Safety certified. As of January 1, 1999, every foodservice establishment in Mississippi must have a full-time certified food manager employed in order to meet the FDA Food Code requirements. Students are encouraged to take this exam.

Course Description: Culinary Arts II is a continuation of the emphasis on management and food preparation. Management topics include marketing, accounting, purchasing, inventory, and advanced customer service. Food preparation techniques covered include potatoes, grains, desserts, baked goods, meat, poultry, seafood, stocks, sauces, and soups. An exploration of culinary history is also included in this course. The course should be taken after the student has successfully passed Culinary Arts I.

Culinary Arts I (Course Code: 996000)

Unit	Title	Hours
1	Introduction	10
2	Human Relations Management	25
3	Food Safety and Sanitation	30
4	Foodservice Equipment, Safety, and Security	30
5	Culinary Foundations	35
6	Breakfast Foods, Dairy, and Sandwiches	25
7	Fruits, Vegetables, Salads, and Garnishes	35
8	Culinary Math	25
		215

Culinary Arts II (Course Code: 996001)

Unit	Title	Hours
9	Orientation	20
10	Hospitality Industry	30
11	Potatoes and Grains	25
12	Customer Communication and Service	25
13	Desserts and Baked Goods	25
14	Culinary Business Concepts	45
15	Meat, Poultry, and Seafood	25
16	Stocks, Sauces, and Soups	25
		220

Culinary Arts Competencies and Objectives

Unit 1: Introduction

1. Identify school and program policies and procedures, and compare/contrast them with industry policies and procedures. (DOK 1)
 - i. Discuss the school handbook and all safety procedures for classroom and building levels. (DOK 1)
 - j. Review program policies in the classroom, laboratory, and industry.
2. Identify career and leadership opportunities in the culinary industry. (DOK 1)
 - a. Investigate career opportunities in the culinary industry to include communication writers, food stylists, marketers, research and development, food science, sales, dietitians, food production, food processing, accounting, entrepreneurs, trainers, and grocery store and deli managers. (DOK 1)
 - b. Investigate the occupational outlook and salaries for culinary careers according to current and future trends. (DOK 2)
 - c. Discuss the difference between school and workplace environments. (DOK 1)
 - d. Explore leadership opportunities available from student youth and industry organizations. (DOK 2)
3. Analyze the importance of service to the culinary industry. (DOK 2)
 - a. Explore the elements of excellent service to include anticipating the customers' needs. (DOK 2)
 - b. Explore the elements of excellent service from the standpoint of the customer. (DOK 2)
 - c. Investigate the importance of positive attitudes and work ethics. (DOK 1)
 - d. Illustrate the qualities of successful foodservice employees. (DOK 2)
 - e. Develop a list of workplace guidelines to include attendance, teamwork, promptness, dependability, questions, fairness, honesty, and a positive attitude. (DOK 1)
4. Formulate a plan for an effective job search. (DOK 1)
 - a. Create a generic cover letter. (DOK 2)
 - b. Identify a network of people that can provide information about job opportunities. (DOK 1)
 - c. Create a high-quality one-page resume. (DOK 3)
 - d. Complete a college and job application form. (DOK 2)
 - e. Construct an electronic portfolio. (DOK 3)
 - f. Participate in a mock effective job interview. (DOK 3)
 - g. Write a generic letter of resignation. (DOK 2)

Unit 2: Human Relations Management

1. Determine the skills necessary to provide professional customer service. (DOK 2)
 - a. State the importance of customer service. (DOK 1)

- b. List the reasons and the ways to make a positive first impression. (DOK 2)
 - c. Describe a variety of customers that may have special needs. (DOK 2)
 - d. Distinguish between effective and ineffective communication with customers by giving examples. (DOK 2)
 - e. Explain how customer satisfaction directly affects a restaurant's success. (DOK 3)
 - f. Create job standards for servers. (DOK 2)
2. Demonstrate excellent interpersonal skills. (DOK 2)
 - a. Exhibit a positive attitude. (DOK 1)
 - b. Practice teamwork. (DOK 2)
 - c. Demonstrate effective verbal and nonverbal communication skills. (DOK 2)
 - d. Apply conflict resolution skills to real-life situations. (DOK 3)
 3. Analyze supervisory skills related to human resource management. (DOK 3)
 - a. Explain how stereotypes and prejudices can negatively affect how people work together. (DOK 1)
 - b. List and demonstrate effective legal interviewing skills. (DOK 2)
 - c. Discuss the importance of having new employee orientation. (DOK 1)
 - d. Describe common elements of orientation programs. (DOK 2)
 - e. Analyze the most effective training technique for different purposes to include on-the-job training, role-playing, and/or group training. (DOK 3)
 - f. List and apply effective techniques used in performance evaluations. (DOK 3)

Unit 3: Food Safety and Sanitation

1. Discuss and relate the importance of food safety to society. (DOK 2)
 - a. List reasons why it is important to keep food safe. (DOK 1)
 - b. Describe good personal hygiene and how it affects food safety. (DOK 1)
 - c. List the steps to proper hand washing. (DOK 2)
 - d. Give examples of potentially hazardous foods. (DOK 2)
 - e. Categorize and describe the microorganisms that cause foodborne illness. (DOK 2)
 - f. Identify and list ways biological, chemical, and physical hazards can contaminate food. (DOK 2)
 - g. Identify the eight most common allergens, associated symptoms, and methods of prevention. (DOK 2)
 - h. Distinguish between situations in which contamination and cross-contamination can occur. (DOK 2)
 - i. List the conditions under which bacteria can multiply rapidly, and use the letters FAT-TOM. (DOK 2)
 - j. Explain how time and temperature guidelines can reduce the growth of microorganisms. (DOK 2)
 - k. Define the food temperature danger zone, and list temperatures that fall within that zone. (DOK 2)

1. Differentiate between different types of thermometers, and demonstrate how to use them. (DOK 2)
2. Explain the importance of establishing a food safety system. (DOK 2)
 - a. List the seven major steps in a Hazard Analysis Critical Control Points (HACCP) system and the four steps to Active Managerial Control focusing on controlling the CDC's five most common risk factors. (DOK 2)
 - b. Analyze a recipe, and rewrite it to meet HACCP guidelines. (DOK 3)
3. Analyze the flow of food through a foodservice establishment. (DOK 2)
 - a. Compare different types of storage areas found in a foodservice operation. (DOK 2)
 - b. Outline proper procedures for receiving, storing, preparing, cooking, holding, cooling, reheating, and serving food that includes use of proper tools and equipment. (DOK 2)
4. Maintain a clean and sanitary kitchen. (DOK 1)
 - a. Define the difference between clean and sanitary. (DOK 1)
 - b. Demonstrate procedures for cleaning and sanitizing tools and equipment. (DOK 2)

Unit 4: Foodservice Equipment, Safety, and Security

1. Implement safe work habits to prevent injuries (ongoing). (DOK 2)
 - a. Discuss OSHA (Occupational Safety and Health Administration) and why it is important. (DOK 1)
 - b. Describe the Hazard Communication Standard requirements for employers. (DOK 1)
 - c. Identify the location and purpose of Material Safety Data Sheets. (DOK 1)
 - d. Identify electrical hazards that contribute to accidental fires and shocks. (DOK 1)
 - e. Classify different types of fires and fire extinguishers to include automatic sprinklers and hood systems. (DOK 1)
 - f. Describe the ways to prevent both fire and chemical burns. (DOK 1)
 - g. List hazards that contribute to injury due to slips, trips, or falls. (DOK 1)
 - h. Outline proper procedures for cleaning spills on floors. (DOK 1)
 - i. Demonstrate the proper use of ladders. (DOK 1)
 - j. Demonstrate proper lifting and carrying procedures to avoid injury. (DOK 2)
 - k. Demonstrate correct and safe use of knives including handling, walking, passing, washing, and storing. (DOK 2)
 - l. Identify other hazards that can cause cuts. (DOK 1)
 - m. List ways to use protective clothing and equipment to prevent injuries. (DOK 1)
2. Explain emergency techniques and procedures. (DOK 1)
 - a. Outline proper actions to take in the event of a fire. (DOK 1)
 - b. Describe basic first aid concepts and procedures for choking, cuts, burns, falls, strains, electrical shocks, and heart attacks. (DOK 1)
 - c. Explain the importance of completing standard reports for accidents or illnesses. (DOK 1)
 - d. Describe procedures to manage robberies, natural disasters, food security, and vandalism. (DOK 2)

3. Analyze the correct use of hand tools. (DOK 2)
 - a. Identify basic kitchen hand tools. (DOK 1)
 - b. Demonstrate proper cleaning, sanitizing, and maintenance of hand tools. (DOK 2)
 - c. Demonstrate measuring and portioning hand tools. (DOK 2)
 - d. Identify, use, and analyze the appropriate types and sizes of pots and pans. (DOK 2)
4. Develop standard operating procedures, and demonstrate the safe use and maintenance of large equipment. (DOK 2)
 - a. Demonstrate how to cut and mix foods using standard kitchen equipment. (DOK 2)
 - b. Compare and contrast cooking foods using various types of steamers, broilers, grills, ranges, fryers, and ovens. (DOK 2)
 - c. Outline how to hold and serve food and beverages using equipment. (DOK 1)
 - d. Demonstrate proper assembly, dismantling, cleaning, sanitizing, and maintenance of foodservice equipment. (DOK 2)

Unit 5: Culinary Foundations

1. Develop and demonstrate basic food preparation skills. (DOK 2)
 - a. Identify the components and functions of a standardized recipe. (DOK 1)
 - b. Recognize abbreviations. (DOK 1)
 - c. Weigh and measure ingredients with measuring devices by weight and volume. (DOK 2)
 - d. List the common equivalents of weights and measures. (DOK 2)
 - e. Convert a standardized recipe to increase and decrease yield. (DOK 2)
 - f. Use correct terminology for basic food preparation techniques. (DOK 2)
 - g. Apply mise en place through practice. (DOK 2)
 - h. Discuss different types of knives, and demonstrate basic cuts. (DOK 2)
 - i. Use common spices and herbs appropriately. (DOK 2)
 - j. Follow a standard recipe to produce a standard product. (DOK 2)
2. Develop and demonstrate basic food cooking methods. (DOK 2)
 - a. Demonstrate the dry heat cooking methods. (DOK 2)
 - b. Demonstrate the moist heat cooking methods. (DOK 2)
 - c. Demonstrate the combination cooking methods. (DOK 2)
3. Discuss the components of a healthy diet. (DOK 1)
 - a. Describe a healthy diet. (DOK 2)
 - b. Identify and discuss the role of nutrients to include carbohydrates, hormones, fiber, starch, and fat. (DOK 2)
 - c. Define and discuss cholesterol, and list the food in which it is found. (DOK 2)
 - d. Discuss the role of protein, water, vitamins, and minerals in a diet, and identify foods that contain these nutrients. (DOK 2)
 - e. Differentiate between complete and incomplete proteins. (DOK 1)
 - f. Interpret information on a food label. (DOK 2)
 - g. Identify and describe the Recommended Dietary Allowances (RDAs) and the Food Guide Pyramid. (DOK 2)
 - h. Determine the role of supplements in the diet. (DOK 2)

4. Design and produce a well-balanced meal. (DOK 3)
 - a. Use the Recommended Dietary Allowances and the Food Guide Pyramid to plan and produce a meal. (DOK 2)
 - b. Apply nutritional concepts to various ways of making recipes more healthful to include sodium and fat reduction, increased fiber intake, and more nutrients. (DOK 2)

Unit 6: Breakfast Foods, Dairy, and Sandwiches

1. Create and evaluate breakfast foods. (DOK 3)
 - a. Prepare and critique basic breakfast food items. (DOK 3)
 - b. Prepare and critique breakfast beverages. (DOK 3)
2. Demonstrate preparation and handling of dairy products. (DOK 2)
 - a. Explain how to keep dairy products safe and sanitary. (DOK 2)
 - b. Differentiate between butter and margarine. (DOK 2)
 - c. Distinguish between several types of cheeses, and give examples of each. (DOK 2)
3. Construct and evaluate several types of sandwiches. (DOK 3)
 - a. Give examples of different types of sandwiches. (DOK 1)
 - b. Identify the three components of a sandwich. (DOK 1)
 - c. Construct various sandwiches. (DOK 3)

Unit 7: Fruits, Vegetables, Salads, and Garnishes

1. Demonstrate and evaluate the preparation of fruits. (DOK 2)
 - a. Identify, describe, and demonstrate the preparation of different fruits. (DOK 2)
 - b. List and explain the USDA quality grades for fresh fruit. (DOK 2)
 - c. Demonstrate the procedures for properly storing ripe fruit. (DOK 2)
 - d. Summarize ways to prevent fruit from spoiling too quickly. (DOK 1)
 - e. Match and cook fruit to appropriate cooking methods. (DOK 2)
 - f. Explain how to prevent enzymatic browning of fruit. (DOK 1)
2. Demonstrate and evaluate the preparation of vegetables. (DOK 2)
 - a. Identify, describe, and demonstrate the preparation of different vegetables. (DOK 2)
 - b. List and explain the USDA quality grades for fresh vegetables. (DOK 2)
 - c. Demonstrate the procedures for properly storing ripe vegetables, roots, and tubers. (DOK 2)
 - d. Summarize ways to prevent vegetables from spoiling too quickly. (DOK 1)
 - e. Match and prepare vegetables according to appropriate cooking methods. (DOK 2)
3. Prepare and evaluate various types of salads. (DOK 2)
 - a. Identify types of salads. (DOK 1)
 - b. Identify types of salad greens used in salad preparation. (DOK 1)
 - c. Identify the parts of a salad. (DOK 1)
 - d. Compare and contrast types of salads served at different points in the meal. (DOK 1)
 - e. Demonstrate appropriate methods to clean salad greens. (DOK 2)
 - f. Prepare and store salads properly. (DOK 2)

4. Prepare and evaluate salad dressings. (DOK 2)
 - a. Differentiate among salad dressings. (DOK 1)
 - b. Prepare and match dressings to appropriate salads. (DOK 2)
5. Demonstrate appropriate garnishing techniques. (DOK 3)
 - a. Describe the importance of a garnish. (DOK 1)
 - b. Investigate common ingredients used to garnish. (DOK 2)
 - c. Design an appropriately garnished plate. (DOK 3)

Unit 8: Culinary Math

1. Apply basic mathematical calculations to culinary practices. (DOK 2)
 - a. Given a list of numbers, add, subtract, multiply, and divide using basic math operations. (DOK 2)
 - b. Given a list of fractions, decimals, whole numbers, and percentages, add, subtract, multiply, and divide. (DOK 2)
2. Apply basic mathematical functions to weights and measures. (DOK 3)
 - a. Convert recipes from original yield to desired yield using conversion factors. (DOK 3)
 - b. Calculate recipe yields. (DOK 2)
3. Apply basic mathematical functions and food handling practices to control food costs. (DOK 2)
 - a. Describe and give examples of controllable food costs, fixed costs, semi-variable costs, and variable costs. (DOK 2)
 - b. Differentiate between the two categories of food purchased: perishable and nonperishable. (DOK 2)
 - c. Outline and follow basic receiving procedures. (DOK 2)
 - d. State the appropriate storage guidelines and temperatures for different perishable foods. (DOK 2)
4. Determine the menu selling price. (DOK 3)
 - a. Explore and investigate the relationship between the menu and costs. (DOK 2)
 - b. Calculate standard portion cost. (DOK 2)
 - c. Compute and compare the different methods of arriving at menu selling prices to include the food cost percentage method, the average check method, the contribution margin method, and the straight markup method. (DOK 3)
5. Apply mathematical procedures to revenue control. (DOK 2)
 - a. Calculate the average check/cover, and discuss its importance. (DOK 2)
 - b. Calculate the total guest check including tax and tip. (DOK 2)
6. Explain and apply principles used in inventory control. (DOK 2)
 - a. Determine dollar value of inventory. (DOK 2)
 - b. Determine daily and monthly food cost and food cost percentage. (DOK 2)

Unit 9: Orientation

1. Review school and program policies and procedures. (DOK 1)
 - a. Discuss the school handbook and all safety procedures for the classroom and building levels. (DOK 1)
 - b. Review program policies in the classroom and the laboratory. (DOK 1)
2. Update career/educational plans. (DOK 1)
 - a. Revise resume. (DOK 1)
 - b. Demonstrate effective interviewing skills. (DOK 1)
 - c. Discuss employer expectations. (DOK 1)
3. Model job retention skills. (DOK 2)
 - a. Discuss diversity in the workplace. (DOK 1)
 - b. Explain a job evaluation and how it relates to career advancement and pay. (DOK 1)
 - c. Model valued professional workplace characteristics. (DOK 2)

Unit 10: Hospitality Industry

1. Research the creation of the modern restaurant. (DOK 1)
 - a. Trace the history of the foodservice industry, and explain its relationship to world history. (DOK 1)
 - b. Research famous chefs, and note their major accomplishments. (DOK 2)
2. Compare and contrast American regional cuisines and international cuisines. (DOK 2)
 - a. Analyze the relationship between global cultures and traditions related to food to include religious practices, ethnicity, demographic variables, colonial exploration, and immigration. (DOK 2)
3. Research the history of foodservice in the United States. (DOK 1)
 - a. Outline the growth of foodservice throughout the history of the United States. (DOK 1)
 - b. List historical entrepreneurs who influenced foodservice in the United States. (DOK 1)
4. Investigate the future of foodservice. (DOK 2)
 - a. List current trends in society, and explain how they influence the foodservice industry. (DOK 2)
 - b. Categorize and differentiate among the segments of the foodservice industry. (DOK 1)
 - c. Investigate and draw conclusions on the impact of future economic, technological, and social changes in the foodservice industry. (DOK 2)
5. Analyze the tourism and travel industry, and determine how the industry will change over time. (DOK 2)
 - a. Explain the role of tourism in the hospitality industry. (DOK 1)
 - b. Categorize the types of businesses that make up the tourism industry. (DOK 2)
 - c. List and discuss why people travel. (DOK 1)
 - d. List the different types of transportation and the advantages and disadvantages of each. (DOK 2)
 - e. List and describe required customer service skills in the travel industry. (DOK 1)

6. Analyze the lodging industry. (DOK 2)
 - a. Explain the role of lodging in the hospitality industry. (DOK 1)
 - b. Identify career opportunities offered by the travel and tourism industry. (DOK 1)
 - c. Describe the differences between leisure and business travelers. (DOK 1)
 - d. List the characteristics of lodging operations. (DOK 1)
 - e. Describe the use of forecasting and overbooking in reservations management. (DOK 2)

Unit 11: Potatoes and Grains

1. Select and store potatoes, grains, legumes, and pasta. (DOK 2)
 - a. Outline methods to select, receive, and store potatoes and grains. (DOK 2)
 - b. Distinguish between different types of wheat. (DOK 2)
2. Create, prepare, and critique classic potato recipes. (DOK 3)
 - a. Identify and describe various types of potatoes. (DOK 1)
 - b. Using a variety of recipes and cooking techniques, prepare potatoes. (DOK 3)
3. Create, prepare, and critique legumes and grain foods. (DOK 3)
 - a. Identify and describe the different types of grains and legumes. (DOK 1)
 - b. Using a variety of recipes and cooking techniques, prepare grains and legumes. (DOK 3)
4. Create and evaluate pasta and dumplings. (DOK 3)
 - a. Identify and describe various types of pasta and dumplings. (DOK 1)
 - b. Using a variety of recipes and cooking techniques, prepare pasta and dumplings. (DOK 3)

Unit 12: Customer Communication and Service

1. Demonstrate various types of high-quality service in the foodservice industry. (DOK 2)
 - a. Demonstrate the similarities and differences among American, French, English, Russian, and self-service styles. (DOK 2)
 - b. Describe and demonstrate table side preparations such as carving meats and slicing desserts. (DOK 2)
 - c. Describe traditional service staff, and list the duties and responsibilities of each. (DOK 1)
 - d. Identify various server tools and the correct way to stock a service station. (DOK 2)
 - e. Dramatize ways of describing and recommending menu items to guests. (DOK 2)
 - f. Dramatize ways of effectively resolving customer complaints. (DOK 2)
 - g. Demonstrate setting and clearing items properly. (DOK 2)
2. Demonstrate personal dining etiquette. (DOK 1)
 - a. Identify the various types of dining utensils and their proper use. (DOK 1)
3. Demonstrate positive customer communications. (DOK 2)
 - a. List ways to respond to and resolve customer complaints. (DOK 1)
 - b. List and demonstrate effective writing skills. (DOK 2)

- c. Model proper and courteous telephone skills through demonstrations. (DOK 2)
- d. State guidelines for communicating effectively during and after a crisis. (DOK 2)
- e. Demonstrate effective listening and speaking skills. (DOK 2)
- f. List and discuss examples of innovative ways to attract and keep customers. (DOK 1)
- g. Demonstrate suggestive selling techniques. (DOK 2)

Unit 13: Desserts and Baked Goods

- 1. Create, prepare, and evaluate breads. (DOK 3)
 - a. Describe the function of common ingredients in baking. (DOK 2)
 - b. Identify and prepare yeast breads and quick breads. (DOK 3)
- 2. Create, prepare, and evaluate baked goods. (DOK 3)
 - a. Discuss and prepare cakes, cookies, pies, and other desserts. (DOK 3)

Unit 14: Culinary Business Concepts

- 1. Apply marketing principles to foodservice. (DOK 2)
 - a. Define marketing. (DOK 1)
 - b. Describe market segmentation. (DOK 1)
 - c. Differentiate between a restaurant promotion and public relations. (DOK 2)
- 2. Develop a menu. (DOK 3)
 - a. Define à la carte, table d'hôte, California menu, du jour, and cycle menus. (DOK 1)
 - b. Organize the information on a menu. (DOK 1)
 - c. Write and create the layout of a menu. (DOK 3)
- 3. Examine the purchasing process. (DOK 1)
 - a. Explain the relationship between primary and intermediary sources and retailer. (DOK 1)
 - b. Explain the difference between formal and informal purchasing processes. (DOK 1)
- 4. Develop standard ordering procedures. (DOK 2)
 - a. Develop a specification list for items based on inventory information. (DOK 2)
 - b. Write purchase orders for items to be purchased. (DOK 2)
- 5. Explain and defend the decisions to be made when purchasing. (DOK 2)
 - a. Explain how production records influence purchasing decisions. (DOK 2)
 - b. List the criteria for selecting appropriate suppliers. (DOK 2)
- 6. Explain the procedures for receiving, storing, and issuing foods and supplies. (DOK 2)
 - a. List proper receiving procedures. (DOK 1)
 - b. Discuss the proper storage procedures for foods and beverages. (DOK 2)
 - c. Differentiate between the periodic order and perpetual inventory methods. (DOK 2)
- 7. Summarize accounting procedures in foodservice. (DOK 2)
 - a. Explain the purpose of accounting records. (DOK 2)
 - b. Define basic accounting transactions and terms. (DOK 2)
- 8. Critique income statements. (DOK 2)

- a. Identify information and terms found on income statements. (DOK 2)
 - b. Explain how to use the information on income statements in the decision-making process. (DOK 2)
9. Critique balance sheets. (DOK 2)
- a. Identify information and terms found on balance sheets. (DOK 2)
 - b. Explain how to use the information on a balance sheet in the decision-making process. (DOK 2)

Unit 15: Meat, Poultry, and Seafood

1. Create, prepare, and evaluate a quality meat product. (DOK 3)
 - a. Describe various kinds of meat. (DOK 1)
 - b. Outline the federal grading systems for meat. (DOK 2)
 - c. Match various cooking methods with various forms of meat. (DOK 2)
 - d. Demonstrate proper procedure for purchasing, storing, and preparing meat. (DOK 3)
2. Prepare and evaluate a quality poultry product. (DOK 3)
 - a. Describe various kinds of poultry. (DOK 1)
 - b. Outline the federal grading systems for poultry. (DOK 2)
 - c. Match various cooking methods with various forms of poultry. (DOK 2)
 - d. Demonstrate proper procedures for purchasing, storing, and preparing poultry. (DOK 3)
3. Create, prepare, and evaluate a quality fish/seafood product. (DOK 3)
 - a. Describe various kinds of fish/seafood. (DOK 1)
 - b. Outline the federal grading systems for fish/seafood. (DOK 2)
 - c. Demonstrate proper procedures for purchasing, storing, and preparing fish/seafood. (DOK 3)
 - d. Match various cooking methods with various forms of fish/seafood. (DOK 2)

Unit 16: Stocks, Sauces, and Soups

1. Create, prepare, and evaluate stocks. (DOK 3)
 - a. Identify the four essential parts of stock and the proper ingredients for each. (DOK 1)
 - b. List and explain the various types of stock and their ingredients. (DOK 1)
 - c. Demonstrate methods for preparing bones for stock. (DOK 3)
 - d. List the ways to cool stock properly. (DOK 2)
 - e. Prepare the ingredients for stock, and cook several kinds of stock. (DOK 3)
2. Create, prepare, and evaluate soups. (DOK 3)
 - a. Identify various types of soups, and give examples. (DOK 1)
 - b. Explain the preparation of the basic ingredients for broth, consommé, purée, clear, and cream soups. (DOK 2)
 - c. Prepare several kinds of soups. (DOK 3)
3. Create, prepare, and evaluate sauces. (DOK 3)
 - a. Identify the grand sauces, and describe other sauces made from them. (DOK 1)

- b. List the proper ingredients for sauces. (DOK 1)
- c. Prepare several kinds of sauces. (DOK 3)
- d. Match sauces to appropriate foods. (DOK 2)

Culinary Arts Competency Profile

Program CIP: 12.0500

Unit 1: Introduction

- _____ 1. Identify school and program policies and procedures. (DOK 1)
- _____ 2. Identify career and leadership opportunities in the culinary industry. (DOK 1)
- _____ 3. Analyze the importance of service to the culinary industry. (DOK 2)
- _____ 4. Formulate a plan for an effective job search. (DOK 4)

Unit 2: Human Relations Management (Basic Customer Service and Human Resources)

Determine the skills necessary to provide professional customer service.

- _____ 1. (DOK 3)
- _____ 2. Demonstrate excellent interpersonal skills. (DOK 2)
- _____ 3. Analyze supervisory skills related to human resource management. (DOK 4)

Unit 3: Food Safety and Sanitation

- _____ 1. Discuss and relate the importance of food safety to society. (DOK 2)
- _____ 2. Explain the importance of establishing a food safety system. (DOK 1)
- _____ 3. Analyze the flow of food through a foodservice establishment. (DOK 4)
- _____ 4. Maintain a clean and sanitary kitchen. (DOK 1)

Unit 4: Foodservice Equipment, Safety, and Security

- _____ 1. Implement safe work habits to prevent injuries (ongoing). (DOK 3)
- _____ 2. Explain emergency techniques and procedures. (DOK 1)
- _____ 3. Analyze the correct use of hand tools. (DOK 3)
- _____ 4. Develop standard operating procedures, and demonstrate the safe use and maintenance of large equipment. (DOK 2)

Unit 5: Culinary Foundations (Culinary Basics and Nutrition)

- _____ 1. Develop and demonstrate basic food preparation skills. (DOK 2)
- _____ 2. Develop and demonstrate basic food cooking methods. (DOK 2)
- _____ 3. Discuss the components of a healthy diet. (DOK 1)
- _____ 4. Design and produce a well-balanced meal. (DOK 4)

Unit 6: Breakfast Foods, Dairy, and Sandwiches

- _____ 1. Create and evaluate breakfast foods. (DOK 3)
- _____ 2. Demonstrate preparation and handling of dairy products. (DOK 2)
- _____ 3. Construct and evaluate several types of sandwiches. (DOK 3)

Unit 7: Fruits, Vegetables, Salads, and Garnishes

- _____ 1. Demonstrate and evaluate the preparation of fruits. (DOK 2)
- _____ 2. Demonstrate and evaluate the preparation of vegetables. (DOK 2)
- _____ 3. Prepare and evaluate various types of salads. (DOK 2)
- _____ 4. Prepare and evaluate salad dressings. (DOK 2)
- _____ 5. Demonstrate appropriate garnishing techniques. (DOK 3)

Unit 8: Culinary Math

- _____ 1. Apply basic mathematical calculations to culinary practices. (DOK 2)
- _____ 2. Apply basic mathematical functions to weights and measures. (DOK 4)
Apply basic mathematical functions and food handling practices to control
- _____ 3. food costs. (DOK 3)
- _____ 4. Determine the menu selling price. (DOK 3)
- _____ 5. Apply mathematical procedures to revenue control. (DOK 2)
- _____ 6. Explain and apply principles used in inventory control. (DOK 2)

Unit 9: Orientation

- _____ 1. Review school and program policies and procedures. (DOK 1)
- _____ 2. Update career/educational plans. (DOK 1)
- _____ 3. Model job retention skills. (DOK 2)

Unit 10: Hospitality Industry

- _____ 1. Research the creation of the modern restaurant. (DOK 1)
Compare and contrast American regional cuisines and international cuisines.
- _____ 2. (DOK 3)
- _____ 3. Research the history of foodservice in the United States. (DOK 1)
- _____ 4. Investigate the future of foodservice. (DOK 2)
Analyze the tourism and travel industry, and determine how the industry will
- _____ 5. change over time. (DOK 4)
- _____ 6. Analyze the lodging industry. (DOK 2)

Unit 11: Potatoes and Grains

- _____ 1. Select and store potatoes, grains, legumes, and pasta. (DOK 2)
- _____ 2. Create, prepare, and critique classic potato recipes. (DOK 3)
- _____ 3. Create, prepare, and critique legumes and grain foods. (DOK 3)
- _____ 4. Create and evaluate pasta and dumplings. (DOK 4)

Unit 12: Customer Communication and Service

- _____ 1. Demonstrate various types of high-quality service in the foodservice industry.

_____ (DOK 2)

- _____ 2. Demonstrate personal dining etiquette. (DOK 1)
- _____ 3. Demonstrate positive customer communications. (DOK 2)

Unit 13: Desserts and Baked Goods

- _____ 1. Create, prepare, and evaluate breads. (DOK 3)
- _____ 2. Create, prepare, and evaluate baked goods. (DOK 3)

Unit 14: Culinary Business Concepts

- _____ 1. Apply marketing principles to foodservice. (DOK 3)
- _____ 2. Develop a menu. (DOK 4)
- _____ 3. Examine the purchasing process. (DOK 1)
- _____ 4. Develop standard ordering procedures. (DOK 2)
- _____ 5. Explain and defend the decisions to be made when purchasing. (DOK 3)
- _____ Explain the procedures for receiving, storing, and issuing foods and supplies.
(DOK 3)
- _____ 6.
- _____ 7. Summarize accounting procedures in foodservice. (DOK 2)
- _____ 8. Critique income statements. (DOK 2)
- _____ 9. Critique balance sheets. (DOK 2)

Unit 15: Meat, Poultry, and Seafood

- _____ 1. Create, prepare, and evaluate a quality meat product. (DOK 3)
- _____ 2. Prepare and evaluate a quality poultry product. (DOK 3)
- _____ 3. Create, prepare, and evaluate a quality fish/seafood product. (DOK 4)

Unit 16: Stocks, Sauces, and Soups

- _____ 1. Create, prepare, and evaluate stocks. (DOK 3)
- _____ 2. Create, prepare, and evaluate soups. (DOK 3)
- _____ 3. Create, prepare, and evaluate sauces. (DOK 3)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

- 22. Using 21st century skills to understand and address global issues
- 23. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
- 24. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

- 22. Knowing how to make appropriate personal economic choices
- 23. Understanding the role of the economy in society
- 24. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

- 22. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
- 23. Exercising the rights and obligations of citizenship at local, state, national, and global levels
- 24. Understanding the local and global implications of civic decisions

CS4 Health Literacy

- 36. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
- 37. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
- 38. Using available information to make appropriate health-related decisions
- 39. Establishing and monitoring personal and family health goals
- 40. Understanding national and international public health and safety issues

CS5 Environmental Literacy

- 29. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
- 30. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
- 31. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
- 32. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

- 22. Think Creatively
- 23. Work Creatively with Others

- 24. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 29. Reason Effectively
 - 30. Use Systems Thinking
 - 31. Make Judgments and Decisions
 - 32. Solve Problems
- CS8 Communication and Collaboration**
 - 15. Communicate Clearly
 - 16. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 15. Access and Evaluate Information
 - 16. Use and Manage Information
- CS10 Media Literacy**
 - 15. Analyze Media
 - 16. Create Media Products
- CS11 ICT Literacy**
 - 8. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 15. Adapt to change
 - 16. Be Flexible
- CS13 Initiative and Self-Direction**
 - 22. Manage Goals and Time
 - 23. Work Independently
 - 24. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 15. Interact Effectively with others
 - 16. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 15. Manage Projects
 - 16. Produce Results
- CS16 Leadership and Responsibility**
 - 15. Guide and Lead Others
 - 16. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

8. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- xx. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- yy. Explain the causes and characteristics of tides. (DOK 1)
- zz. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- aaa. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- bbb. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- ccc. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
- Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
- ddd. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
3. **Apply an understanding of the diverse organisms found in aquatic environments.**
- qq. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
- rr. Research, calculate, and interpret population data. (DOK 2)
- ss. Research and compare reproductive processes in aquatic organisms. (DOK 2)
- tt. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
- uu. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
- vv. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
- lll. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
- mmm. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
- nnn. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- h. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- ooo. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ppp. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- qqq. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- rrr. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- sss. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ttt. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- xx. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
 - Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- yy. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- zz. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- aaa. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
 - Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- bbb. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
 - Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- ccc. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
 - ATP structure
 - ATP function
- ddd. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
 - Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- v. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
 - Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- w. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- x. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
4. **Analyze and explain the structures and function of the levels of biological organization.**
- cc. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- dd. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- ee. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- ff. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
5. **Demonstrate an understanding of the molecular basis of heredity.**
- cc. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- dd. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- ee. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
- ff. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
- Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- jj. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
- Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
- kk. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
- ll. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
- mm. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
- nn. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- xx. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
 - yy. Clarify research questions and design laboratory investigations. (DOK 3)
 - zz. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
 - aaa. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
 - bbb. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
 - ccc. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
 - ddd. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- cc. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
 - dd. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
 - ee. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
 - The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
 - ff. Differentiate between photosynthesis and cellular respiration. (DOK 2)
 - Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- jj. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
 - kk. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
 - ll. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
 - Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- mm. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- nn. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- lll. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- mmm. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- nnn. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- ooo. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- ppp. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- qqq. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- rrr. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- sss. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- ttt. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- o. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- p. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- xx. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- yy. Formulate questions that can be answered through research and experimental design. (DOK 3)
- zz. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- bbb. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ccc. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ddd. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- jj. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- kk. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- ll. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- mm. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- nn. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- qq. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- rr. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- ss. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- tt. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- uu. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- vv. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- cc. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- dd. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- ee. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- ff. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- cc. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- dd. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- ee. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- ff. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- xx. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- yy. Clarify research questions and design laboratory investigations. (DOK 3)
- zz. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- bbb. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- ccc. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

ddd. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

xx. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)

- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

yy. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)

zz. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)

- Properties and interactions of the three fundamental particles of the atom
- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

aaa. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)

- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

bbb. Compare the properties of compounds according to their type of bonding. (DOK 1)

- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

ccc. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

ddd. Develop a three-dimensional model of molecular structure. (DOK 2)

- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

cc. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

- dd. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- ee. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- ff. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
4. **Analyze the relationship between microscopic and macroscopic models of matter.**
- cc. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- dd. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- ee. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- ff. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations

- Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- v. Analyze and explain acid/base reactions. (DOK 2)
 - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
 - w. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
 - x. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. **Apply inquiry-based and problem-solving processes and skills to scientific investigations.**

- xx. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- yy. Formulate questions that can be answered through research and experimental design. (DOK 3)
- zz. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

- bbb. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ccc. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- ddd. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Demonstrate an understanding of the properties, structure, and function of organic compounds.**
- qq. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- rr. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- ss. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- tt. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- uu. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- vv. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another
- 3. Discuss the versatility of polymers and the diverse application of organic chemicals.**
- v. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- w. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- x. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.
- E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- xx. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- yy. Formulate questions that can be answered through research and experimental design. (DOK 3)
- zz. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- bbb. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ccc. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ddd. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- cc. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- dd. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- ee. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

- ff. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere
3. **Discuss factors which are used to explain the geological history of earth.**
- eee. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
- fff. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
- ggg. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
- hhh. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
- iii. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
- jjj. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
- kkk. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
- lll. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
4. **Demonstrate an understanding of earth systems relating to weather and climate.**
- jj. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
- kk. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
- ll. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

mm. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)

nn. Research and explain how external forces affect earth's topography. (DOK 2)

- How surface water and groundwater act as the major agents of physical and chemical weathering
- How soil results from weathering and biological processes
- Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

cc. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)

- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
- Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
- Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)

dd. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)

ee. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)

- Photosynthesis and the atmosphere
- Multicellular animals and marine environments
- Land plants and terrestrial environments

ff. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

xx. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols

- Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- yy. Formulate questions that can be answered through research and experimental design. (DOK 3)
- zz. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- bbb. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ccc. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ddd. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)
- 2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.**
- xx. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
- yy. Explain the flow of matter and energy in ecosystems. (DOK 2)
- Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
- zz. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- aaa. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
- How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
- bbb. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- ccc. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- ddd. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)
- 3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.**
- v. Summarize the effects of human activities on resources in the local environments. (DOK 2)
- Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources

- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
- w. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
- x. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- xx. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- yy. Clarify research questions and design laboratory investigations. (DOK 3)
- zz. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- bbb. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- ccc. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ddd. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- xx. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- yy. Describe how organic components are integral to biochemical processes. (DOK 2)
- zz. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
- Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- aaa. Explain the significance of the discovery of nucleic acids. (DOK 1)
- bbb. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- ccc. Cite examples to compare the consequences of the different types of mutations. (DOK 1)

ddd. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

xx. Cite evidence that supports the significance of Mendel’s concept of “particulate inheritance” to explain the understanding of heredity. (DOK 1)

yy. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
- Chromosomal theory of inheritance

zz. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)

- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

aaa. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)

- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

bbb. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)

ccc. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)

ddd. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

xx. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- yy. Formulate questions that can be answered through research and experimental design. (DOK 3)
- zz. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- bbb. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ccc. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ddd. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
- zzz. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- aaaa. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- bbbb. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
- Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- cccc. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- dddd. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- eeee. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- ffff. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- gggg. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- hhhh. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)

- iiii. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)
- jjjj. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- xx. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- yy. Identify questions that can be answered through scientific investigations. (DOK 3)
- zz. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- aaa. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- bbb. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- ccc. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ddd. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- jj. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects

- Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- kk. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)
 - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- ll. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- mm. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- nn. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- cc. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- dd. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
- ee. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
- ff. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- cc. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
- dd. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)

- ee. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
 - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)
 - ff. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
 - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
- 5. Investigate and apply principles of physical and chemical changes in matter.**
- v. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
 - w. Balance chemical equations. (DOK 2)
 - x. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. Investigate and apply principles of physical and chemical changes in matter.

- xx. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- yy. Clarify research questions, and design laboratory investigations. (DOK 3)
- zz. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

- bbb. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- ccc. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ddd. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Develop an understanding of concepts related to forces and motion.**
- cc. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- dd. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- ee. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- ff. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
- jj. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
- kk. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- ll. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- mm. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

nn. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. Discuss the characteristics and properties of light and sound.

jj. Describe and model the characteristics and properties of mechanical waves. (DOK 2)

- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

kk. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)

ll. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)

mm. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)

nn. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. Apply an understanding of magnetism, electric fields, and electricity.

v. Analyze and explain the relationship between electricity and magnetism. (DOK 2)

- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

w. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)

x. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. Analyze and explain concepts of nuclear physics.

o. Analyze and explain the principles of nuclear physics. (DOK 1)

- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

p. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)

- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- xx. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- yy. Clarify research questions, and design laboratory investigations. (DOK 3)
- zz. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
- aaa. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
- bbb. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- ccc. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- ddd. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

- qq. Describe the characteristics of the electromagnetic spectrum.
- rr. Using images and graphs, interpret the absorption/reflection spectrum.
- ss. Distinguish between passive vs. active sensor systems.
- tt. Analyze the effects of changes in spatial, temporal, and spectral resolution.
- uu. Analyze the effects on images due to changes in scale.
- vv. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- xx. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

- yy. Formulate questions that can be answered through research and experimental design. (DOK 3)
- zz. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- aaa. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- bbb. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- ccc. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- ddd. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of levels of organization and animal classification.**
- cc. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- dd. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- ee. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- ff. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenetic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia
- 3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.**
- jj. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- kk. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups

- ll. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
 - mm. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
 - Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
 - nn. Contrast food chains and food webs. (DOK 2)
4. **Demonstrate an understanding of the principles of animal genetic diversity and evolution.**
- o. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
 - Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
 - p. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

National Restaurant Association ProStart Certification

ProStart Learning Objectives

- 1PS0** Introduction: Preparing for a Successful Career
- 1PS1** Successful Customer Relations
- 1PS2** Preparing and Serving Safe Food
- 1PS3** Preventing Accidents and Injuries
- 1PS4** Kitchen Basics
- 1PS5** Foodservice Equipment
- 1PS6** Nutrition
- 1PS7** Breakfast Foods and Sandwiches
- 1PS8** Working with People
- 1PS9** Salads and Garnishes
- 1PS10** Business Math
- 1PS11** Fruits and Vegetables
- 1PS12** Controlling Foodservice Costs
- 2PS0** Introduction: Preparing for a Successful Career
- 2PS1** The History of Foodservice
- 2PS2** Potatoes and Grains
- 2PS3** The Lodging Industry
- 2PS4** The Art of Service
- 2PS5** Desserts and Baked Goods
- 2PS6** Marketing and the Menu
- 2PS7** Purchasing and Inventory Control
- 2PS8** Meat, Poultry, and Seafood
- 2PS9** Standard Accounting Practices
- 2PS10** Stocks, Soups, and Sauces
- 2PS11** Tourism and the Retail Industry
- 2PS12** Communicating with Customers

National Restaurant Association ServSafe Certification

ServSafe Course Content

- SS1** Providing Safe Food
 - The Dangers and Prevention of Foodborne Illness
 - Preventing Foodborne Illness
 - How Food Becomes Unsafe
 - The Food Safety Responsibilities of a Manager
- SS2** The Microworld

Microbial Contaminants

Bacteria

Viruses

Parasites

Fungi

SS3 Contamination, Food Allergens, and Foodborne Illness

Types of Foodborne Contamination

Deliberate Contamination of Food

Food Allergens

SS4 The Safe Foodhandler

How Foodhandlers Can Contaminate Food

Components of a Good Personal Hygiene Program

Management's Role in a Personal Hygiene Program

SS5 The Flow of Food: An Introduction

Preventing Cross-Contamination

Time and Temperature Control

Monitoring Time and Temperature

SS6 The Flow of Food: Purchasing and Receiving

General Principles

Inspecting Food

SS7 The Flow of Food: Storage

General Storage Guidelines

Types of Storage

SS8 The Flow of Food: Preparation

Handling Food

Thawing Food Properly

Preparing Specific Food

Cooking Guidelines

Cooking Temperatures

Cooling Food

Reheating Food

SS9 The Flow of Food: Service

Holding Food

Serving Food Safely

Types of Foodservice Operations

SS10 Food Safety Systems

Food Safety Programs

Active Managerial Control
HACCP
Crisis Management

SS11 Sanitary Facilities and Pest Management
Facilities and Equipment
Cleaning and Sanitizing
Integrated Pest Management

SS12 Food Safety Regulation and Standards
Government Regulatory System for Food
The Food Code
Foodservice Inspection Process

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.

- b. Plan and manage activities to develop a solution or complete a project.
- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Collision Repair Technician Executive Summary	638
Course Outlines.....	640
Collision Repair Technician Competencies and Objectives	644
Collision Repair Technician Competency Profile	648
Appendix A: 21st Century Skills Standards	650
Appendix B: MS Academic Standards	652
Appendix C: ACT College Readiness Standards.....	682
Appendix D: Pathway Content Standards.....	696
Appendix E: National Educational Technology Standards for Students	697

Collision Repair Technology

Collision Repair Technology Executive Summary

Collision Repair is a pathway for students in the Transportation career cluster. The following description is from the current Standard Course of Study for Career–Technical Education, Mississippi Department of Education. Collision Repair is a hands-on program that will prepare students for employment or continuing education in the collision repair industry. The content is based on industry content. The content consists of fundamentals; mechanical/electrical components; nonstructural analysis and damage repair; structural analysis and damage repair; and painting and refinishing.

The program is aligned with the NATEF 2006 Collision Repair and Refinishing standards, which were retrieved May 1, 2006, from <http://www.natef.org>.

Industry Certification

The Collision Repair pathway was written to incorporate the **National Automotive Technicians Education Foundation (NATEF)** and the **Inter-Industry Conference on Auto Collision Repair (I-CAR)** learning objectives, content, and hours. Any student who successfully completes this program will be eligible to apply to obtain the ASE exams. ASE requires 2 years of employment before certificates are issued. Students receive 1 year of credit for completion of the secondary program. Students who take certifications before the 2-year requirement is met will be granted certifications after they complete 1 year of collision repair employment. NATEF and I-CAR are national certifications recognized throughout the automotive service industry. Each district should implement a maximum student number due to the size of each lab. Programs seeking certification (NATEF) may receive certification in Painting and Refinishing. Programs can seek certification in other areas if they so desire.

Assessment

Students will be assessed using the Collision Repair MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the transportation instructional design specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Collision Repair Technology program, the following student prerequisites are in place:

13. C or higher in English (the previous year)
14. C or higher in Math (last course taken or the instructor can specify the math)
15. Instructor Approval and TABE Reading Score (eighth grade or higher)

or

1. TABE Reading Score (eighth grade or higher)
2. Instructor Approval

or

1. Instructor Approval

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn one Applied Mathematics Credit that can be used for graduation requirements.

The applied academic credit has not been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A 967 educator license is required to teach the Collision Repair pathway. The requirements for the 967 licensure endorsement are listed below:

1. Applicant must have earned a 2-year college degree (associate degree) or higher from an accredited institution of higher education.
2. Applicant must have 2 years of documented collision repair service experience.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
4. Applicant must complete the individualized Professional Development Plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
5. Applicant must hold ASE certificates in Painting and Refinishing or I-CAR Paint and Refinishing certification.
6. Applicant must successfully complete an approved computer literacy certification exam.
7. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the Mississippi Department of Education.
8. Applicant must successfully complete a Collision Repair certification workshop, module, or course that is approved by the Mississippi Department of Education.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://redesign.rcu.msstate.edu>. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510, and ask for the Professional Learning Specialist.

Course Outlines

This curriculum framework allows multiple options for local school districts to implement based on the local needs of industry and students. The first option groups units into four one-Carnegie-unit courses. The second option groups units into a 2-year, four-Carnegie-unit program. An in-depth discussion of each option is listed in the following material.

Option 1

This Collision Repair Pathway option emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF) and the Inter-Industry Conference on Auto Collision Repair (I-CAR) learning objectives and content.

Collision Repair Pathway (four Carnegie units total) is a program that will prepare students for the collision repair industry. The content is divided into four one-credit courses. These courses are to be taken sequentially. Safety is an integral part of every course and activity. A student must complete all four courses to be a completer and to receive the one math credit.

- Safety will be reinforced and tested at the beginning of each year and throughout the content.
- Students are not to enroll into multiple courses at the same time.
- Courses cannot be taken out of the above order unless the instructor approves. Foundation knowledge in each course must be mastered to move to the next unit.
- Students must complete collision courses with a score of 80/C or higher in classwork to advance to the next level.

Course Description: Fundamentals of Collision Repair (Course Code: 997102)

Fundamentals of Collision Repair contains information on safety, tool identification/use, employee information, collision estimating, paint mixing/matching, service specification and service information, measurement, personal/ business finance, introduction to steering and suspension systems, concepts of electronic/electrical systems, concepts of brake systems, introduction to heating/cooling systems, concepts of cooling systems, introduction to restraint systems, inspecting and analyzing body components, repairs to outer body panels, and introductory welding, information on frame inspection and repair, unibody inspection and repair, and introductory welding/cutting applications.

Course Description: Intermediate Painting and Refinishing (Course Code: 997103)

The Intermediate Painting and Refinishing course contains information and skills relating to painting and refinishing operations and surface preparations.

Course Description: Advanced Fundamentals of Collision Repair (Course Code: 997104)

Advanced Fundamentals of Collision Repair contains information on safety, tool identification/use, employee information, collision estimating, paint mixing/matching, service specification and service information, measurement, personal and business skills, metal finishing and body filling, movable glass/hardware, advanced welding, unibody measurement and repair, fixed glass procedures, and advanced welding/cutting applications.

Course Description: Advanced Painting and Refinishing (Course Code: 997105)

The Advanced Painting and Refinishing course contains information and skills relating to mixing and matching paint; paint defects, causes, and cures; and final detail practices.

Fundamentals of Collision Repair (One Carnegie Unit) - Course Code: 997102

Unit	Title	Hours
1	Fundamentals of Collision Repair	65
2	Fundamentals of Collision Repair (Basic Mechanical and Electrical Components)	25
3	Fundamentals of Collision Repair (Basic Non-Structural Analysis and Damage Repair)	25
4	Fundamentals of Collision Repair (Basic Structural Analysis and Damage Repair)	25
		140

Intermediate Painting and Refinishing (One Carnegie Unit) - Course Code: 997103

Unit	Title	Hours
5	Intermediate Painting and Refinishing	140
		140

Advanced Fundamentals of Collision Repair (One Carnegie Unit) - Course Code: 997104

Unit	Title	Hours
6	Safety (Review), Employability Skills, and Business Skills	80
7	Advanced Non-Structural Analysis and Damage Repair	30
8	Advanced Structural Analysis and Damage Repair	30
		140

Advanced Painting and Refinishing (One Carnegie Unit) – Course Code: 997105

Unit	Title	Hours
9	Advanced Painting and Refinishing	140
		140

Option 2

This Collision Repair Pathway option also emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF) and the Inter-Industry Conference on Auto Collision Repair (I-CAR) learning objectives and content.

The content is divided into two courses. Safety is an integral part of every course and activity. A student must complete both courses to be a completer and to receive the one math credit.

Course Description: Collision Repair I (Course Code: 997100) Fundamentals of Collision Repair contains information on safety, tool identification/use, employee information, collision estimating, paint mixing/matching, service specification and service information, measurement, and personal/ business finance, introduction to steering and suspension systems, concepts of electronic/electrical systems, concepts of brake systems, introduction to heating /cooling systems, concepts to cooling systems, introduction to restraint systems, inspecting and analyzing body components, repairs to outer body panels, and introductory welding, frame inspection and repair, unibody inspection and repair, and introductory welding/cutting applications.

Course Description: Collision Repair Technology II (Course Code: 997101) Advanced Fundamentals of Collision Repair contains information on safety, tool identification/use, employee information, collision estimating, paint mixing/matching, service specification and service information, measurement, personal and business skills, metal finishing and body filling, movable glass/hardware, advanced welding, frame inspection and repair, unibody measurement and repair, fixed glass procedures, and advanced welding/cutting applications.

Collision Repair I (Two Carnegie Units) - Course Code: 997100

Unit	Title	Hours
1	Fundamentals of Collision Repair	65
2	Fundamentals of Collision Repair (Basic Mechanical and Electrical Components)	25
3	Fundamentals of Collision Repair (Basic Non-Structural Analysis and Damage Repair)	25
4	Fundamentals of Collision Repair (Basic Structural Analysis and Damage Repair)	25
5	Intermediate Painting and Refinishing	140
		280

Collision Repair II (Two Carnegie Units) - Course Code: 997101

Unit	Title	Hours
6	Safety (Review), Employability Skills, and Business Skills	80
7	Advanced Non-Structural Analysis and Damage Repair	30
8	Advanced Structural Analysis and Damage Repair	30
9	Advanced Painting and Refinishing	140
		280

- Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
- Students must complete the first year with a score of 80/C or higher in classwork to advance to the next level.

Collision Repair Technician Competencies and Objectives

Unit 1: Fundamentals of Collision Repair

1. Introduce, describe, and distinguish local program and vocational/career technical center policies and procedures. (DOK1)
 - a. Describe local program and vocational/career technical center policies and procedures including dress code, attendance, academic requirements, discipline, and the school technology acceptable use policy and transportation regulations. (DOK 1)
 - b. Compare and contrast local program policies, procedures, and expectations to industry policies, procedures, and expectations. (DOK 2)
2. Introduce, describe, and express employment opportunities and responsibilities of the collision repair industry. (DOK1)
 - a. Introduce concepts associated with the collision repair industry; describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. (DOK 1)
 - b. Describe basic employee responsibilities and how to communicate effectively in on-the-job situations. Identify and apply the practices that affect employer and employee decision making as it relates to identifying and applying appropriate algebraic formulas to personal finance situations, linear programming to business decisions, and algebraic formulas to personal and business investments. (DOK 2)
 - c. Discuss the history of the collision repair industry to include materials, terminology, and techniques. (DOK 2)
 - d. Research and report the computerized systems used for estimating collision repairs, measuring damage, and mixing or matching paint. (DOK 3)
3. Investigate and replicate leadership skills and personal development. (DOK1)
 - a. Demonstrate effective team-building and leadership skills. (DOK 1)
 - b. Model appropriate work ethics. (DOK 1)
4. Model general safety rules for working in a shop/lab and an industry setting. (DOK3)
 - a. Explain the importance of following all safety rules and policies (report all on-the-job injuries and accidents), evacuation policy, substance abuse policy, and procedures when working near pressurized or high temperature, and explain electrical hazards and the action to take when an electrical shock occurs when performing collision operations (personal protective equipment, procedures for lifting heavy objects, and MSDS sheets). (DOK 3)
 - b. Explain the process by which fires start, fire prevention of various flammable liquids, the classes of fire and the types of extinguishers. (DOK 3)
 - c. Identify and demonstrate the safe and proper use of common hand tools. (DOK 2)
5. Interpret and apply service specifications and information. (DOK3).
 - a. Locate and interpret service specifications and information, using both print and computerized service information references vehicle and major component identification numbers (VIN, certification, and calibration labels). (DOK 1)
 - b. Interpret and apply information to a specific job on a specific vehicle. (DOK 3)
6. Demonstrate measurement practices used in the automotive service. (DOK2)

- a. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm. (DOK 1)
 - b. Identify the different types of bolts (grade, diameter, length, and thread pitch), nuts, and washers, and describe their appropriate uses. (DOK 1)
 - c. Identify different glues and sealants used in automotive service, and describe their appropriate uses. (DOK 2)
7. Manage personal and business finances to include aspects of employer–employee decision making and consumer credit. (DOK2)
- a. Design, analyze, and develop business finance concepts and skills. (DOK 3)

Unit 2: Fundamentals of Collision Repair (Basic Mechanical and Electrical Components)

1. Identify, evaluate, and practice suspension and steering components and systems. (DOK2)
 - a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, and causes and corrections; measure vehicle ride height and check for front wheel setback; determine needed repairs. (DOK 1)
 - b. Identify and inspect (where applicable) steering linkage components, shock absorbers, upper/lower control arms, and related components. (DOK 1)
 - c. Analyze and diagnose wheel and tire repairs according to manufacturer's specifications. (DOK 2)
2. Practice concepts and procedures related to electrical/electronic systems. (DOK2)
 - a. Diagnose electrical/electronic components. (DOK 3)
 - b. Diagnose and perform procedures related to the battery. (DOK 1)
 - c. Inspect and repair various electrical/electronic components. (DOK 1)
3. Diagnose and apply practices related to brakes and braking systems. (DOK3)
 - a. Diagnose various brake components and the replacement/repair procedures. (DOK 4)
 - b. Identify and discuss factors related to brake fluid. (DOK 3)
 - c. Identify and discuss factors related to brake shoes. (DOK 2)
4. Discuss and apply practices related to heating and air conditioning. (DOK1)
 - a. Identify and comply with environmental concerns relating to refrigerants and coolants. (DOK 1)
 - b. Locate and identify A/C system service ports; discuss the procedure of evacuation and recharging of the A/C system including checking for leaks. (DOK 1)
5. Identify and discuss cooling systems. (DOK1)
 - a. Identify and inspect engine cooling and heater system hoses, belts, radiator, pressure cap, coolant recovery system, and water pump. (DOK 1)
 - b. Discuss the procedure to recover, refill, and bleed a system with proper coolant and check the level of protection; leak test system and dispose of materials in accordance with EPA specifications. (DOK 2)
6. Diagnose and repair active restraint systems procedures and practices. (DOK2)
 - a. Analyze and replace (if needed) components related to seat belts. (DOK 2)

Unit 3: Fundamentals of Collision Repair (Basic Non – Structural Analysis and Damage Repair)

1. Inspect, analyze, perform, and evaluate procedures and skills pertaining to non-structural analysis and damage repair. (DOK3)
 - a. Identify, inspect, determine necessary action, and perform that procedure when preparing body components. (DOK 3)
 - b. Inspect, analyze, and perform repairs as they relate to outer body panels: Repairs, replacement, and adjustments. (DOK 4)
 - c. Determine and perform skills and evaluate procedures as they relate to metal finishing and body filling. (DOK 2)
 - d. Identify and determine correct procedure and perform the skill as it relates to metal welding and cutting procedures for non-structural applications. (DOK 3)

Unit 4: Fundamentals of Collision Repair (Basic Structural Analysis and Damage Repair)

1. Inspect and apply skills and techniques related to vehicles pertaining to structural and damage repair. (DOK3)
 - a. Identify and inspect, determine necessary action, and perform that procedure when performing frame inspection and repair. (DOK 3)
 - b. Identify, diagnose, recommend, and/or perform the necessary repair action in unibody inspection, measurement, and repair. (DOK 3)
2. Identify, analyze, and perform the proper metal welding procedures to complete a repair according to manufacturer's specifications. (DOK3)
 - a. Identify, practice, and evaluate metal welding and cutting procedures for structural applications. (DOK 3)

Unit 5: Intermediate Painting and Refinishing

1. Identify, perform, and appraise vehicles as it pertains to painting and refinishing. (DOK3)
 - a. Practice safety precautions for painting and refinishing operations. (DOK 2)
 - b. Demonstrate and evaluate surface preparation information and skills. (DOK 3)

Unit 6: Safety (Review), Employability Skills, and Business Skills

1. Introduce and understand general safety rules for working in a shop/lab and industry. (DOK1)
 - a. Explain the importance of following all safety rules and policies. (DOK 1)
2. Demonstrate proper use and care for laboratory equipment related to the collision industry. (DOK2)
 - a. Describe basic employee responsibilities. (DOK1)
 - b. Design a resume and letter of application and complete a job application. DOK2
 - c. Demonstrate an understanding of the impact of consumer credit (advantages and disadvantages of installment loans, applying algebraic formulas to consumer credit). (DOK 2)

- d. Design, collect, and apply information for planning a trip. (DOK2)

Unit 7: Advanced Non – Structural Analysis and Damage Repair

- 1. Inspect, analyze, perform, and evaluate procedures and skills pertaining to advanced non-structural analysis and damage repair. (DOK2)
 - a. Identify and utilize metal finishing and body filling procedures. (DOK 2)
 - b. Inspect and diagnose moveable glass and hardware. (DOK 2)
 - c. Identify, analyze, and perform operations pertaining to welding. (DOK 2)
 - d. Recognize and apply plastics and adhesives. (DOK 2)

Unit 8: Advanced Structural Analysis and Damage Repair

- 1. Inspect, analyze, perform skills, and evaluate vehicles pertaining to advanced structural analysis and damage repair. (DOK2)
 - a. Identify, analyze, and perform frame inspection and repair. (DOK 2)
 - b. Analyze and determine necessary action to repair unibody inspection, measurement, and repair. (DOK 3)
 - c. Perform procedures to fixed glass. (DOK 2)
 - d. Identify and perform metal welding and cutting principles and practices. (DOK 2)

Unit 9: Advanced Painting and Refinishing

- 1. Identify, perform, and appraise vehicles pertaining to advanced painting and refinishing. (DOK2)
 - a. Identify and perform paint related skills and techniques as it pertains to mixing, matching, and applying. (DOK 2)
 - b. Identify and analyze paint defect causes and cures. (DOK 3)
 - c. Explain and perform final detail practices. (DOK 2)

Collision Repair Technician Competency Profile

Program CIP: 47.0603

Unit 1: Fundamentals of Collision Repair

- _____ 1. Introduce, describe, and distinguish local program and vocational/career technical center policies and procedures. (DOK 1)
- _____ 2. Introduce, describe, and express employment opportunities and responsibilities of the collision repair industry. (DOK 1)
- _____ 3. Investigate and replicate leadership skills and personal development. (DOK 1)
- _____ 4. Model general safety rules for working in a shop/lab and an industry setting. (DOK 3)
- _____ 5. Interpret and apply service specifications and information. (DOK 3)
- _____ 6. Demonstrate measurement practices used in the automotive service. (DOK 2)
- _____ 7. Manage personal and business finances to include aspects of employer–employee decision making and consumer credit. (DOK 2)

Unit 2: Fundamentals of Collision Repair (Mechanical and Electrical Components)

- _____ 1. Identify, evaluate, and practice suspension and steering components and systems. (DOK 2)
- _____ 2. Practice concepts and procedures related to electrical/electronic systems. (DOK 2)
- _____ 3. Diagnose and apply practices related to brakes and braking systems. (DOK 3)
- _____ 4. Discuss and apply practices related to heating and air conditioning. (DOK 1)
- _____ 5. Identify and discuss cooling systems. (DOK 1)
- _____ 6. Diagnose and repair active restraint systems procedures and practices. (DOK 2)

Unit 3: Fundamentals of Collision Repair (Basic Non – Structural Analysis and Damage Repair)

- _____ 1. Inspect, analyze, perform, and evaluate procedures and skills pertaining to non-structural analysis and damage repair. (DOK 3)

Unit 4: Fundamentals of Collision Repair (Basic Structural Analysis and Damage Repair)

- _____ 1. Inspect and apply skills and techniques related to vehicles pertaining to structural and damage repair. (DOK 3)
- _____ 2. Identify, analyze, and perform the proper metal welding procedures to complete a repair according to manufacturer’s specifications. (DOK 3)

Unit 5: Intermediate Painting and Refinishing

1. Identify, perform, and appraise vehicles as it pertains to painting and refinishing. (DOK 3)

Unit 6: Safety (Review), Employability Skills, and Business Skills

1. Introduce and understand general safety rules for working in a shop/lab and industry. (DOK 1)
2. Demonstrate proper use and care for laboratory equipment related to the collision industry. (DOK 2)

Unit 7: Advanced Non – Structural Analysis and Damage Repair

1. Inspect, analyze, perform, and evaluate procedures and skills pertaining to advanced non-structural analysis and damage repair. (DOK 2)

Unit 8: Advanced Structural Analysis and Damage Repair

1. Inspect, analyze, perform skills, and evaluate vehicles pertaining to advanced structural analysis and damage repair. (DOK 2)

Unit 9: Advanced Painting and Refinishing

1. Identify, perform, and appraise vehicles pertaining to advanced painting and refinishing. (DOK 2)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

- 25. Using 21st century skills to understand and address global issues
- 26. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
- 27. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

- 25. Knowing how to make appropriate personal economic choices
- 26. Understanding the role of the economy in society
- 27. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

- 25. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
- 26. Exercising the rights and obligations of citizenship at local, state, national, and global levels
- 27. Understanding the local and global implications of civic decisions

CS4 Health Literacy

- 41. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
- 42. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
- 43. Using available information to make appropriate health-related decisions
- 44. Establishing and monitoring personal and family health goals
- 45. Understanding national and international public health and safety issues

CS5 Environmental Literacy

- 33. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
- 34. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
- 35. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
- 36. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

- 25. Think Creatively
- 26. Work Creatively with Others

- 27. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 33. Reason Effectively
 - 34. Use Systems Thinking
 - 35. Make Judgments and Decisions
 - 36. Solve Problems
- CS8 Communication and Collaboration**
 - 17. Communicate Clearly
 - 18. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 17. Access and Evaluate Information
 - 18. Use and Manage Information
- CS10 Media Literacy**
 - 17. Analyze Media
 - 18. Create Media Products
- CS11 ICT Literacy**
 - 9. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 17. Adapt to change
 - 18. Be Flexible
- CS13 Initiative and Self-Direction**
 - 25. Manage Goals and Time
 - 26. Work Independently
 - 27. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 17. Interact Effectively with others
 - 18. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 17. Manage Projects
 - 18. Produce Results
- CS16 Leadership and Responsibility**
 - 17. Guide and Lead Others
 - 18. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

9. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- eee. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- fff. Explain the causes and characteristics of tides. (DOK 1)
- ggg. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- hhh. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- iii. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- jjj. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
- Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
- kkk. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
3. **Apply an understanding of the diverse organisms found in aquatic environments.**
- ww. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
- xx. Research, calculate, and interpret population data. (DOK 2)
- yy. Research and compare reproductive processes in aquatic organisms. (DOK 2)
- zz. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
- aaa. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
- bbb. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
4. **Draw conclusions about the relationships between human activity and aquatic organisms.**
- uuu. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
- vvv. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
- www. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- i. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- xxx. Formulate questions that can be answered through research and experimental design. (DOK 3)
- yyy. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- zzz. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- aaaa. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- bbbb. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- cccc. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- eee. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- fff. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- ggg. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- hhh. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- iii. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- jjj. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
 - ATP function
- kkk. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- y. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- z. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- aa. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- gg. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- hh. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- ii. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- jj. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- gg. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- hh. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- ii. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
 - jj. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness
- 6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.**
- oo. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
 - pp. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
 - qq. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
 - rr. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
 - ss. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- fff. Clarify research questions and design laboratory investigations. (DOK 3)
- ggg. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- iii. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- jjj. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- kkk. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- gg. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
- hh. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
- ii. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
- The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
- jj. Differentiate between photosynthesis and cellular respiration. (DOK 2)
- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- oo. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
- pp. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
- qq. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
- Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- rr. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- ss. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- uuu. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- vvv. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- www. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- xxx. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- yyy. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- zzz. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- aaaa. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- bbbb. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- cccc. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- q. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- r. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- fff. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- oo. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- pp. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- qq. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- rr. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- ss. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- ww. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- xx. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- yy. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- zz. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- aaa. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- bbb. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- gg. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- hh. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- ii. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- jj. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- gg. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- hh. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- ii. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- jj. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- fff. Clarify research questions and design laboratory investigations. (DOK 3)
- ggg. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- iii. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- jjj. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

kkk. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

eee. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)

- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

fff. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)

ggg. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)

- Properties and interactions of the three fundamental particles of the atom
- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

hhh. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)

- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

iii. Compare the properties of compounds according to their type of bonding. (DOK 1)

- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

jjj. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

kkk. Develop a three-dimensional model of molecular structure. (DOK 2)

- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

gg. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

hh. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)

- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- ii. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- jj. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
- 4. Analyze the relationship between microscopic and macroscopic models of matter.**
- gg. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- hh. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- ii. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- jj. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements

- Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**
- y. Analyze and explain acid/base reactions. (DOK 2)
 - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
 - z. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
 - aa. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- fff. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

- jjj. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)
- kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Demonstrate an understanding of the properties, structure, and function of organic compounds.**
- ww. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)
- Structures of hydrocarbon compounds
 - Isomerism in hydrocarbon compounds
- xx. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)
- yy. Apply principles of geometry and hybridization to organic molecules. (DOK 2)
- Lewis structures for organic molecules
 - Bond angles
 - Hybridization (as it applies to organic molecules)
- zz. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)
- aaa. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)
- bbb. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)
- Structural formulas from functional group names and vice versa
 - Chemical and physical properties of compounds containing functional groups
 - Equations representing the transformation of one functional group into another
- 3. Discuss the versatility of polymers and the diverse application of organic chemicals.**
- y. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)
- Common polymers
 - Synthesis of polymers from monomers by addition or condensation
 - Condensations of plastics according to their commercial types
 - Elasticity and other polymer properties
- z. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)
- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
 - Compounds that have the property to dye materials
 - Petrochemical production
 - Biologically active compounds in terms of functional group substrate interaction
- aa. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

- E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- E2 Develop an understanding of the history and evolution of the universe and earth.
- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.
- E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- fff. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- gg. Summarize the origin and evolution of the universe. (DOK 2)
 - Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- hh. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- ii. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)

- jj. Summarize the early evolution of the earth, including the formation of Earth's solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere
3. **Discuss factors which are used to explain the geological history of earth.**
- mmm. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
- nnn. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
- ooo. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
- ppp. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
- qqq. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
- rrr. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
- sss. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
- ttt. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)
4. **Demonstrate an understanding of earth systems relating to weather and climate.**
- oo. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
- pp. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
- qq. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)

- rr. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
- ss. Research and explain how external forces affect earth's topography. (DOK 2)
 - How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes
 - Processes and hazards associated with both sudden and gradual mass wasting

5. Apply an understanding of ecological factors to explain relationships between earth systems.

- gg. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
 - Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- hh. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- ii. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
 - Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- jj. Cite evidence about how dramatic changes in earth's atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols

- Proper use and care of the compound light microscope, slides, chemicals, etc.
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

fff. Formulate questions that can be answered through research and experimental design. (DOK 3)

ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)

jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)

kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

eee. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)

fff. Explain the flow of matter and energy in ecosystems. (DOK 2)

- Interactions between biotic and abiotic factors
- Indigenous plants and animals and their roles in various ecosystems
- Biogeochemical cycles within the environment

ggg. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)

hhh. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)

- How a species adapts to its niche
- Process of primary and secondary succession and its effects on a population
- How changes in the environment might affect organisms

iii. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)

jjj. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)

kkk. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

y. Summarize the effects of human activities on resources in the local environments. (DOK 2)

- Sources, uses, quality, and conservation of water
- Renewable and nonrenewable resources
- Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem

- z. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)
- aa. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

- eee. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- fff. Clarify research questions and design laboratory investigations. (DOK 3)
- ggg. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)
- iii. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- jjj. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- kkk. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

- eee. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)
- fff. Describe how organic components are integral to biochemical processes. (DOK 2)
- ggg. Differentiate among the processes by which plants and animals reproduce. (DOK 1)
 - 1)
 - Cell cycle and mitosis
 - Meiosis, spermatogenesis, and oogenesis
- hhh. Explain the significance of the discovery of nucleic acids. (DOK 1)
- iii. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)
- jjj. Cite examples to compare the consequences of the different types of mutations. (DOK 1)

kkk. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

eee. Cite evidence that supports the significance of Mendel's concept of "particulate inheritance" to explain the understanding of heredity. (DOK 1)

fff. Apply classical genetics principles to solve basic genetic problems. (DOK 2)

- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
- Inheritance of autosomal and sex-linked traits
- Inheritance of traits influenced by multiple alleles and traits with polygenic inheritance
- Chromosomal theory of inheritance

ggg. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)

- Genetic variability
- Hardy-Weinberg formula
- Migration and genetic drift
- Natural selection in humans

hhh. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)

- Steps in genetic engineering experiments
- Use of restriction enzymes
- Role of vectors in genetic research
- Use of transformation techniques

iii. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)

jjj. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)

kkk. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

eee. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)

- Safety rules and symbols
- Proper use and care of the compound light microscope, slides, chemicals, etc.

- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- fff. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)
- 2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.**
- kkkk. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- llll. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- mmmm. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
- Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- nnnn. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
- Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- oooo. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- pppp. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- qqqq. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- rrrr. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- ssss. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)

tttt. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)

uuuu. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

PS 2 Describe and explain how forces affect motion.

PS 3 Demonstrate an understanding of general properties and characteristics of waves.

PS 4 Develop an understanding of the atom.

PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

eee. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)

- Safety symbols and safety rules in all laboratory activities
- Proper use and care of the compound light microscope
- Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

fff. Identify questions that can be answered through scientific investigations. (DOK 3)

ggg. Identify and apply components of scientific methods in classroom investigations. (DOK 3)

- Predicting, gathering data, drawing conclusions
- Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
- Critically analyzing current investigations/problems using periodicals and scientific scenarios

hhh. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)

iii. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)

jjj. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

kkk. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

ooo. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)

- Inertia and distance-time graphs to determine average speed
- Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects

- Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion
 - Simple harmonic motion (oscillation)
- pp. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)
 - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- qq. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- rr. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- ss. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- gg. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- hh. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
- ii. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
- jj. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- gg. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
- hh. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)

- ii. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)
 - Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectroscopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)
 - jj. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
 - Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
- 5. Investigate and apply principles of physical and chemical changes in matter.**
- y. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
 - z. Balance chemical equations. (DOK 2)
 - aa. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. Investigate and apply principles of physical and chemical changes in matter.

- eee. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- fff. Clarify research questions, and design laboratory investigations. (DOK 3)
- ggg. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)

- iii. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- jjj. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- kkk. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Develop an understanding of concepts related to forces and motion.**
- gg. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- hh. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- ii. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- jj. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
- oo. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
- pp. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- qq. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- rr. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency

ss. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)

4. Discuss the characteristics and properties of light and sound.

oo. Describe and model the characteristics and properties of mechanical waves. (DOK 2)

- Simple harmonic motion
- Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
- Energy of a wave in terms of amplitude and frequency.
- Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)

pp. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)

qq. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)

rr. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)

ss. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)

5. Apply an understanding of magnetism, electric fields, and electricity.

y. Analyze and explain the relationship between electricity and magnetism. (DOK 2)

- Characteristics of static charge and how a static charge is generated
- Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
- Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
- Coulomb's law

z. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)

aa. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)

6. Analyze and explain concepts of nuclear physics.

q. Analyze and explain the principles of nuclear physics. (DOK 1)

- The mass number and atomic number of the nucleus of an isotope of a given chemical element
- The conservation of mass and the conservation of charge
- Nuclear decay

r. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)

- Quantum energy and emission spectra
- Photoelectric and Compton effects

Spatial Information Science

SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- eee. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- fff. Clarify research questions, and design laboratory investigations. (DOK 3)
- ggg. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
- hhh. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
- iii. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- jjj. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- kkk. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

- ww. Describe the characteristics of the electromagnetic spectrum.
- xx. Using images and graphs, interpret the absorption/reflection spectrum.
- yy. Distinguish between passive vs. active sensor systems.
- zz. Analyze the effects of changes in spatial, temporal, and spectral resolution.
- aaa. Analyze the effects on images due to changes in scale.
- bbb. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- eee. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

- fff. Formulate questions that can be answered through research and experimental design. (DOK 3)
- ggg. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- hhh. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- iii. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- jjj. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- kkk. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of levels of organization and animal classification.

- gg. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
 - Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- hh. Identify and describe characteristics of the major phyla. (DOK 1)
 - Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- ii. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- jj. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
 - Phylogenetic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.

- oo. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- pp. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
 - Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups

- qq. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)
- rr. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)
- Terrestrial and aquatic ecosystems
 - Herbivores, carnivores, omnivores, decomposers and other feeding relationships
 - Symbiotic relationships such as mutualism, commensalisms, and parasitism
- ss. Contrast food chains and food webs. (DOK 2)
4. **Demonstrate an understanding of the principles of animal genetic diversity and evolution.**
- q. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)
- Relationship between natural selection and evolution
 - Mutations, crossing over, nondisjunction
 - Nonrandom mating, migration, etc.
 - Effects of genetic drift on evolution
- r. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author’s Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer's position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer's position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards

The Collision Repair Technology program is written to incorporate the National Automotive Technicians Education Foundation (NATEF) and the Inter-Industry Conference on Auto Collision Repair (I-CAR) learning objectives, content, and hours.

- CRN1 Non-Structural Analysis and Damage Repair
- CRS2 Structural Analysis and Damage Repair
- CRS3 Mechanical and Electrical Components
- CRP4 Painting and Refinishing

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.
- b. Plan and manage activities to develop a solution or complete a project.

- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.

FRAMEWORKS FOR
VOCATIONAL-TECHNICAL PROGRAMS
REVISED IN
2011

SECONDARY
EXECUTIVE SUMMARY
2011

Direct inquiries to

Director of Bureau of Vocational Instructional Development
Office of Vocational Education and Workforce
Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
(601) 359-3940

Robin Parker
Curriculum Coordinator
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
(662) 325-2510
robin.parker@rcu.msstate.edu

Additional copies

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
<https://cia.rcu.msstate.edu/curriculum/download.asp>
(662) 325-2510

Published by

Office of Vocational Education and Workforce
Development
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Mississippi State University
Mississippi State, MS 39762

The Mississippi Department of Education, Office of Vocational Education and Workforce Development does not discriminate on the basis of race, color, religion, national origin, sex, age, or disability in the provision of educational programs and services or employment opportunities and benefits. The following office has been designated to handle inquiries and complaints regarding the non-discrimination policies of the Mississippi Department of Education: Director, Office of Human Resources, Mississippi Department of Education, 359 North West Street, Suite 359, Jackson, Mississippi 39201, (601) 359-3511.

Foreword

Secondary vocational-technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act III, 1998; and No Child Left Behind Act of 2001).

Each secondary vocational-technical course consists of a series of instructional units which focus on a common theme. All units have been written using a common format which includes the following components:

- Unit Number and Title
- Suggested Time on Task - An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75-80 percent of the time in the course.
- Competencies and Suggested Objectives
 - A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies.
 - The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.
- Suggested Teaching Strategies - This section of each unit indicates strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies which reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.
- Suggested Assessment Strategies - This section indicates strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.
- Integrated Academic Topics, Workplace Skills, Technology Standards, and Occupational Standards - This section identifies related academic topics as required in the Subject Area Assessment Program (SATP) in Algebra I, Biology I, English II, and U. S. History from 1877, which are integrated into the content of the unit. It also identifies the 21st Century

Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. The need for these types of skills have been recognized for some time and the 21st Century Skills are adapted in part from the 1991 report from the U.S. Secretary of Labor's Commission on Achieving Necessary Skills (SCANS). Another important aspect of learning and working in the 21st century involves technology skills, and the International Society for Technology in Education, developers of the National Education Technology Standards (NETS), were strategic partners in the Partnership for 21st Century Skills.

- References - A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Table of Contents

Automotive Service Technician Executive Summary	704
Course Outlines.....	706
Automotive Service Technician Competencies and Objectives	711
Automotive Service Technician Competency Profile.....	725
Appendix A: 21st Century Skills Standards	727
Appendix B: MS Academic Standards	729
Appendix C: ACT College Readiness Standards.....	759
Appendix D: Pathway Content Standards.....	773
Appendix E: National Educational Technology Standards for Students	775

Automotive Service Technology Executive Summary

Program Description

Automotive Service is a pathway for students in the Transportation career cluster. The following description is from the current Standard Course of Study for Career–Technical Education, Mississippi Department of Education.

Industry Certification

The Automotive Service pathway includes classroom and hands-on experiences that prepare students for employment or continuing education in the auto service industry. This program was written to incorporate the National Institute for Automotive Service Excellence (ASE) learning objectives/content and hours. Any student who successfully completes this program will be eligible to apply to obtain the ASE exams. ASE requires 2 years of employment before certificates are issued. Students receive 1 year of credit for completion of the secondary program. Students who take certifications before the 2-year requirement is met will be granted certifications after they complete 1 year of automotive employment. This is a national certification program recognized throughout the automotive service industry. Each district should implement a maximum student number due to the size of each lab.

Assessment

Students will be assessed using the Automotive Service MS-CPAS2 test. The MS-CPAS2 blueprint can be found at <http://redesign.rcu.msstate.edu/curriculum/>. If there are questions regarding assessment of this program, please contact the Transportation Instructional Design Specialists at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be able to experience success in the Automotive Service pathway, the following student prerequisites are in place:

1. C or Higher in English (the previous year)
2. C or Higher in Math (last course taken, or the instructor can specify the math)
3. Instructor Approval

or

3. TABE Reading Score (eighth grade or higher)
4. Instructor Approval

or

1. Instructor Approval

Proposed Applied Academic Credit

Applied Mathematics content from the curriculum was aligned to the 2007 Mississippi Mathematics Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program, students will earn 1/2 Applied Mathematics credit that can be used for graduation requirements.

Applied Physics content from the curriculum was aligned to the 2007 Mississippi Science Framework Revised Academic Benchmarks. It is proposed that upon the completion of this program (option 1 or option 2), students will earn 1/2 Applied Physics credit that can be used for graduation requirements.

The applied academic credit has *not* been approved by the Mississippi Commission on School Accreditation or by the State Board of Education. If there are questions regarding applied academic credit, please contact the Coordinator of Workforce Education at the Research and Curriculum Unit at 662.325.2510.

Licensure Requirements

A 966 educator license is required to teach the Automotive Service pathway courses. The requirements for the 966 licensure endorsement are listed below:

9. Applicant must have earned a 2-year college degree (associate's degree) or higher from an accredited institution of higher education.
10. Applicant must have 2 years of documented automotive service experience.
11. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the Redesign Education Program (REP).
12. Applicant must complete the individualized professional development plan (PDP) requirements of the VIP or REP prior to the expiration date of the 3-year vocational license.
13. Applicant must hold ASE certificates in brakes, electrical/electronics, engine performance, and steering and suspension.
14. Applicant must successfully complete an approved computer literacy certification exam.
15. Applicant must successfully complete a certification for an online learning workshop, module, or course that is approved by the Mississippi Department of Education.
16. The applicant must successfully complete an Automotive Service certification workshop, module, or course that is approved by the Mississippi Department of Education.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at <http://rcu.redesign.edu>. If you have specific questions about the content of each training session provided, you will need to contact the Research and Curriculum Unit at 662.325.2510 and ask for the Professional Learning Specialist.

Course Outlines

This pathway provides options for local school districts to implement based on student needs and scheduling demand. The first option groups units into one-credit courses for a total of four Carnegie units. The second option groups units into two-credit courses. A description of each option is listed next.

Option 1

The Automotive Service pathway emphasizes industry-based content with time being allocated between lecture and lab activities. Safety is an integral part of every course and activity. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF). There are four courses in this option: Fundamentals I, Brakes, and Introduction to Electrical/Electronic Systems; Advanced Electrical/Electronic Systems; Engine Performance I; and Engine Performance II and Suspension/Steering Systems and Alternative Fuels. Courses should be scheduled so the student completes all courses in 2 years.

Course Description: The Fundamentals I, Brakes, and Introduction to Electrical/Electronic Systems course contains an introduction, safety, measurement, and tool/technical references content. It also contains an introduction to brake systems: disc brakes, drum brakes, and antilock brakes. This course also contains an introduction to electrical/electronic systems information and terminology. The Basic Electrical/Electronic Systems course contains electrical/electronic system theory, battery systems, starting systems, and charging systems.

Course Description: The Advanced Electrical/Electronic Systems course contains information on lighting systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: The Engine Performance I courses contain information on safety, employability skills, basic automobile service, general engine components and theory of operation, concepts of computerized engine control systems, and ignition systems.

Course Description: The Engine Performance II and Suspension/Steering Systems and Alternative Fuels courses contain information on fuel, air induction, and exhaust systems; concepts of emission control systems; concepts of engine service; general suspension/steering theory; steering system inspection, diagnosis, and repair; concepts of front, rear, and miscellaneous systems; and wheel/tire alignment concepts, alternative fuels general information for service and maintenance.

Automotive Service I, Part A (One Carnegie Unit) - Course Code: 997002

Unit	Title	Hours
1	Fundamentals I, Brakes, and Introduction to Electrical/Electronic Systems	89
2	Basic Electrical/Electronic Systems	51
		130

Note: The hours listed above are based on 140 hours of instruction for one Carnegie unit credit. ASE-certified programs are required to spend the following hours of instruction for the following units:

- Brakes and Electrical/Electronic Systems (135 hours)
- Basic Electrical/Electronic Systems (60 hours)

Automotive Service I, Part B (One Carnegie Unit) - Course Code: 997003

Unit	Title	Hours
3	Advanced Electrical/Electronic Systems	140
		140

Note: The hours listed above are based on 140 hours of instruction for one Carnegie unit credit. ASE-certified programs are required to spend the following hours of instruction for the following units:

- Advanced Electrical/Electronic Systems (140 hours)

Automotive Service II, Part A (One Carnegie Unit) - Course Code: 997004

Unit	Title	Hours
4	Engine Performance I	140

			140
--	--	--	-----

Note: The hours listed above are based on 140 hours of instruction for one Carnegie unit credit. ASE-certified programs are required to spend the following hours of instruction for the following units:

- Engine Performance I (140 hours)

Automotive Service II, Part B (One Carnegie Unit) - Course Code: 997005

Unit	Title	Hours
5	Engine Performance II	45
6	Suspension/Steering Systems and Alternative Fuels	95
		140

Note: The hours listed above are based on 140 hours of instruction for one Carnegie unit credit. ASE-certified programs are required to spend the following hours of instruction for the following units:

- Engine Performance II (80 hours)
- Steering and Suspension (95 hours)
- Safety will be reinforced and tested at the beginning of each course.
 - ✓ Courses must be taken in order unless the instructor approves. Foundation knowledge in each course must be mastered to move to the next unit.
 - ✓ Students must complete automotive courses with a score of 80/C or higher in classwork to advance to the next level.
 - ✓ To effectively assess mastery respective to a course’s instructional hours, the pathway blueprint will test units upon completion of their last hour of instruction.

Option 2

This Automotive Service pathway option also emphasizes industry-based content with time being allocated between lecture and lab activities. The content is aligned with National Institute for Automotive Service Excellence (ASE) standards to ensure that programs can be recommended for certification by National Automotive Technicians Educational Foundation (NATEF). The content is divided into two courses. The content of the first course is Introduction,

Safety, and Tools/Technical References, along with Basic Automotive Service, Brakes, Introduction to Electrical/Electronic Systems, and Basic Electrical/Electronic Systems. The second course content is Advanced Electrical/Electronic Systems, Steering and Suspension, and Engine Performance content. Safety is an integral part of every course and activity. A student must complete both courses to be a completer and to receive the 1/2 credit for physics and math.

Course Description: Automotive Service Technology I (Course CIP Code: 997000)

The Fundamentals, Brakes, and Introduction to Electrical/Electronic Systems course contains an introduction, safety, measurement, and tool/technical references content. It also contains an introduction to brake systems: disc brakes, drum brakes, and antilock brakes. This course also contains an introduction to electrical/electronic information and terminology. The Basic Electrical/Electronic Systems course contains electrical/electronic system theory, battery systems, starting systems, and charging systems. The Advanced Electrical/Electronic Systems course contains information on lighting systems, concepts of gauges, warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair.

Course Description: Automotive Service Technology II (Course CIP Code: 997001)

The Engine Performance I course contains information on safety, employability skills, basic automobile service, general engine components and theory of operation, concepts of computerized engine control systems, and ignition systems. The Engine Performance II and Steering and Suspension course contains information on fuel, air induction, and exhaust systems; concepts of emission control system; concepts of engine service; general suspension/steering theory; steering system inspection, diagnosis, and repair; concepts of front , rear, and miscellaneous systems; and wheel/tire alignment concepts; and alternative fuels general information for service and maintenance.

Automotive Service I (Two Carnegie Units) - Course Code: 997000

Unit	Title	Hours
1	Fundamentals I, Brakes, and Introduction to Electrical/Electronic Systems	89
2	Basic Electrical/Electronic Systems	51
3	Advanced Electrical/Electronic Systems	140
		280

Note: The hours listed above are based on 140 hours of instruction for one Carnegie unit credit. ASE-certified programs are required to spend the following hours of instruction for the following units:

- Brakes and Introduction to Electrical/Electronic Systems (135 hours)
- Basic Electrical/Electronic Systems (60 hours)
- Advanced Electrical/Electronic Systems (140 hours)

Automotive Service II (Two Carnegie Units) - Course Code: 997001

Unit	Title	Hours
4	Engine Performance I	140
5	Engine Performance II	45
6	Steering/Suspension and Alternative Fuels	95
		280

Note: The hours listed above are based on 140 hours of instruction for one Carnegie unit credit. ASE-certified programs are required to spend the following hours of instruction for the following units:

- Engine Performance I (140 hours)
- Engine Performance II (80 hours)
- Steering and Suspension (95 hours)
 - ✓ Scheduling and operating more than one course in the same classroom/laboratory with the same teacher is not allowed.
 - ✓ Students must complete the first year with a score of 80/C or higher in classwork to advance to the next level.
 - ✓ To effectively assess mastery respective to a course’s instructional hours, the pathway blueprint will test units upon completion of their last hour of instruction.

Automotive Service Technician Competencies and Objectives

Unit 1: Fundamentals I, Brakes, and Introduction to Electrical/Electronic Systems

1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
 - a. Describe local program and vocational/career technical center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations. (DOK 1)
2. Describe employment opportunities and responsibilities. (DOK 1).
 - a. Describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. (DOK 1)
 - b. Describe basic employee responsibilities. (DOK 1)
3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA. (DOK 2)
 - a. Demonstrate effective team-building and leadership skills. (DOK 2)
 - b. Practice appropriate work ethics. (DOK 2)
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2).
 - a. Demonstrate following verbal and written instructions. (DOK 2)
 - b. Practice following verbal and written instructions. (DOK 2)
 - c. Communicate effectively with customers, colleagues, and employers. (DOK 2)
5. Discuss the history of the automotive industry to include materials, terminology, and techniques. (DOK 1)
 - a. Discuss terminology related to the automotive industry. (DOK 1)
 - b. Explain and demonstrate techniques used in the automotive industry. (DOK 1)
 - c. Explore the history of the automotive industry. (DOK 1)
6. Identify and describe general safety rules, components of an automobile, tools / equipment, measurement practices, and fasteners for working in a shop/lab and industry. (DOK 1).
 - a. Describe how to avoid on-site accidents. (DOK 1)
 - b. Explain the relationship between housekeeping and safety. (DOK 1)
 - c. Explain the importance of following all safety rules and company safety policies. (DOK 1)
 - d. Explain the importance of reporting all on-the-job injuries and accidents. (DOK 1)
 - e. Explain the need for evacuation policies and the importance of following them. (DOK 1)
 - f. Explain the employer's substances abuse policy and how it relates to safety. (DOK 1)
 - g. Explain the safety procedures when working near pressurized or high temperature. (DOK 1)
 - h. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm. (DOK 1)

- i. Measure the inside diameter, outside diameter, and/or depth to the nearest 0.001 in. and nearest 0.1 mm, using precision measuring instruments (micrometers, calipers, and dial indicators). (DOK 1)
 - j. Locate service specifications and information, using both print and computerized service information references (VIN, certification, and calibration labels). (DOK 1)
 - k. Identify and demonstrate the safe and proper use of impact wrenches; drills; grinders; hydraulic presses; lifting and hoisting equipment; cleaning equipment; common hand tools including wrenches, sockets, pliers, screwdrivers, and striking tools; and other tools used in the automotive field. (DOK 1)
 - l. Organize and maintain a systematic storage system for hand and power tools. (DOK 1)
 - m. Identify the different types of bolts, nuts, and washers and describe their appropriate uses. (DOK 1)
 - n. Identify bolts by grade, diameter, length, and thread pitch. (DOK 1)
 - o. Identify and describe the use of various glues and sealants. (DOK1)
 - p. Restore internal and external threads. (DOK1)
7. Identify and apply concepts regarding safety procedures and practices in and around automotive operations. (DOK 2)
- a. Inspect and care for personal protective equipment. (DOK 2)
 - b. Identify and explain the procedures for lifting heavy objects. (DOK 2)
 - c. Explain the function of the MSDS. (DOK 2)
 - d. Interpret the requirements of the MSDS. (DOK 2)
 - e. Explain the process by which fires start. (DOK 2)
 - f. Explain fire prevention of various flammable liquids. (DOK 2)
 - g. Explain the classes of fire and the types of extinguishers. (DOK 2)
 - h. Explain injuries when electrical contact occurs. (DOK 2)
8. Explore general brake systems and theories of operation. (DOK 3)
- a. Complete a work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. (DOK 3)
 - b. Identify and interpret brake system concern; determine necessary action. (DOK 3)
 - c. Research applicable vehicle and service information, such as brake system operation, vehicle service history, service precautions, and technical service bulletins. (DOK 3)
 - d. Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration details, and calibration decals). (DOK 3)
 - e. Identify and demonstrate the safe and proper use of common hand tools including wrenches, sockets, pliers, screwdrivers, striking tools, and so forth. (DOK 3)
 - f. Identify and demonstrate the safe and proper use of lifting and hoisting equipment. (DOK 3)
 - g. Identify and demonstrate the safe and proper use of cleaning equipment. (DOK 3)
 - h. Identify and demonstrate the safe and proper use of power equipment including impact wrenches, drills, grinders, and presses. (DOK 3)
 - i. Identify the different types of bolts, nuts, and washers, and describe their appropriate uses. (DOK 3)
 - j. Identify bolts by grade, diameter, length, and thread pitch. (DOK 3)

- k. Identify different glues and sealants used in automotive service, and describe their appropriate uses. (DOK 3)
 - l. Restore internal and external threads. (DOK 3)
 - m. Locate service specifications and information, using both print and computerized service information references. (DOK 3)
 - n. Interpret and apply information to a specific job on a specific vehicle. (DOK 3)
 - o. Locate and interpret vehicle and major component identification numbers (VIN, certification, and calibration labels). (DOK 3)
 - p. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm. (DOK 3)
 - q. Measure the inside diameter, outside diameter, and/or depth to the nearest 0.001 in. and nearest 0.1 mm, using precision measuring instruments (micrometers, calipers, and dial indicators). (DOK 3)
 - r. Distinguish between accuracy and precision. (DOK 3)
 - s. Determine when an instrument is out of calibration. (DOK 3)
 - t. Determines factors that affect stopping distance? (DOK 3)
 - u. Define friction and which factors affect the size of the force of friction. (DOK 3)
 - v. Discuss kinetic energy and the work–energy theorem. (DOK 3)
 - w. Define work, and relate work as it applies to stopping a car in motion. (DOK 3)
9. Apply concepts of hydraulic brake systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
- a. Diagnose pressure concerns in the brake system using hydraulic principles (Pascal’s law). (DOK 2)
 - b. Measure brake pedal height; determine necessary action. (DOK 2)
 - c. Check master cylinder for internal and external leaks and proper operation; determine necessary action. (DOK 2)
 - d. Remove, bench bleed, and reinstall master cylinder. (DOK 2)
 - e. Diagnose poor stopping, pulling, or dragging concerns caused by malfunctions in the hydraulic system; determine necessary action. (DOK 2)
 - f. Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, or wear; tighten loose fittings and supports; determine necessary action. (DOK 2)
 - g. Fabricate and/or install brake lines (double flare and ISO types); replace hoses, fittings, and supports as needed. (DOK 2)
 - h. Select, handle, store, and fill brake fluids to proper level. (DOK 2)
 - i. Inspect, test, and/or replace metering (hold-off), proportioning (balance), pressure differential, and combination valves. (DOK 2)
 - j. Inspect, test, and/or replace components of brake warning light system. (DOK 2)
 - k. Bleed (manual, pressure, vacuum, or surge) brake system. (DOK 2)
 - l. Flush hydraulic system. (DOK 2)
 - m. Discuss floor jack as a type of hydraulic system employing Pascal’s principle. (DOK 2)
10. Apply concepts of disc brake systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)

- a. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pedal pulsation concerns; determine necessary action. (DOK.2)
 - b. Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing; determine necessary action. (DOK 2)
 - c. Clean and inspect caliper mounting and slides for wear and damage; determine necessary action. (DOK 2)
 - d. Remove, clean, and inspect pads and retaining hardware; determine necessary action. (DOK 2)
 - e. Disassemble and clean caliper assembly; inspect parts for wear, rust, scoring, and damage; replace seal, boot, and damaged or worn parts. (DOK 2)
 - f. Reassemble, lubricate, and reinstall caliper, pads, and related hardware; seat pads, and inspect for leaks. (DOK 2)
 - g. Clean, inspect, and measure rotor with a dial indicator and a micrometer; follow manufacturer's recommendations in determining need to machine or replace. (DOK 2)
 - h. Remove and reinstall rotor. (DOK 2)
 - I. Refinish rotor off vehicle. (DOK 2)
 - j. Adjust calipers equipped with an integrated parking brake system. (DOK 2)
 - k. Install wheel, torque lug nuts, and make final checks and adjustments. (DOK 2)
11. Apply concepts of drum brake systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- a. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pedal pulsation concerns; determine necessary action. (DOK 3)
 - b. Remove, clean (using proper safety procedures), inspect, and measure brake drums; determine necessary action. (DOK 3)
 - c. Refinish brake drum. (DOK 3)
 - d. Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble. (DOK 3)
 - e. Remove, inspect, and install wheel cylinders. (DOK 3)
 - f. Pre-adjust brake shoes and parking brake before installing brake drums or drum/hub assemblies and wheel bearings. (DOK 3)
 - g. Install wheel, torque lug nuts, and make final checks and adjustments. (DOK 3)
 - h. Discuss $\text{torque} = \text{perpendicular X length of torque arm}$. (DOK 3)
 - i. Discuss the effect of length on the amount of torque extended and why an extension handle is used to increase torque. (DOK 3)
12. Apply concepts of power assist unit systems by performing inspection, diagnosis, and repair, if needed.(DOK 3)
- a. Test pedal-free travel with and without engine running; check power assist operation. (DOK 3)
 - b. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster. (DOK 3)
 - c. Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; determine necessary action. (DOK 3)

- d. Inspect and test hydraulically assisted power brake system for leaks and proper operation; determine necessary action. (DOK 3)
 - e. Measure and adjust master cylinder pushrod length. (DOK 3)
13. Apply concepts of miscellaneous systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
- a. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine necessary action. (DOK 2)
 - b. Remove, clean, inspect, repack, and install wheel bearings, and replace seals; install hub and adjust wheel bearings. (DOK 2)
 - c. Check parking brake cables and components for wear, rusting, binding, and corrosion; clean, lubricate, or replace as needed. (DOK 2)
 - d. Check parking brake operation; determine necessary action. (DOK 2)
 - e. Check operation of parking brake indicator light system. (DOK 2)
 - f. Check operation of brake stoplight system; determine necessary action. (DOK 2)
 - g. Replace wheel bearing and race. (DOK 2)
 - h. Inspect and replace wheel studs. (DOK 2)
 - i. Remove and reinstall sealed wheel bearing assembly. (DOK 2)
 - j. Discuss ways to reduce friction by lubrication. Discuss rolling friction versus sliding friction. (DOK 2)
14. Apply concepts of antilock brake, traction control systems, and vehicle stability control systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- a. Identify and inspect antilock brake system (ABS) components; determine necessary action. (DOK 3)
 - b. Diagnose poor stopping, wheel lockup, abnormal pedal feel or pulsation, and noise concerns caused by the antilock brake system (ABS); determine necessary action. (DOK 3)
 - c. Diagnose antilock brake system (ABS) electronic control(s) and components using self-diagnosis and/or recommended test equipment; determine necessary action. (DOK 3)
 - d. Depressurize high-pressure components of the antilock brake system (ABS). (DOK 3)
 - e. Diagnose antilock brake system (ABS) braking concerns caused by vehicle modifications (tire size, curb height, final drive ratio, etc.). (DOK 3)
 - f. Identify traction control/vehicle stability control system components. (DOK 3)
 - g. Discuss why an ABS system is better in terms of the stopping friction in the disc brakes versus the sliding friction when the tires lock and skid with a lesser coefficient of friction. (DOK 3)

Unit 2: Basic Electrical/Electronic Systems

- 1. Explore general electrical/electronic systems and theories of operation. (DOK 3)
 - a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. (DOK 3)
 - b. Identify and interpret electrical/electronic system concerns; determine necessary action. (DOK 3)

- c. Research applicable vehicle and service information, such as electrical/electronic system operation, vehicle service history, service precautions, and technical service bulletins. (DOK 3)
 - d. Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, and calibration decals). (DOK 3)
 - e. Diagnose electrical/electronic integrity of series, parallel, and series-parallel circuits using principles of electricity (Ohm's law). (DOK 3)
 - f. Use wiring diagrams during diagnosis of electrical circuit problems. (DOK 3)
 - g. Demonstrate the proper use of a digital multimeter (DMM) during diagnosis of electrical circuit problems. (DOK 3)
 - h. Check electrical circuits with a test light; determine necessary action. (DOK 3)
 - i. Measure source voltage, and perform voltage drop tests in electrical/electronic circuits using a voltmeter; determine necessary action. (DOK 3)
 - j. Measure current flow in electrical/electronic circuits and components using an ammeter; determine necessary action. (DOK 3)
 - k. Check continuity and measure resistance in electrical/electronic circuits and components using an ohmmeter; determine necessary action. (DOK 3)
 - l. Check electrical circuits using fused jumper wires; determine necessary action. (DOK 3)
 - m. Locate shorts, grounds, opens, and resistance problems in electrical/electronic circuits; determine necessary action. (DOK 3)
 - n. Measure and diagnose the cause(s) of excessive key-off battery drain (parasitic draw); determine necessary action. (DOK 3)
 - o. Inspect and test fusible links, circuit breakers, and fuses; determine necessary action. (DOK 3)
 - p. Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; perform necessary action. (DOK 3)
 - q. Remove and replace terminal end from connector. (DOK 3)
 - r. Repair connectors and terminal ends. (DOK 3)
 - s. Perform solder repair of electrical wiring. (DOK 3)
 - t. Identify safety procedures and location of hybrid vehicle high-voltage circuit disconnect (service plug). (DOK 3)
 - u. Define current, resistance, and voltage, and discuss Ohm's law. (DOK 3)
 - v. Define and contrast series and parallel circuits; sketch series and parallel circuits. (DOK 3)
 - w. Define ground, short circuit, open circuit, and the resistance associated with short circuits and open circuits. (DOK 3)
 - x. Discuss the ground for an automobile and for a house. (DOK 3)
 - y. Discuss fuses and circuit breakers in parallel circuits where $I_{\text{total}} = I_{\text{fuse}} = I_1 + I_2 + I_3$. (DOK 3)
2. Apply concepts of battery systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- a. Perform battery state-of-charge test; determine necessary action. (DOK 3)
 - b. Perform battery capacity test (or conductance test); confirm proper battery capacity for vehicle application; determine necessary action. (DOK 3)

- c. Maintain or restore electronic memory functions. (DOK 3)
 - d. Inspect, clean, fill, and replace battery. (DOK 3)
 - e. Perform slow/fast battery charge. (DOK 3)
 - f. Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed. (DOK 3)
 - g. Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed. (DOK 3)
 - h. Start a vehicle using jumper cables and a battery or auxiliary power supply. (DOK 3)
 - i. Identify high-voltage circuits of electric or hybrid electric vehicle and related safety precautions. (DOK 3)
 - j. Identify hybrid vehicle auxiliary (12 V) battery service and repair and test procedures. (DOK 3)
 - k. Discuss terminal potential difference (TPD) and electromotive force (EMF) for a battery. $TPD = EMF - IR_B$ (discharging) $TPD = EMF + IR_B$ (charging). Using a voltmeter or automobile/truck voltmeter, determine the TPD of a battery switch when the switch is turned to on (without engine running), the TPD when the engine is starting (battery is discharging), and the TPD when the engine is running (battery is charging). (DOK 3)
3. Apply concepts of starting systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- a. Perform starter current draw and circuit voltage drop tests; determine necessary repair. (DOK 3)
 - b. Inspect and test the starter components, relays, and solenoids; determine necessary repair. (DOK 3)
 - c. Remove and install the starter. (DOK 3)
 - d. Inspect test switches, connectors, and wires of starter control circuits; perform necessary action. (DOK 3)
 - e. Differentiate between electrical and engine mechanical problems that cause slow-crank or no-crank conditions. (DOK 3)
 - f. Discuss terrestrial magnetism and electromagnetism using wire, nail, and battery. Discuss the solenoid as an electromagnet and how it engages the starter to the flywheel. (DOK 3)
 - g. Discuss why the starter must be disengaged from the flywheel when the car is running in terms of gear ratio and angular velocity in revolutions per minute. (DOK 3)
4. Apply concepts of charging systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- a. Perform a charging system test, and diagnose the cause or causes for the following: output, undercharging, no-charge, overcharge, and voltage drop; determine necessary repair. (DOK 3)
 - b. Remove, inspect, adjust, and **install** the generator (alternator) and components. (DOK 3)

Unit 3: Advanced Electrical/Electronic Systems

1. Explore lighting systems and theories of operation. (DOK 3)

- a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. (DOK 3)
 - b. Diagnose lighting system problems related to brighter than normal, intermittent, dim, or no light operation; determine necessary actions. (DOK 3)
 - c. Inspect, replace, and aim headlights and bulbs. (DOK 3)
 - d. Inspect and diagnose incorrect turn and hazard lighting systems; determine necessary actions. (DOK 3)
 - e. Identify system voltage and safety precautions associated with high-intensity discharge headlights. (DOK 3)
 - f. Discuss parabolic reflections such as headlights. (DOK 3)
 - g. Relate the location of the filament to high beam and low beam operation. (DOK 3)
 - h. Discuss rearview mirrors as convex mirrors and why objects appear smaller than they actually are. (DOK 3)
 - i. Discuss how “night view” device was on the interior rear-view mirror. (DOK 3)
2. Apply concepts of gauges, warning devices, and driver information systems by performing inspection, diagnosis, and repair, if needed. ((DOK 3))
 - a. Inspect and test gauges and gauge sending units for cause of intermittent, high, low, or no gauge readings; determine necessary action. (DOK 3)
 - b. Inspect and test connectors, wires, and printed circuit boards of gauge circuits; determine necessary action. (DOK 3)
 - c. Diagnose the cause of incorrect operation of warning devices and other driver information systems; determine necessary action. (DOK 3)
 - d. Discuss blinker operation and wiper speed control in terms of capacitors and resistors. (DOK 3)
 3. Apply concepts of horn and wiper/washer systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Diagnose incorrect horn operation; determine necessary action. (DOK 3)
 - b. Diagnose incorrect wiper/washer operation; perform necessary action. (DOK 3)
 - c. Diagnose wiper speed control and park problems; perform necessary action. (DOK 3)
 4. Apply concepts of accessories by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Diagnose and repair motor driven accessory circuits, air conditioner/ heater systems, heated accessories, electrical locks, radios, body electronics, communication systems, and anti-theft systems. (DOK 3)
 - b. Disarm and enable the air bag system for vehicle service. (DOK 3)
 - c. Diagnose body electronic system circuits using a scan tool; determine necessary action. (DOK 3)
 - d. Diagnose incorrect heated glass, mirror, or seat operation; determine necessary action. (DOK 3)

Unit 4: Engine Performance I

1. Identify and describe the major systems and components of an automobile. (DOK 2)

- a. Identify the major components of the following major systems and describe their purposes and/or functions:
 1. Power train (DOK 2)
 2. Chassis, steering, and suspension (DOK 2)
 3. Fuel (DOK 2)
 4. Electrical (DOK 2)
 5. Cooling (DOK 2)
 6. Exhaust (DOK 2)
 - b. Describe the operation of a four-stroke cycle engine. (DOK 2)
 - c. Discuss power as $\text{Work/Time} = \text{Force} * \text{Distance/Time}$. (DOK 2)
 - d. Relate speed to power; as V increases, power = work/time = energy/time also increases, so fuel consumption increases with the car's speed. (DOK 2)
 - e. Research/plot graph of fuel consumption miles per gallon versus speed. (DOK 2)
 - f. Describe the use of electronics and computer control in modern automobiles. (DOK 2)
2. Inspect and perform general maintenance (lubrication, oils, and fluids). (DOK 2)
 - a. Discuss the importance of regularly scheduled maintenance procedures as outlined in the owner's manual and related to vehicle performance and longevity. (DOK 2)
 - b. Complete a work order and maintenance record for a given vehicle. (DOK 2)
 - c. Visually inspect the engine lubrication system for leaks, and determine needed repairs. (DOK 2)
 - d. Select proper lubricants and filters for lubrication service. (DOK 2)
 - e. Change engine oil and filter according to manufacturer's specifications and in accordance with disposal procedures. (DOK 2)
 - f. Perform a chassis and body lubrication. (DOK 2)
 - g. Inspect and service as needed other filters on the engine including air, fuel, PCV valve, crankcase vent filters, and so forth. (DOK 2)
 - h. Conduct a general preventive maintenance inspection of hoses and belts, fluid levels, wiper blades, headlights and accessory lights, tires, exhaust, shocks, and so forth; repair/replace/adjust as needed. (DOK 2)
 - i. Clean and service a battery including case, cables, and connections, and check electrolyte level (if applicable). (Maintain electronic memory functions while cleaning.) (DOK 2)
 3. Perform cooling system maintenance. (DOK 3)
 - a. Inspect and pressure test a cooling system for proper operation; repair and/or replace thermostats, thermostat gasket, hoses, radiator caps, and so forth as needed. (DOK 3)
 - b. Drain, flush, and refill a cooling system. (DOK 3)
 - c. Test condition and strength of antifreeze/coolant. (DOK 3)
 - d. Discuss freezing point depressions and boiling point elevation for covalent solutions such as sugar in water or ethylene glycol (antifreeze) in radiation. Research/plot freezing point depression versus percentage/volume of engine coolant. (DOK 3)
 4. Perform tire and wheel diagnosis and repair. (DOK 2)
 - a. Diagnose and inspect tire wear and inflation; perform necessary actions. (DOK 2)
 - b. Diagnose and repair wheel/tire vibration, shimmying, and noise. (DOK 2)
 - c. Rotate tires following manufacturer's specifications. (DOK 2)

- d. Diagnose and repair vehicle pull (lead) problems. (DOK 2)
- e. Remove, inspect, and repair tire and wheel assemblies. (DOK 2)
- 5. Explore general engine components and theories of operation. (DOK 2)
 - a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. (DOK 2)
 - b. Identify and interpret engine performance concern; determine necessary action. (DOK 2)
 - c. Research applicable vehicle and service information, such as engine management system operation, vehicle service history, service precautions, and technical service bulletins. (DOK 2)
 - d. Locate and interpret vehicle and major component identification numbers. (DOK 2)
 - e. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine necessary action. (DOK 2)
 - f. Diagnose abnormal engine noise or vibration concerns; determine necessary action. (DOK 2)
 - g. Diagnose abnormal exhaust color, odor, and sound; determine necessary action. (DOK 2)
 - h. Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action. (DOK 2)
 - i. Perform cylinder power balance test; determine necessary action. (DOK 2)
 - j. Perform cylinder cranking and running compression tests; determine necessary action. (DOK 2)
 - k. Perform cylinder leakage test; determine necessary action. (DOK 2)
 - l. Diagnose engine mechanical, electrical, electronic, fuel, and ignition concerns; determine necessary action. (DOK 2)
 - m. Verify engine operating temperature; determine necessary action. (DOK 2)
 - n. Perform cooling system pressure tests; check coolant condition; inspect and test radiator, pressure cap, coolant recovery tank, and hoses; perform necessary action. (DOK 2)
 - o. Verify correct camshaft timing. (DOK 2)
 - p. Discuss operation of oscilloscope as plot of voltage versus time. (DOK 2)
 - q. Discuss frequency and period and their relationship as it relates to oscilloscope operations. (DOK 2)
- 6. Apply concepts of computerized engine controls by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Discuss theory and operation of engine controls. (DOK 3)
 - b. Retrieve, record, and clear stored diagnostic codes on OBD I and OBD II systems. (Clear codes when applicable.) (DOK 3)
 - c. Diagnose the causes of emissions and drivability concerns with stored or active; and non-stored diagnostic trouble codes; determine necessary actions. (DOK 3)
 - d. Check for module communication (including CAN/BUS systems) errors, and interpret scan tool data. (DOK 3)
 - e. Inspect, test, and repair computerized engine control system sensors, power train/engine control modules (PCM/ECM), actuators, and circuits using a graphing

- (GMM) millimeter/digital storage oscilloscope (DSO); perform necessary action. (DOK 3)
- f. Access and use service information to perform step-by-step diagnosis. DOK 3
7. Apply concepts of ignition systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Discuss theory and operation of ignition systems. (DOK 3)
 - b. Diagnose ignition-system-related problems such as no-starting, hard starting, engine misfire, poor driveability; spark knock, power loss, poor mileage, and emissions concerns; determine necessary action. (DOK 3)
 - c. Inspect and test ignition, primary and secondary circuit wiring, components, and pickup sensors or triggering devices; test ignition coil(s); perform necessary action. (DOK3)
 - d. Discuss electrostatic force $F = k Q_1Q_2/d^2$ and resistance to puncture for air (30,000 V/cm). (DOK3)
 - e. Discuss charging effects of points and the spark plug. (DOK3)

Unit 5: Engine Performance II

1. Apply concepts of fuel, air induction, and exhaust systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
 - a. Discuss theory and operation of fuel systems. (DOK 2)
 - b. Diagnose drivability problems related to fuel systems; determine necessary action. (DOK 2)
 - c. Replace components related to fuel systems; make required adjustments. (DOK 2)
 - d. Test electronic fuel, air induction, and fuel-delivery components and circuits; determine necessary action. (DOK 2)
 - e. Inspect and test the exhaust systems; determine and perform necessary action. (DOK 2)
 - f. Discuss the causes of atmospheric pressure (weight of the air above a location) and the effect of altitude on pressure and automotive performance. (DOK 2)
2. Apply concepts of emissions control systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Discuss theory and operation of emissions control systems. (DOK 3)
 - b. Diagnose emissions control system; determine necessary action.
 - c. Inspect, clean, and replace positive crankcase ventilation (PCV) system components. (DOK 3)
 - d. Inspect, clean, and replace electrical/electronic components of the exhaust gas recirculation (EGR) system. (DOK 3)
 - e. Inspect and replace the air management system. (DOK 3)
3. Apply concepts of engine service by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Remove and replace the timing belt; verify correct camshaft timing. (DOK 3)
 - b. Perform cylinder cranking compression and leakage test. (DOK 3)
 - c. Describe common parts failures and wear points in a four-cycle engine. (DOK 3)

- d. Diagnose unusual engine noise and vibrations, and determine needed actions. (DOK 3)
- e. Diagnose unusual exhaust color, odor, and sound; determine needed repairs. (DOK 3)
- f. Perform engine running compression test; determine necessary action. (DOK 3)
- g. Identify hybrid vehicle internal combustion engine service precautions. (DOK 3)

Unit 6: Suspension/Steering Systems and Alternative Fuels

1. Explore general suspension and steering systems and theories of operation. (DOK 3)
 - a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. (DOK 3)
 - b. Identify and interpret suspension and steering concern; determine necessary action. (DOK 3)
 - c. Research applicable vehicle and service information, such as suspension and steering system operation, vehicle service history, service precautions, and technical service bulletins. (DOK 3)
 - d. Locate and interpret vehicle and major component identification numbers. (DOK 3)
2. Apply concepts of steering systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
 - a. Disable and enable supplemental restraint system (SRS). (DOK 2)
 - b. Diagnose steering column noises, looseness, and binding concerns (including tilt mechanisms); determine necessary action. (DOK 2)
 - c. Diagnose power steering gear (non-rack-and-pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action. (DOK 2)
 - d. Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action. (DOK 2)
 - e. Inspect steering shaft universal joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; perform necessary action. (DOK 2)
 - f. Adjust non-rack-and-pinion worm bearing preload and sector lash. (DOK 2)
 - g. Inspect and replace rack and pinion steering gear inner tie rod ends (sockets) and bellows boots. (DOK 2)
 - h. Determine proper power steering fluid type; inspect fluid level and condition. (DOK 2)
 - i. Flush, fill, and bleed power steering system. (DOK 2)
 - j. Diagnose power steering fluid leakage; determine necessary action. (DOK 2)
 - k. Remove, inspect, replace, and adjust power steering pump belt. (DOK 2)
 - l. Remove and reinstall power steering pump. (DOK 2)
 - m. Remove and reinstall press fit power steering pump pulley; check pulley and belt alignment. (DOK 2)
 - n. Inspect and replace power steering hoses and fittings. (DOK 2)
 - o. Inspect and replace Pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper. (DOK 2)
 - p. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps. (DOK 2)

- q. Test and diagnose components of electronically controlled steering systems using a scan tool; determine necessary action. (DOK 2)
 - r. Identify hybrid vehicle power steering system electrical circuits and service and safety precautions. (DOK 2)
3. Apply concepts of front, rear, and related suspension systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
 - a. Diagnose short- and long-arm suspension system noises, body sway, and uneven riding height concerns; determine necessary action. (DOK 3)
 - b. Diagnose strut suspension system noises, body sway, and uneven riding height concerns; determine necessary action. (DOK 3)
 - c. Remove, inspect, and install upper and lower control arms, bushings, shafts, and rebound bumpers. (DOK 3)
 - e. Remove, inspect, and install strut rods and bushings. (DOK 3)
 - f. Remove, inspect, and install upper and/or lower ball joints. (DOK 3)
 - g. Remove, inspect, and install steering knuckle assemblies. (DOK 3)
 - h. Remove, inspect, install, and adjust suspension system torsion bars; inspect mounts. (DOK 3)
 - i. Remove, inspect, and install stabilizer bar bushings, brackets, and links. (DOK 3)
 - j. Remove, inspect, and install strut cartridge or assembly, strut coil spring, insulators (silencers), and upper strut bearing mount. (DOK 3)
 - k. Remove, inspect, and install leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings, and mounts. (DOK 3)
 - l. Inspect, remove, and replace shock absorbers. (DOK 3)
 - m. Remove, inspect, and service or replace front- and rear-wheel bearings. (DOK 3)
 - n. Test and diagnose components of electronically controlled suspension systems using a scan tool; determine necessary action. (DOK 3)
 - o. Diagnose, inspect, adjust, repair or replace components of electronically controlled steering systems (including sensors, switches, and actuators); initialize system as required. (DOK 3)
 - p. Describe the function of the idle speed compensation switch. (DOK 3)
 - q. Lubricate suspension and steering systems. (DOK 3)
 - r. Discuss simple harmonic motion in spring/mass systems, frequency, and resonance. Discuss damping, and criticize damping by shock absorbers. (DOK3)
 - s. Discuss “washboard” ruts on gravel roads as a result of resonant oscillation by car/spring system. (DOK3)
 4. Apply concepts of wheel/tire alignment by performing inspection, diagnosis, and repair, if needed. (DOK 2)
 - a. Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine necessary action. (DOK 2)
 - b. Perform pre-alignment inspection; perform necessary action. (DOK 2)
 - c. Prepare vehicle for wheel alignment on the alignment machine; perform four wheel alignment by checking and adjusting front and rear wheel caster, camber and toe as required; center steering wheel. (DOK 2)
 - d. Check toe-out-on-turns (turning radius); determine necessary action. (DOK 2)

- e. Check SAI (steering axis inclination) and included angle; determine necessary action. (DOK 2)
 - f. Check rear-wheel thrust angle; determine necessary action. (DOK 2)
 - g. Check for front-wheel setback; determine necessary action. (DOK 2)
 - h. Check front and/or rear cradle (subframe) alignment; determine necessary action. (DOK 2)
 - i. Inspect tire condition; identify tire wear patterns; check and adjust air pressure; determine necessary action. (DOK 2)
 - j. Diagnose wheel/tire vibration, shimmy, and noise; determine necessary action. (DOK 2)
 - k. Rotate tires according to manufacturer's recommendations. (DOK 2)
 - l. Measure wheel, tire, axle flange, and hub runout; determine necessary action. (DOK 2)
 - m. Diagnose tire pull problems; determine necessary action. (DOK 2)
 - n. Dismount, inspect, and remount tire on wheel; Balance wheel and tire assembly (static and dynamic). (DOK 2)
 - o. Reinstall wheel; torque lug nuts. (DOK 2)
 - p. Inspect tire and wheel assembly for air loss; perform necessary action. (DOK 2)
 - q. Repair tire using internal patch. (DOK 2)
5. Research alternative fuels concepts and components. (DOK 2)^{AST, PRA4}
- a. Research alternative fuel concepts and components as they relate to the automotive industry. (DOK 2)
Identify and discuss alternative fuel concepts and components currently being used on today's automobiles. (DOK 2)

Automotive Service Technician Competency Profile

Program CIP: 47.0604

Unit 1: Fundamentals I, Brakes and Introduction to Electrical/Electronic Systems

- _____ 1. Describe local program and vocational/career technical center policies and procedures. (DOK 1)
- _____ 2. Describe employment opportunities and responsibilities. (DOK 1)
- _____ 3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA. (DOK 2)
- _____ 4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. (DOK 2)
- _____ 5. Discuss the history of the automotive industry to include materials, terminology, and techniques. (DOK 1)
- _____ 6. Identify and describe general safety rules, components of an automobile, tools / equipment, measurement practices, and fasteners for working in a shop/lab and industry. (DOK 1)
- _____ 7. Identify and apply concepts regarding safety procedures and practices in and around automotive operations. (DOK 2)
- _____ 8. Explore general brake systems and theories of operation. (DOK 3)
- _____ 9. Apply concepts of hydraulic brake systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
- _____ 10. Apply concepts of disc brake systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
- _____ 11. Apply concepts of drum brake systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- _____ 12. Apply concepts of power assist unit systems by performing inspection, diagnosis, and repair, if needed.(DOK 3)
- _____ 13. Apply concepts of miscellaneous systems by performing inspection, diagnosis, and repair, if needed. (DOK 2)
- _____ 14. Apply concepts of antilock brake, traction control systems, and vehicle stability control systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)

Unit 2: Basic Electrical/Electronic Systems

- _____ 1. Explore general electrical/electronic systems and theories of operation. (DOK 3)
- _____ 2. Apply concepts of battery systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- _____ 3. Apply concepts of starting systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)
- _____ 4. Apply concepts of charging systems by performing inspection, diagnosis, and repair, if needed. (DOK 3)

Unit 3: Advanced Electrical/Electronic Systems

- _____ 1. Explore lighting systems and theories of operation. (DOK 3)
_____ Apply concepts of gauges, warning devices, and driver information systems
- _____ 2. by performing inspection, diagnosis, and repair, if needed. ((DOK 3))
_____ Apply concepts of horn and wiper/washer systems by performing inspection,
- _____ 3. diagnosis, and repair, if needed. (DOK 3)
- _____ 4. Apply concepts of accessories by performing inspection, diagnosis, and
_____ repair, if needed. (DOK 3)

Unit 4: Engine Performance I

- _____ 1. Identify and describe the major systems and components of an automobile.
_____ (DOK 2)
- _____ 2. Inspect and perform general maintenance (lubrication, oils, and fluids).
_____ (DOK 2)
- _____ 3. Perform cooling system maintenance. (DOK 3)
- _____ 4. Perform tire and wheel diagnosis and repair. (DOK 2)
- _____ 5. Explore general engine components and theories of operation. (DOK 2)
_____ Apply concepts of computerized engine controls by performing inspection,
- _____ 6. diagnosis, and repair, if needed. (DOK 3)
- _____ 7. Apply concepts of ignition systems by performing inspection, diagnosis, and
_____ repair, if needed. (DOK 3)

Unit 5: Engine Performance II

- _____ 1. Apply concepts of fuel, air induction, and exhaust systems by performing
_____ inspection, diagnosis, and repair, if needed (DOK 2)
- _____ 2. Apply concepts of emissions control systems by performing inspection,
_____ diagnosis, and repair, if needed. (DOK 3)
- _____ 3. Apply concepts of engine service by performing inspection, diagnosis, and
_____ repair, if needed (DOK 3)

Unit 6: Suspension/Steering Systems and Alternative Fuels

- _____ 1. Explore general suspension and steering systems and theories of operation.
_____ (DOK 3)
- _____ 2. Apply concepts of steering systems by performing inspection, diagnosis, and
_____ repair, if needed. (DOK 2)
- _____ 3. Apply concepts of front, rear, and related suspension systems by performing
_____ inspection, diagnosis, and repair, if needed. (DOK 3)
- _____ 4. Apply concepts of wheel/tire alignment by performing inspection, diagnosis,
_____ and repair, if needed. (DOK 2)
- _____ 5. Research alternative fuels concepts and components. (DOK 2)

Appendix A: 21st Century Skills Standards

CSS1-21st Century Themes

CS1 Global Awareness

- 28. Using 21st century skills to understand and address global issues
- 29. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
- 30. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

- 28. Knowing how to make appropriate personal economic choices
- 29. Understanding the role of the economy in society
- 30. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

- 28. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
- 29. Exercising the rights and obligations of citizenship at local, state, national, and global levels
- 30. Understanding the local and global implications of civic decisions

CS4 Health Literacy

- 46. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
- 47. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
- 48. Using available information to make appropriate health-related decisions
- 49. Establishing and monitoring personal and family health goals
- 50. Understanding national and international public health and safety issues

CS5 Environmental Literacy

- 37. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems
- 38. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
- 39. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
- 40. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

- 28. Think Creatively
- 29. Work Creatively with Others

- 30. Implement Innovations
- CS7 Critical Thinking and Problem Solving**
 - 37. Reason Effectively
 - 38. Use Systems Thinking
 - 39. Make Judgments and Decisions
 - 40. Solve Problems
- CS8 Communication and Collaboration**
 - 19. Communicate Clearly
 - 20. Collaborate with Others

CSS3-Information, Media and Technology Skills

- CS9 Information Literacy**
 - 19. Access and Evaluate Information
 - 20. Use and Manage Information
- CS10 Media Literacy**
 - 19. Analyze Media
 - 20. Create Media Products
- CS11 ICT Literacy**
 - 10. Apply Technology Effectively

CSS4-Life and Career Skills

- CS12 Flexibility and Adaptability**
 - 19. Adapt to change
 - 20. Be Flexible
- CS13 Initiative and Self-Direction**
 - 28. Manage Goals and Time
 - 29. Work Independently
 - 30. Be Self-directed Learners
- CS14 Social and Cross-Cultural Skills**
 - 19. Interact Effectively with others
 - 20. Work Effectively in Diverse Teams
- CS15 Productivity and Accountability**
 - 19. Manage Projects
 - 20. Produce Results
- CS16 Leadership and Responsibility**
 - 19. Guide and Lead Others
 - 20. Be Responsible to Others

Appendix B: MS Academic Standards

MISSISSIPPI SCIENCE FRAMEWORK COMPETENCIES

Marine and Aquatic Science

- AQ 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- AQ 2 Develop an understanding of physical and chemical properties of water and aquatic environments.
- AQ 3 Apply an understanding of the diverse organisms found in aquatic environments.
- AQ 4 Draw conclusions about the relationships between human activity and aquatic organisms.

10. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- a. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- b. Formulate questions that can be answered through research and experimental design. (DOK 3)
- c. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- d. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- e. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- f. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- g. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of physical and chemical properties of water and aquatic environments.

- lll. Analyze the physical and chemical properties of water, and justify why it is essential to living organisms. (DOK 1)
- mmm. Explain the causes and characteristics of tides. (DOK 1)
- nnn. Research, create diagrams, and summarize principles related to waves and current characteristics and formation. (DOK 2)

- ooo. Compare and contrast the physical and chemical parameters of dissolved O₂, pH, temperature, salinity, and results obtained through analysis of different water column depths/zones. (DOK 2)
- ppp. Investigate the causes and effects of erosion and discuss conclusions. (DOK 2)
- qqq. Describe and differentiate among the major geologic features of specific aquatic environments. (DOK 1)
- Plate tectonics
 - Rise, slope, elevation, and depth
 - Formation of dunes, reefs, barrier/volcanic islands, and coastal/flood plains
 - Watershed formation as it relates to bodies of freshwater
- rrr. Compare and contrast the unique abiotic and biotic characteristics of selected aquatic ecosystems. (DOK 2)
- Barrier island, coral reef, tidal pool, and ocean
 - River, stream, lake, pond, and swamp
 - Bay, sound, estuary, and marsh
- 3. Apply an understanding of the diverse organisms found in aquatic environments.**
- ccc. Analyze and explain the diversity and interactions among aquatic life. (DOK 3)
- Adaptations of representative organisms for their aquatic environments
 - Relationship of organisms in food chains/webs within aquatic environments
- ddd. Research, calculate, and interpret population data. (DOK 2)
- eee. Research and compare reproductive processes in aquatic organisms. (DOK 2)
- fff. Differentiate among characteristics of planktonic, nektonic, and benthic organisms. (DOK 1)
- ggg. Explore the taxonomy of aquatic organisms, and use dichotomous keys to differentiate among the organisms. (DOK 2)
- hhh. Research and explain the symbiotic relationships in aquatic ecosystems. (DOK 3)
- 4. Draw conclusions about the relationships between human activity and aquatic organisms.**
- dddd. Describe the impact of natural and human activity on aquatic ecosystems, and evaluate the effectiveness of various solutions to environmental problems. (DOK 3)
- Sources of pollution in aquatic environments and methods to reduce the effects of the pollution
 - Effectiveness of a variety of methods of environmental management and stewardship
 - Effects of urbanization on aquatic ecosystems and the effects of continued expansion
- eeee. Research and cite evidence of the effects of natural phenomena such as hurricanes, floods, or drought on aquatic habitats and organisms. (DOK 3)
- ffff. Discuss the advantages and disadvantages involved in applications of modern technology in aquatic science. (DOK 2)
- Careers related to aquatic science
 - Modern technology within aquatic science (e.g., mariculture and aquaculture)
 - Contributions of aquatic technology to industry and government

Biology I

- BIOI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOI 2 Describe the biochemical basis of life, and explain how energy flows within and between the living systems.
- BIOI 3 Investigate and evaluate the interaction between living organisms and their environment.
- BIOI 4 Analyze and explain the structures and function of the levels of biological organization.
- BIOI 5 Demonstrate an understanding of the molecular basis of heredity.
- BIOI 6 Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- j. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- gggg. Formulate questions that can be answered through research and experimental design. (DOK 3)
- hhhh. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 2)
- iiii. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- jjjj. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- kkkk. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- llll. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Describe the biochemical basis of life, and explain how energy flows within and between the living systems.

- lll. Explain and compare with the use of examples the types of bond formation (e.g., covalent, ionic, hydrogen, etc.) between or among atoms. (DOK 2)
- Subatomic particles and arrangement in atoms
 - Importance of ions in biological processes
- mmm. Develop a logical argument defending water as an essential component of living systems (e.g., unique bonding and properties including polarity, high specific heat, surface tension, hydrogen bonding, adhesion, cohesion, and expansion upon freezing). (DOK 2)
- nnn. Classify solutions as acidic, basic, or neutral, and relate the significance of the pH scale to an organism's survival (e.g., consequences of having different concentrations of hydrogen and hydroxide ions). (DOK 2)
- ooo. Compare and contrast the structure, properties, and principle functions of carbohydrates, lipids, proteins, and nucleic acids in living organisms. (DOK 2)
- Basic chemical composition of each group
 - Building components of each group (e.g., amino acids, monosaccharides, nucleotides, etc.)
 - Basic functions (e.g., energy, storage, cellular, heredity) of each group
- ppp. Examine the life processes to conclude the role enzymes play in regulating biochemical reactions. (DOK 2)
- Enzyme structure
 - Enzyme function, including enzyme-substrate specificity and factors that affect enzyme function (pH and temperature)
- qqq. Describe the role of adenosine triphosphate (ATP) in making energy available to cells. (DOK 1)
- ATP structure
 - ATP function
- rrr. Analyze and explain the biochemical process of photosynthesis and cellular respiration, and draw conclusions about the roles of the reactant and products in each. (DOK 3)
- Photosynthesis and respiration (reactants and products)
 - Light-dependent reactions and light independent reactions in photosynthesis, including requirements and products of each
 - Aerobic and anaerobic processes in cellular respiration, including products each and energy differences

3. Investigate and evaluate the interaction between living organisms and their environment.

- bb. Compare and contrast the characteristics of the world's major biomes (e.g., deserts, tundra, taiga, grassland, temperate forest, tropical rainforest). (DOK 2)
- Plant and animal species
 - Climate (temperature and rainfall)
 - Adaptations of organisms

- cc. Provide examples to justify the interdependence among environmental elements. (DOK 2)
- Biotic and abiotic factors in an ecosystem (e.g., water, carbon, oxygen, mold, leaves)
 - Energy flow in ecosystems (e.g., energy pyramids and photosynthetic organisms to herbivores, carnivores, and decomposers)
 - Roles of beneficial bacteria
 - Interrelationships of organisms (e.g., cooperation, predation, parasitism, commensalism, symbiosis, and mutualism)
- dd. Examine and evaluate the significance of natural events and human activities on major ecosystems (e.g., succession, population growth, technology, loss of genetic diversity, consumption of resources). (DOK 2)
- 4. Analyze and explain the structures and function of the levels of biological organization.**
- kk. Differentiate among plant and animal cells and eukaryotic and prokaryotic cells. (DOK 2)
- Functions of all major cell organelles and structures (e.g., nucleus, mitochondrion, rough ER, smooth ER, ribosomes, Golgi bodies, vesicles, lysosomes, vacuoles, microtubules, microfilaments, chloroplast, cytoskeleton, centrioles, nucleolus, chromosomes, nuclear membrane, cell wall, cell membrane [active and passive transport], cytosol)
 - Components of mobility (e.g., cilia, flagella, pseudopodia)
- ll. Differentiate between types of cellular reproduction. (DOK 1)
- Main events in the cell cycle and cell mitosis (including differences in plant and animal cell divisions)
 - Binary fission (e.g., budding, vegetative propagation, etc.)
 - Significance of meiosis in sexual reproduction
 - Significance of crossing over
- mm. Describe and differentiate among the organizational levels of organisms (e.g., cells, tissues, organs, systems, types of tissues.) (DOK 1)
- nn. Explain and describe how plant structures (vascular and nonvascular) and cellular functions are related to the survival of plants (e.g., movement of materials, plant reproduction). (DOK 1)
- 5. Demonstrate an understanding of the molecular basis of heredity.**
- kk. Analyze and explain the molecular basis of heredity and the inheritance of traits to successive generations by using the Central Dogma of Molecular Biology. (DOK 3)
- Structures of DNA and RNA
 - Processes of replication, transcription, and translation
 - Messenger RNA codon charts
- ll. Utilize Mendel's laws to evaluate the results of monohybrid Punnett squares involving complete dominance, incomplete dominance, codominance, sex linked, and multiple alleles (including outcome percentage of both genotypes and phenotypes). (DOK 2)

- mm. Examine inheritance patterns using current technology (e.g., pedigrees, karyotypes, gel electrophoresis). (DOK 2)
- nn. Discuss the characteristics and implications of both chromosomal and gene mutations. (DOK 2)
 - Significance of nondisjunction, deletion, substitutions, translocation, frame shift mutation in animals
 - Occurrence and significance of genetic disorders such as sickle cell anemia, Tay-Sachs disorder, cystic fibrosis, hemophilia, Down syndrome, color blindness

6. Demonstrate an understanding of principles that explain the diversity of life and biological evolution.

- tt. Draw conclusions about how organisms are classified into a hierarchy of groups and subgroups based on similarities that reflect their evolutionary relationships. (DOK 2)
 - Characteristics of the six kingdoms
 - Major levels in the hierarchy of taxa (e.g., kingdom, phylum/division, class, order, family, genus, and species)
 - Body plans (symmetry)
 - Methods of sexual reproduction (e.g., conjugation, fertilization, pollination)
 - Methods of asexual reproduction (e.g., budding, binary fission, regeneration, spore formation)
- uu. Critique data (e.g., comparative anatomy, Biogeography, molecular biology, fossil record, etc.) used by scientists (e.g., Redi, Needham, Spallanzani, Pasteur) to develop an understanding of evolutionary processes and patterns. (DOK 3)
- vv. Research and summarize the contributions of scientists (including Darwin, Malthus, Wallace, Lamarck, and Lyell) whose work led to the development of the theory of evolution. (DOK 2)
- ww. Analyze and explain the roles of natural selection, including the mechanisms of speciation (e.g., mutations, adaptations, geographic isolation) and applications of speciation (e.g., pesticide and antibiotic resistance). (DOK 3)
- xx. Differentiate among chemical evolution, organic evolution, and the evolutionary steps along the way to aerobic heterotrophs and photosynthetic autotrophs. (DOK 2)

Biology II

- BIOII 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BIOII 2 Describe and contrast the structures, functions, and chemical processes of the cell.
- BIOII 3 Investigate and discuss the molecular basis of heredity.
- BIOII 4 Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.
- BIOII 5 Develop an understanding of organism classification.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Use current technologies such as CD-ROM, DVD, Internet, and on-line data search to explore current research related to a specific topic. (DOK 3)
- mmm. Clarify research questions and design laboratory investigations. (DOK 3)
- nnn. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- ppp. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- qqq. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- rrr. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Describe and contrast the structures, functions, and chemical processes of the cell.**
- kk. Relate the structure and function of a selectively permeable membrane to its role in diffusion and osmosis. (DOK 2)
- ll. Summarize how cell regulation controls and coordinates cell growth and division. (DOK 2)
- mm. Analyze and describe the function of enzymes in biochemical reactions. (DOK 2)
- The impact of enzymatic reactions on biochemical processes
 - Factors that affect enzyme function (e.g., pH, concentration, temperature, etc.)
- nn. Differentiate between photosynthesis and cellular respiration. (DOK 2)
- Cellular sites and major pathways of anaerobic and aerobic respiration (with reactants, products, and ATP per monosaccharide)
 - Cellular respiration with respect to the sites at which they take place, the reactions involved, and the energy input and output in each stage (e.g., glycolysis, Krebs cycle, electron transport chain)
 - Pigments, absorption, reflection of light, and light-dependent and light-independent reactions of photosynthesis
 - Oxidation and reduction reactions
- 3. Investigate and discuss the molecular basis of heredity.**
- tt. Explain how the process of meiosis clarifies the mechanism underlying Mendel's conclusions about segregation and independent assortment on a molecular level. (DOK 1)
- uu. Research and explain how major discoveries led to the determination of DNA structure. (DOK 2)
- vv. Relate gene expression (e.g., replication, transcription, translation) to protein structure and function. (DOK 2)
- Translation of a messenger RNA strand into a protein
 - Processing by organelles so that the protein is appropriately packaged, labeled, and eventually exported by the cell

- Messenger RNA codon charts to determine the effects of different types of mutations on amino acid sequence and protein structure (e.g., sickle cell anemia resulting from base substitution mutation)
 - Gene expression regulated in organisms so that specific proteins are synthesized only when they are needed by the cell (e.g., allowing cell specialization)
- ww. Assess the potential implications of DNA technology with respect to its impact on society. (DOK 3)
- Modern DNA technologies (e.g., polymerase chain reaction (PCR), gene splicing, gel electrophoresis, transformation, recombinant DNA) in agriculture, medicine, and forensics
- xx. Develop a logical argument defending or refuting bioethical issues arising from applications of genetic technology (e.g., the human genome project, cloning, gene therapy, stem cell research). (DOK 3)
- 4. Demonstrate an understanding of the factors that contribute to evolutionary theory and natural selection.**
- dddd. Explain the history of life on earth, and infer how geological changes provide opportunities and constraints for biological evolution. (DOK 2)
- Main periods of the geologic timetable of earth's history
 - Roles of catastrophic and gradualistic processes in shaping planet Earth
- eeee. Provide support for the argument based upon evidence from anatomy, embryology, biochemistry, and paleontology that organisms descended with modification from common ancestry. (DOK 2)
- ffff. Identify and provide supporting evidence for the evolutionary relationships among various organisms using phylogenetic trees and cladograms. (DOK 2)
- gggg. Formulate a scientific explanation based on fossil records of ancient life-forms, and describe how new species could originate as a result of geological isolation and reproductive isolation. (DOK 2)
- hhhh. Compare and contrast the basic types of selection (e.g., disruptive, stabilizing, directional, etc.). (DOK 2)
- iiii. Cite examples to justify behaviors that have evolved through natural selection (e.g., migration, parental care, use of tools, etc.). (DOK 1)
- jjjj. Research and explain the contributions of 19th century scientists (e.g., Malthus, Wallace, Lyell, and Darwin) on the formulation of ideas about evolution. (DOK 2)
- kkkk. Develop a logical argument describing ways in which the influences of 20th century science have impacted the development of ideas about evolution (e.g., synthetic theory of evolution, molecular biology). (DOK 3)
- llll. Analyze changes in an ecosystem resulting from natural causes (succession), changes in climate, human activity (pollution and recycling), or introduction of nonnative species. (DOK 2)
- 5. Develop an understanding of organism classification.**
- s. Classify organisms according to traditional Linnaean classification characteristics (e.g., cell structure, biochemistry, anatomy, fossil record, methods of reproduction) and the cladistic approach. (DOK 2)
- t. Categorize organisms according to the characteristics that distinguish them as Bacteria, Archaea, or Eucarya. (DOK 1)

- Bacteria, fungi, and protists
- Characteristics of invertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to phyla (e.g., Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, and Arthropoda) and classes (e.g., Insecta, Crustacea, Arachnida, Mollusca, Echinodermata)
- Characteristics of vertebrates (e.g., habitat, reproduction, body plan, locomotion) as related to classes (e.g., Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia)
- Nomenclature of various types of plants (e.g., Bryophyta, Tracheophyta, Gymnospermae, Angiospermae, Monocotyledonae, Dicotyledonae, vascular plants, nonvascular plants)

Botany

- BO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- BO 2 Distinguish among the characteristics of botanical organization, structure, and function.
- BO 3 Demonstrate an understanding of plant reproduction.
- BO 4 Draw conclusions about the factors that affect the adaptation and survival of plants.
- BO 5 Relate an understanding of plant genetics to its uses in modern living.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- mmm. Formulate questions that can be answered through research and experimental design. (DOK 3)
- nnn. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- ppp. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- qqq. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- rrr. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Distinguish among the characteristics of botanical organization, structure, and function.

- tt. Relate plant cell structures to their functions (e.g., major organelles, cell wall components, photosynthetic chemical reactions, plant pigments, plant tissues, roots, stems, leaves, flowers). (DOK 1)
- uu. Differentiate the characteristics found in various plant divisions. (DOK 2)
 - Differences and similarities of nonvascular plants
 - Characteristics of seed-bearing and non-seed bearing vascular plants relative to taxonomy
 - Major vegetative structures and their modifications in angiosperms and gymnosperms
- vv. Compare and contrast leaf modifications of gymnosperms and angiosperms (e.g., needles, overlapping scales, simple leaves, compound leaves, evergreen trees, and deciduous trees). (DOK 2)
- ww. Apply the modern classification scheme utilized in naming plants to identify plant specimens. (DOK 2)
 - Classification scheme used in botany
 - Classification of native Mississippi plants
- xx. Use inquiry to investigate and discuss the physical and chemical processes of plants. (DOK 3)
 - Relationships among photosynthesis, cellular respiration, and translocation
 - Importance of soil type and soil profiles to plant survival
 - Mechanism of water movement in plants
 - Effects of environmental conditions for plant survival
 - Tropic responses of a plant organ to a given stimulus

3. Demonstrate an understanding of plant reproduction.

- ccc. Compare and contrast reproductive structures (e.g., cones, flowers). (DOK 2)
- ddd. Differentiate among the vegetative organs of monocots, herbaceous dicots, and woody dicots. (DOK 1)
- eee. Differentiate between the structures and processes of sexual and asexual reproduction in plants. (DOK 1)
 - Reproductive structures, their modifications, and the mechanisms involved in plant reproduction
 - Functions of flower parts, seeds, cones
 - Spore production in bryophytes and ferns
- fff. Explain and provide examples of the concept of alternation of generations and its examples. (DOK 2)
- ggg. Categorize types of fruits and methods of seed distribution in plants. (DOK 1)
- hhh. Research and compare various methods of plant propagation. (DOK 2)

4. Draw conclusions about the factors that affect the adaptation and survival of plants.

- kk. List and assess several adaptations of plants to survive in a given biome. (DOK 2)
- ll. Design and conduct an experiment to determine the effects of environmental factors on photosynthesis. (DOK 3)

- mm. Explain how natural selection and the evolutionary consequences (e.g., adaptation or extinction) support scientific explanations for similarities of ancient life-forms in the fossil record and molecular similarities present in living organisms. (DOK 2)
- nn. Research factors that might influence or alter plant stability, and propose actions that may reduce the negative impacts of human activity. (DOK 2)

5. Relate an understanding of plant genetics to its uses in modern living.

- kk. Research, prepare, and present a position relating to issues surrounding the current botanical trends involving biotechnology. (DOK 3)
- ll. Apply an understanding of the principles of plant genetics to analyze monohybrid and dihybrid crosses, and predict the potential effects the crosses might have on agronomy and agriculture. (DOK 3)
- mm. Discuss the effects of genetic engineering of plants on society. (DOK 2)
- nn. Describe the chemical compounds extracted from plants, their economical importance, and the impact on humans. (DOK 3)
 - Plant extracts, their function, and origin
 - Impact of the timber industry on local and national economy

Chemistry I

- CHI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- CHI 2 Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.
- CHI 3 Develop an understanding of the periodic table.
- CHI 4. Analyze the relationship between microscopic and macroscopic models of matter.
- CHI 5 Compare factors associated with acid/base and oxidation/reduction reactions.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- mmm. Clarify research questions and design laboratory investigations. (DOK 3)
- nnn. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- ppp. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- qqq. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- rrr. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Demonstrate an understanding of the atomic model of matter by explaining atomic structure and chemical bonding.

lll. Describe and classify matter based on physical and chemical properties and interactions between molecules or atoms. (DOK 1)

- Physical properties (e.g., melting points, densities, boiling points) of a variety of substances
- Substances and mixtures
- Three states of matter in terms of internal energy, molecular motion, and the phase transitions between them

mmm. Research and explain crucial contributions and critical experiments of Dalton, Thomson, Rutherford, Bohr, de Broglie, and Schrödinger, and describe how each discovery contributed to the current model of atomic and nuclear structure. (DOK 2)

nnn. Develop a model of atomic and nuclear structure based on theory and knowledge of fundamental particles. (DOK 2)

- Properties and interactions of the three fundamental particles of the atom
- Laws of conservation of mass, constant composition, definite proportions, and multiple proportions

ooo. Write appropriate equations for nuclear decay reactions, describe how the nucleus changes during these reactions, and compare the resulting radiation with regard to penetrating ability. (DOK 1)

- Three major types of radioactive decay (e.g., alpha, beta, gamma) and the properties of the emissions (e.g., composition, mass, charge, penetrating power)
- The concept of half-life for a radioactive isotope (e.g., carbon-14 dating) based on the principle that the decay of any individual atom is a random process

ppp. Compare the properties of compounds according to their type of bonding. (DOK 1)

- Covalent, ionic, and metallic bonding
- Polar and nonpolar covalent bonding
- Valence electrons and bonding atoms

qqq. Compare different types of intermolecular forces, and explain the relationship between intermolecular forces, boiling points, and vapor pressure when comparing differences in properties of pure substances. (DOK 1)

rrr. Develop a three-dimensional model of molecular structure. (DOK 2)

- Lewis dot structures for simple molecules and ionic compounds
- Valence shell electron pair repulsion theory (VSEPR)

3. Develop an understanding of the periodic table.

kk. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)

ll. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)

- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements

- Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- mm. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- nn. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
4. **Analyze the relationship between microscopic and macroscopic models of matter.**
- kk. Calculate the number of protons, neutrons, and electrons in individual isotopes using atomic numbers and mass numbers, write electron configurations of elements and ions following the Aufbau principle, and balance equations representing nuclear reactions. (DOK 1)
- ll. Analyze patterns and trends in the organization of elements in the periodic table, and compare their relationship to position in the periodic table. (DOK 2)
- Atomic number, atomic mass, mass number, and number of protons, electrons, and neutrons in isotopes of elements
 - Average atomic mass calculations
 - Chemical characteristics of each region
 - Periodic properties (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius)
- mm. Classify chemical reactions by type. (DOK 2)
- Single displacement, double displacement, synthesis (combination), decomposition, disproportionation, combustion, or precipitation
 - Products (given reactants) or reactants (given products) for each reaction type
 - Solubility rules for precipitation reactions and the activity series for single and double displacement reactions
- nn. Use stoichiometry to calculate the amount of reactants consumed and products formed. (DOK 3)
- Difference between chemical reactions and chemical equations
 - Formulas and calculations of the molecular (molar) masses
 - Empirical formula given the percent composition of elements
 - Molecular formula given the empirical formula and molar mass
5. **Compare factors associated with acid/base and oxidation/reduction reactions.**

- bb. Analyze and explain acid/base reactions. (DOK 2)
 - Properties of acids and bases, including how they affect indicators and the relative pH of the solution
 - Formation of acidic and basic solutions
 - Definition of pH in terms of the hydronium ion concentration and the hydroxide ion concentration
 - The pH or pOH from the hydrogen ion or hydroxide ion concentrations of solution
 - How a buffer works and examples of buffer solutions
- cc. Classify species in aqueous solutions according to the Arrhenius and Bronsted-Lowry definitions respectively, and predict products for aqueous neutralization reactions. (DOK 2)
- dd. Analyze a reduction/oxidation reaction (REDOX) to assign oxidation numbers (states) to reaction species, and identify the species oxidized and reduced, the oxidizing agent, and reducing agent. (DOK 2)

Organic Chemistry

- ORGC 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ORGC 2 Demonstrate an understanding of the properties, structure, and function of organic compounds.
- ORGC 3 Discuss the versatility of polymers and the diverse application of organic chemicals.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- mmm. Formulate questions that can be answered through research and experimental design. (DOK 3)
- nnn. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- ppp. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- qqq. Recognize and analyze alternative explanations for experimental results, and make predictions based on observations and prior knowledge. (DOK 3)

rrr. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Demonstrate an understanding of the properties, structure, and function of organic compounds.

ccc. Apply International Union of Pure and Applied Chemistry (IUPAC) nomenclature, and differentiate the structure of aliphatic, aromatic, and cyclic hydrocarbon compounds. (DOK 1)

- Structures of hydrocarbon compounds
- Isomerism in hydrocarbon compounds

ddd. Relate structure to physical and chemical properties of hydrocarbon. (DOK 1)

eee. Apply principles of geometry and hybridization to organic molecules. (DOK 2)

- Lewis structures for organic molecules
- Bond angles
- Hybridization (as it applies to organic molecules)

fff. Write, complete, and classify common reactions for aliphatic, aromatic, and cyclic hydrocarbons. (DOK 1)

ggg. Construct, solve, and explain equations representing combustion reactions, substitution reactions, dehydrogenation reactions, and addition reactions. (DOK 2)

hhh. Classify functional groups (e.g., alcohols, ethers, aldehydes, ketones, carboxylic acids, esters, amines, amides, and nitriles) by their structure and properties. (DOK 2)

- Structural formulas from functional group names and vice versa
- Chemical and physical properties of compounds containing functional groups
- Equations representing the transformation of one functional group into another

3. Discuss the versatility of polymers and the diverse application of organic chemicals.

bb. Describe and classify the synthesis, properties, and uses of polymers. (DOK 2)

- Common polymers
- Synthesis of polymers from monomers by addition or condensation
- Condensations of plastics according to their commercial types
- Elasticity and other polymer properties

cc. Develop a logical argument supporting the use of organic chemicals and their application in industry, drug manufacture, and biological chemistry. (DOK 1)

- Common uses of polymers and organic compounds in medicine, drugs, and personal care products
- Compounds that have the property to dye materials
- Petrochemical production
- Biologically active compounds in terms of functional group substrate interaction

dd. Research and summarize the diversity, applications, and economics of industrial chemicals (solvents, coatings, surfactants, etc.). (DOK 3)

Earth and Space Science

E1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.

E2 Develop an understanding of the history and evolution of the universe and earth.

- E3 Discuss factors that are used to explain the geological history of earth.
- E4 Demonstrate an understanding of earth systems relating to weather and climate.
- E5 Apply an understanding of ecological factors to explain relationships between earth systems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers.
- mmm. Formulate questions that can be answered through research and experimental design. (DOK 3)
- nnn. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- ppp. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- qqq. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- rrr. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of the history and evolution of the universe and earth.

- kk. Summarize the origin and evolution of the universe. (DOK 2)
- Big bang theory
 - Microwave background radiation
 - The Hubble constant
 - Evidence of the existence of dark matter and dark energy in the universe and the history of the universe
- ll. Differentiate methods used to measure space distances, including astronomical unit, light-year, stellar parallax, Cepheid variables, and the red shift. (DOK 1)
- mm. Interpret how gravitational attraction played a role in the formation of the planetary bodies and how the fusion of hydrogen and other processes in “ordinary” stars and supernovae lead to the formation of all other elements. (DOK 2)
- nn. Summarize the early evolution of the earth, including the formation of Earth’s solid layers (e.g., core, mantle, and crust), the distribution of major elements, the origin of internal heat sources, and the initiation of plate tectonics. (DOK 2)
- How the decay of radioactive isotopes is used to determine the age of rocks, earth, and the solar system
 - How Earth acquired its initial oceans and atmosphere

3. Discuss factors which are used to explain the geological history of earth.

- uuu. Develop an understanding of how plate tectonics create certain geological features, materials, and hazards. (DOK 1)
- Plate tectonic boundaries (e.g., divergent, convergent, and transform)
 - Modern and ancient geological features to each kind of plate tectonic boundary
 - Production of particular groups of igneous and metamorphic rocks and mineral resources
 - Sedimentary basins created and destroyed through time
- vvv. Compare and contrast types of mineral deposits/groups (e.g., oxides, carbonates, halides, sulfides, sulfates, silicates, phosphates). (DOK 2)
- www. Categorize minerals and rocks by determining their physical and/or chemical characteristics. (DOK 2)
- xxx. Justify the causes of certain geological hazards (e.g., earthquakes, volcanoes, tsunamis) to their effects on specific plate tectonic locations. (DOK 2)
- yyy. Interpret and explain how rock relationships and fossils are used to reconstruct the geologic history of the earth. (DOK 2)
- zzz. Apply principles of relative age (e.g., superposition, original horizontality, crosscutting relations, and original lateral continuity) to support an opinion related to earth's geological history. (DOK 3)
- Types of unconformity (e.g., disconformity, angular unconformity, nonconformity)
 - Geological timetable
- aaaa. Apply the principle of uniformitarianism to relate sedimentary rock associations and their fossils to the environments in which the rocks were deposited. (DOK 2)
- bbbb. Compare and contrast the relative and absolute dating methods (e.g., the principle of fossil succession, radiometric dating, and paleomagnetism) for determining the age of the earth. (DOK 1)

4. Demonstrate an understanding of earth systems relating to weather and climate.

- tt. Explain the interaction of earth systems that affect weather and climate. (DOK 1)
- Latitudinal variations in solar heating
 - The effects of Coriolis forces on ocean currents, cyclones, anticyclones, ocean currents, topography, and air masses (e.g., warm fronts, cold fronts, stationary fronts, and occluded fronts).
- uu. Interpret the patterns in temperature and precipitation that produce the climate regions on earth, and relate them to the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming). (DOK 2)
- vv. Justify how changes in global climate and variation in earth/sun relationships contribute to natural and anthropogenic (human-caused) modification of atmospheric composition. (DOK 2)
- ww. Summarize how past and present actions of ice, wind, and water contributed to the types and distributions of erosional and depositional features in landscapes. (DOK 1)
- xx. Research and explain how external forces affect earth's topography. (DOK 2)
- How surface water and groundwater act as the major agents of physical and chemical weathering
 - How soil results from weathering and biological processes

- Processes and hazards associated with both sudden and gradual mass wasting
5. **Apply an understanding of ecological factors to explain relationships between earth systems.**
- kk. Draw conclusions about how life on earth shapes earth systems and responds to the interaction of earth systems (lithosphere, hydrosphere, atmosphere, and biosphere). (DOK 3)
- Nature and distribution of life on earth, including humans, to the chemistry and availability of water
 - Distribution of biomes (e.g., terrestrial, freshwater, and marine) to climate regions through time
 - Geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) that interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming and channeling of rivers)
- ll. Interpret the record of shared ancestry (fossils), evolution, and extinction as related to natural selection. (DOK 2)
- mm. Identify the cause and effect relationships of the evolutionary innovations that most profoundly shaped earth systems. (DOK 1)
- Photosynthesis and the atmosphere
 - Multicellular animals and marine environments
 - Land plants and terrestrial environments
- nn. Cite evidence about how dramatic changes in earth’s atmosphere influenced the evolution of life. (DOK 1)

Environmental Science

- ES 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ES 2 Develop an understanding of the relationship of ecological factors that affect an ecosystem.
- ES 3 Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- mmm. Formulate questions that can be answered through research and experimental design. (DOK 3)

- nnn. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- ppp. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- qqq. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- rrr. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK3)

2. Develop an understanding of the relationship of ecological factors that affect an ecosystem.

- lll. Compare ways in which the three layers of the biosphere change over time and their influence on an ecosystem's ability to support life. (DOK 2)
- mmm. Explain the flow of matter and energy in ecosystems. (DOK 2)
 - Interactions between biotic and abiotic factors
 - Indigenous plants and animals and their roles in various ecosystems
 - Biogeochemical cycles within the environment
- nnn. Predict the impact of the introduction, removal, and reintroduction of an organism on an ecosystem. (DOK 3)
- ooo. Develop a logical argument explaining the relationships and changes within an ecosystem. (DOK 2)
 - How a species adapts to its niche
 - Process of primary and secondary succession and its effects on a population
 - How changes in the environment might affect organisms
- ppp. Explain the causes and effects of changes in population dynamics (e.g., natural selection, exponential growth, predator/prey relationships) to carrying capacity and limiting factors. (DOK 2)
- qqq. Research and explain how habitat destruction leads to the loss of biodiversity. (DOK 2)
- rrr. Compare and contrast the major biomes of the world's ecosystems, including location, climate, adaptations and diversity. (DOK 1)

3. Discuss the impact of human activities on the environment, conservation activities, and efforts to maintain and restore ecosystems.

- bb. Summarize the effects of human activities on resources in the local environments. (DOK 2)
 - Sources, uses, quality, and conservation of water
 - Renewable and nonrenewable resources
 - Effects of pollution (e.g., water, noise, air, etc.) on the ecosystem
- cc. Research and evaluate the impacts of human activity and technology on the lithosphere, hydrosphere, and atmosphere, and develop a logical argument to support how communities restore ecosystems. (DOK 3)

- dd. Research and evaluate the use of renewable and nonrenewable resources, and critique efforts to conserve natural resources and reduce global warming in the United States including (but not limited) to Mississippi. (DOK 3)

Genetics

- G 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- G 2 Analyze the structure and function of the cell and cellular organelles.
- G 3 Apply the principles of heredity to demonstrate genetic understandings.

1. Use critical thinking and scientific problem solving in designing and performing biological research and experimentation. (L, P, E)

lll. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)

mmm. Clarify research questions and design laboratory investigations. (DOK 3)

nnn. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)

ooo. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for pie, bar, and line graphs) to draw conclusions and make inferences. (DOK 3)

ppp. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

qqq. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)

rrr. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)

2. Review the structure and function of the cell as it applies to genetics. (L)

lll. Cite evidence to illustrate how the structure and function of cells are involved in the maintenance of life. (DOK 2)

mmm. Describe how organic components are integral to biochemical processes. (DOK 2)

nnn. Differentiate among the processes by which plants and animals reproduce. (DOK 1)

- Cell cycle and mitosis
- Meiosis, spermatogenesis, and oogenesis

ooo. Explain the significance of the discovery of nucleic acids. (DOK 1)

ppp. Analyze and explain the structure and function of DNA and RNA in replication, transcription, translation and DNA repair. (DOK 2)

qqq. Cite examples to compare the consequences of the different types of mutations. (DOK 1)

rrr. Draw conclusions about the importance and potential impacts of the process of gene transfer used in biotechnology. (DOK 3)

3. Analyze the structure and function of DNA and RNA molecules. (L, P)

- lll. Cite evidence that supports the significance of Mendel’s concept of “particulate inheritance” to explain the understanding of heredity. (DOK 1)
- mmm. Apply classical genetics principles to solve basic genetic problems. (DOK 2)
- Genes and alleles, dominance, recessiveness, the laws of segregation, and independent assortment
 - Inheritance of autosomal and sex-linked traits
 - Inheritance of traits influenced by multiple alleles and traits with polygenetic inheritance
 - Chromosomal theory of inheritance
- nnn. Apply population genetic concepts to summarize variability of multicellular organisms. (DOK 2)
- Genetic variability
 - Hardy-Weinberg formula
 - Migration and genetic drift
 - Natural selection in humans
- ooo. Distinguish and explain the applications of various tools and techniques used in DNA manipulation. (DOK 1)
- Steps in genetic engineering experiments
 - Use of restriction enzymes
 - Role of vectors in genetic research
 - Use of transformation techniques
- ppp. Research and present a justifiable explanation the practical uses of biotechnology (e.g., chromosome mapping, karyotyping, and pedigrees). (DOK 2)
- qqq. Develop and present a scientifically-based logical argument for or against moral and ethical issues related to genetic engineering. (DOK 3)
- rrr. Research genomics (human and other organisms), and predict benefits and medical advances that may result from the use of genome projects. (DOK 2)

Geology

-
- GE1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- GE2 Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
- Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers

- mmm. Formulate questions that can be answered through research and experimental design. (DOK 3)
- nnn. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- ppp. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- qqq. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- rrr. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of plate tectonics and geochemical and ecological processes that affect earth.

- vvvv. Differentiate the components of the earth's atmosphere and lithosphere. (DOK 1)
- wwww. Research and summarize explanations of how earth acquired its initial atmosphere and oceans. (DOK 2)
- xxxx. Compare the causes and effects of internal and external components that shape earth's topography. (DOK 2)
 - Physical weathering (e.g., atmospheric, glacial, etc.)
 - Chemical weathering agents (e.g., acid precipitation, carbon dioxide, oxygen, water, etc.)
- yyyy. Develop an understanding of how plate tectonics create certain geologic features, materials, and hazards. (DOK 2)
 - Types of crustal movements and the resulting landforms (e.g., seafloor spreading, paleomagnetic measurements, and orogenesis)
 - Processes that create earthquakes and volcanoes
 - Asthenosphere
- zzzz. Summarize the theories of plate development and continental drift, and describe the causes and effects involved in each. (DOK 2)
- aaaa. Develop a logical argument to explain how geochemical and ecological processes (e.g., rock, hydrologic, carbon, nitrogen) interact through time to cycle matter and energy and how human activity alters the rates of these processes (e.g., fossil fuel formation and combustion, damming, and channeling of rivers). (DOK 2)
- bbbb. Interpret how the earth's geological time scale relates to geological history, landforms, and life-forms. (DOK 2)
- cccc. Research and describe different techniques for determining relative and absolute age of the earth (e.g., index of fossil layers, superposition, radiometric dating, etc.). (DOK 1)
- dddd. Summarize the geological activity of the New Madrid fault line, and compare and contrast it to geological activity in other parts of the world. (DOK 2)
- eeee. Identify and differentiate the major geological features in Mississippi (e.g., Delta, Coastal Areas, etc.). (DOK 1)

- ffff. Evaluate an emergency preparedness plan for natural disasters associated with crustal movement. (DOK 3)

Physical Science

- PS 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PS 2 Describe and explain how forces affect motion.
- PS 3 Demonstrate an understanding of general properties and characteristics of waves.
- PS 4 Develop an understanding of the atom.
- PS 5 Investigate and apply principles of physical and chemical changes in matter.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Use appropriate laboratory safety symbols and procedures to design and conduct a scientific investigation. (DOK 2)
- Safety symbols and safety rules in all laboratory activities
 - Proper use and care of the compound light microscope
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- mmm. Identify questions that can be answered through scientific investigations. (DOK 3)
- nnn. Identify and apply components of scientific methods in classroom investigations. (DOK 3)
- Predicting, gathering data, drawing conclusions
 - Recording outcomes and organizing data from a variety of sources (e.g., scientific articles, magazines, student experiments, etc.)
 - Critically analyzing current investigations/problems using periodicals and scientific scenarios
- ooo. Interpret and generate graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- ppp. Analyze procedures and data to draw conclusions about the validity of research. (DOK 3)
- qqq. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- rrr. Communicate effectively to present and explain scientific results, using appropriate terminology and graphics. (DOK 3)

2. Describe and explain how forces affect motion.

- tt. Demonstrate and explain the basic principles of Newton's three laws of motion including calculations of acceleration, force, and momentum. (DOK 2)
- Inertia and distance-time graphs to determine average speed
 - Net force (accounting for gravity, friction, and air resistance) and the resulting motion of objects
 - Effects of the gravitational force on objects on Earth and effects on planetary and lunar motion

- Simple harmonic motion (oscillation)
- uu. Explain the connection between force, work, and energy. (DOK 2)
- Force exerted over a distance (results in work done)
 - Force-distance graph (to determine work)
 - Network on an object that contributes to change in kinetic energy (work-to-energy theorem)
- vv. Describe (with supporting details and diagrams) how the kinetic energy of an object can be converted into potential energy (the energy of position) and how energy is transferred or transformed (conservation of energy). (DOK 2)
- ww. Draw and assess conclusions about charges and electric current. (DOK 2)
- Static/current electricity and direct current/alternating current
 - Elements in an electric circuit that are in series or parallel
 - Conductors and insulators
 - Relationship between current flowing through a resistor and voltage flowing across a resistor
- xx. Cite evidence and explain the application of electric currents and magnetic fields as they relate to their use in everyday living (e.g., the application of fields in motors and generators and the concept of electric current using Ohm's law). (DOK 2)
- 3. Demonstrate an understanding of general properties and characteristics of waves.**
- kk. Differentiate among transverse, longitudinal, and surface waves as they propagate through a medium (e.g., string, air, water, steel beam). (DOK 1)
- ll. Compare properties of waves (e.g., superposition, interference, refraction, reflection, diffraction, Doppler effect), and explain the connection among the quantities (e.g., wavelength, frequency, period, amplitude, and velocity). (DOK 2)
- mm. Classify the electromagnetic spectrum's regions according to frequency and/or wavelength, and draw conclusions about their impact on life. (DOK 2)
- The emission of light by electrons when moving from higher to lower levels
 - Energy (photons as quanta of light)
 - Additive and subtractive properties of colors
 - Relationship of visible light to the color spectrum
- nn. Explain how sound intensity is measured and its relationship to the decibel scale. (DOK 1)
- 4. Develop an understanding of the atom.**
- kk. Cite evidence to summarize the atomic theory. (DOK 1)
- Models for atoms
 - Hund's rule and Aufbau process to specify the electron configuration of elements
 - Building blocks of matter (e.g., proton, neutron, and electron) and elementary particles (e.g., positron, mesons, neutrinos, etc.)
 - Atomic orbitals (s, p, d, f) and their basic shapes
- ll. Explain the difference between chemical and physical changes, and demonstrate how these changes can be used to separate mixtures and compounds into their components. (DOK 2)
- mm. Research the history of the periodic table of the elements, and summarize the contributions that led to the atomic theory. (DOK 2)

- Contributions of scientists (e.g., John Dalton, J.J. Thomson, Ernest Rutherford, Newton, Einstein, Neils, Bohr, Louis de Broglie, Erwin Schrödinger, etc.)
 - Technology (e.g., X-rays, cathode-ray tubes, spectrosopes)
 - Experiments (e.g., gold-foil, cathode-ray, etc.)
- nn. Utilize the periodic table to predict and explain patterns and draw conclusions about the structure, properties, and organization of matter. (DOK 2)
- Atomic composition and valence electron configuration (e.g., atomic number, mass number of protons, neutrons, electrons, isotopes, and ions)
 - Periodic trends using the periodic table (e.g., valence, reactivity, atomic radius)
 - Average atomic mass from isotopic abundance
 - Solids, liquids, and gases
 - Periodic properties of elements (e.g., metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity, electron affinity, ionization energy, atomic/covalent/ionic radius) and how they relate to position in the periodic table
- 5. Investigate and apply principles of physical and chemical changes in matter.**
- bb. Write chemical formulas for compounds comprising monatomic and polyatomic ions. (DOK 1)
- cc. Balance chemical equations. (DOK 2)
- dd. Classify types of chemical reactions (e, g., composition, decomposition, single displacement, double displacement, combustion, acid/base reactions). (DOK 2)

Physics I

- PHYI 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- PHYI 2 Develop an understanding of concepts related to forces and motion.
- PHYI 3 Develop an understanding of concepts related to work and energy.
- PHYI 4 Discuss the characteristics and properties of light and sound.
- PHYI 5 Apply an understanding of magnetism, electric fields, and electricity.
- PHYI 6 Analyze and explain concepts of nuclear physics.

1. Investigate and apply principles of physical and chemical changes in matter.

- lll. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- mmm. Clarify research questions, and design laboratory investigations. (DOK 3)
- nnn. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences. (DOK 3)
- ppp. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)

- qqq. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- rrr. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBL's, etc.). (DOK 3)
- 2. Develop an understanding of concepts related to forces and motion.**
- kk. Use inquiry to investigate and develop an understanding of the kinematics and dynamics of physical bodies. (DOK 3)
- Vector and scalar quantities
 - Vector problems (solved mathematically and graphically)
 - Vector techniques and free-body diagrams to determine the net force on a body when several forces are acting on it
 - Relations among mass, inertia, and weight
- ll. Analyze, describe, and solve problems by creating and utilizing graphs of one-dimensional motion (e.g., position, distance, displacement, time, speed, velocity, acceleration, the special case of free fall). (DOK 2)
- mm. Analyze real-world applications to draw conclusions about Newton's three laws of motion. (DOK 2)
- nn. Apply the effects of the universal gravitation law to graph and interpret the force between two masses, acceleration due to gravity, and planetary motion. (DOK 2)
- Situations where g is constant (falling bodies)
 - Concept of centripetal acceleration undergoing uniform circular motion
 - Kepler's third law
 - Oscillatory motion and the mechanics of waves
- 3. Develop an understanding of concepts related to work and energy.**
- tt. Explain and apply the conservation of energy and momentum. (DOK 2)
- Concept of work and applications
 - Concept of kinetic energy, using the elementary work-energy theorem
 - Concept of conservation of energy with simple examples
 - Concepts of energy, work, and power (qualitatively and quantitatively)
 - Principles of impulse in inelastic and elastic collisions
- uu. Analyze real-world applications to draw conclusions about mechanical potential energy (the energy of configuration). (DOK 3)
- vv. Apply the principles of impulse, and compare conservation of momentum and conservation of kinetic energy in perfectly inelastic and elastic collisions. (DOK 1)
- ww. Investigate and summarize the principles of thermodynamics. (DOK 2)
- How heat energy is transferred from higher temperature to lower temperature until equilibrium is reached
 - Temperature and thermal energy as related to molecular motion and states of matter
 - Problems involving specific heat and heat capacity
 - First and second laws of thermodynamics as related to heat engines, refrigerators, and thermal efficiency
- xx. Develop the kinetic theory of ideal gases and explain the concept of Carnot efficiency. (DOK 2)
- 4. Discuss the characteristics and properties of light and sound.**

- tt. Describe and model the characteristics and properties of mechanical waves. (DOK 2)
 - Simple harmonic motion
 - Relationships among wave characteristics such as velocity, period, frequency, amplitude, phase, and wavelength
 - Energy of a wave in terms of amplitude and frequency.
 - Standing waves and waves in specific media (e.g., stretched string, water surface, air, etc.)
 - uu. Differentiate and explain the Doppler effect as it relates to a moving source and to a moving observer. (DOK 1)
 - vv. Explain the laws of reflection and refraction, and apply Snell's law to describe the relationship between the angles of incidence and refraction. (DOK 2)
 - ww. Use ray tracing and the thin lens equation to solve real-world problems involving object distance from lenses. (DOK 2)
 - xx. Investigate and draw conclusions about the characteristics and properties of electromagnetic waves. (DOK 2)
- 5. Apply an understanding of magnetism, electric fields, and electricity.**
- bb. Analyze and explain the relationship between electricity and magnetism. (DOK 2)
 - Characteristics of static charge and how a static charge is generated
 - Electric field, electric potential, current, voltage, and resistance as related to Ohm's law
 - Magnetic poles, magnetic flux and field, Ampère's law and Faraday's law
 - Coulomb's law
 - cc. Use schematic diagrams to analyze the current flow in series and parallel electric circuits, given the component resistances and the imposed electric potential. (DOK 2)
 - dd. Analyze and explain the relationship between magnetic fields and electrical current by induction, generators, and electric motors. (DOK 2)
- 6. Analyze and explain concepts of nuclear physics.**
- s. Analyze and explain the principles of nuclear physics. (DOK 1)
 - The mass number and atomic number of the nucleus of an isotope of a given chemical element
 - The conservation of mass and the conservation of charge
 - Nuclear decay
 - t. Defend the wave-particle duality model of light, using observational evidence. (DOK 3)
 - Quantum energy and emission spectra
 - Photoelectric and Compton effects

Spatial Information Science

- SP 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- SP 2 Develop an understanding of geographic information systems.

1. Demonstrate the basic concepts of global positioning systems (GPS). (E)

- lll. Use current technologies such as CD-ROM, DVD, Internet, and online data search to explore current research related to a specific topic. (DOK 3)
- mmm. Clarify research questions, and design laboratory investigations. (DOK 3)
- nnn. Demonstrate the use of scientific inquiry and methods to formulate, conduct, and evaluate laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, and theory development). (DOK 3)
- ooo. Organize data to construct graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs), draw conclusions, and make inferences). (DOK 3)
- ppp. Evaluate procedures, data, and conclusions to critique the scientific validity of research. (DOK 3)
- qqq. Formulate and revise scientific explanations and models using logic and evidence (data analysis). (DOK 3)
- rrr. Collect, analyze, and draw conclusions from data to create a formal presentation using available technology (e.g., computers, calculators, SmartBoard, CBLs, etc.). (DOK 3)

2. Demonstrate the basic concepts of remote sensing. (E, P)

- ccc. Describe the characteristics of the electromagnetic spectrum.
- ddd. Using images and graphs, interpret the absorption/reflection spectrum.
- eee. Distinguish between passive vs. active sensor systems.
- fff. Analyze the effects of changes in spatial, temporal, and spectral resolution.
- ggg. Analyze the effects on images due to changes in scale.
- hhh. Identify the types of sensor platforms.

Zoology

- ZO 1 Apply inquiry-based and problem-solving processes and skills to scientific investigations.
- ZO 2 Develop an understanding of levels of organization and animal classification.
- ZO 3 Differentiate among animal life cycles, behaviors, adaptations, and relationships.
- ZO 4 Demonstrate an understanding of the principles of animal genetic diversity and evolution.

1. Apply inquiry-based and problem-solving processes and skills to scientific investigations.

- lll. Conduct a scientific investigation demonstrating safe procedures and proper care of laboratory equipment. (DOK 2)
 - Safety rules and symbols
 - Proper use and care of the compound light microscope, slides, chemicals, etc.
 - Accuracy and precision in using graduated cylinders, balances, beakers, thermometers, and rulers
- mmm. Formulate questions that can be answered through research and experimental design. (DOK 3)

- nnn. Apply the components of scientific processes and methods in classroom and laboratory investigations (e.g., hypotheses, experimental design, observations, data analyses, interpretations, theory development). (DOK 3)
- ooo. Construct and analyze graphs (e.g., plotting points, labeling x-and y-axis, creating appropriate titles and legends for circle, bar, and line graphs). (DOK 2)
- ppp. Analyze procedures, data, and conclusions to determine the scientific validity of research. (DOK 3)
- qqq. Recognize and analyze alternative explanations for experimental results and to make predictions based on observations and prior knowledge. (DOK 3)
- rrr. Communicate and defend a scientific argument in oral, written, and graphic form. (DOK 3)

2. Develop an understanding of levels of organization and animal classification.

- kk. Explain how organisms are classified, and identify characteristics of major groups. (DOK 1)
- Levels of organization of structures in animals (e.g., cells, tissues, organs, and systems)
 - Characteristics used to classify organisms (e.g., cell structure, biochemistry, anatomy, fossil record, and methods of reproduction)
- ll. Identify and describe characteristics of the major phyla. (DOK 1)
- Symmetry and body plan
 - Germ layers and embryonic development
 - Organ systems (e.g., digestive, circulatory, excretory, and reproductive)
 - Locomotion and coordination
- mm. Distinguish viruses from bacteria and protists, and give examples. (DOK 1)
- nn. Differentiate among the characteristics of bacteria, archaea, and eucarya. (DOK 1)
- Phylogenic sequencing of the major phyla
 - Invertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following phyla: Porifera, Cnidarians, Nematoda, Annelida, Platyhelminthes, Arthropoda, Insecta, Crustacea, Arachnida, Mollusca [Bivalvia and Gastropoda], and Echinodermata)
 - Vertebrate characteristics (e.g., habitat, reproduction, body plan, locomotion) of the following classes: Agnatha, Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, and Mammalia

3. Differentiate among animal life cycles, behaviors, adaptations, and relationships.

- tt. Describe life cycles, alternation of generations, and metamorphosis of various animals, and evaluate the advantages and disadvantages of asexual and sexual reproduction. (DOK 1)
- uu. Describe and explain concepts of animal behavior, and differentiate between learned and innate behavior. (DOK 1)
- Division of labor within a group of animals
 - Communication within animals groups
 - Degree of parental care given in animal groups
- vv. Evaluate the unique protective adaptations of animals as they relate to survival. (DOK 2)

ww. Compare and contrast ecological relationships, and make predictions about the survival of populations under given circumstances. (DOK 3)

- Terrestrial and aquatic ecosystems
- Herbivores, carnivores, omnivores, decomposers and other feeding relationships
- Symbiotic relationships such as mutualism, commensalisms, and parasitism

xx. Contrast food chains and food webs. (DOK 2)

4. Demonstrate an understanding of the principles of animal genetic diversity and evolution.

s. Categorize and explain sources of genetic variation on the cellular level (e.g., mutations, crossing over, and nondisjunction) and the population level (e.g., nonrandom mating, migration, etc.). (DOK 2)

- Relationship between natural selection and evolution
- Mutations, crossing over, nondisjunction
- Nonrandom mating, migration, etc.
- Effects of genetic drift on evolution

t. Develop a logical argument defending or refuting issues related to genetic engineering of animals. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

- Identify the basic purpose or role of a specified phrase or sentence.
- Delete a clause or sentence because it is obviously irrelevant to the essay.
- Identify the central idea or main topic of a straightforward piece of writing.
- Determine relevancy when presented with a variety of sentence-level details.
- Identify the focus of a simple essay, applying that knowledge to add a sentence that sharpens that focus or to determine if an essay has met a specified goal.
- Delete material primarily because it disturbs the flow and development of the paragraph.
- Add a sentence to accomplish a fairly straightforward purpose such as illustrating a given statement.
- Apply an awareness of the focus and purpose of a fairly involved essay to determine the rhetorical effect and suitability of an existing phrase or sentence or to determine the need to delete plausible but irrelevant material.
- Add a sentence to accomplish a subtle rhetorical purpose such as to emphasize, to add supporting detail, or to express meaning through connotation.
- Determine whether a complex essay has accomplished a specific purpose.
- Add a phrase or sentence to accomplish a complex purpose, often expressed in terms of the main focus of the essay.

E2 Organization, Unity, and Coherence

- Use conjunctive adverbs or phrases to show time relationship in simple narrative essays (e.g., *then*, *this time*, etc.).
- Select the most logical place to add a sentence in a paragraph.
- Use conjunctive adverbs or phrases to express straightforward logical relationships (e.g., *first*, *afterward*, *in response*).
- Decide the most logical place to add a sentence in an essay.
- Add a sentence that introduces a simple paragraph.
- Determine the need for conjunctive adverbs or phrases to create subtle logical connections between sentences (e.g., *therefore*, *however*, *in addition*).
- Rearrange the sentences in a fairly uncomplicated paragraph for the sake of logic.
- Add a sentence to introduce or conclude the essay or to provide a transition between paragraphs when the essay is fairly straightforward.
- Make sophisticated distinctions concerning the logical use of conjunctive adverbs or phrases, particularly when signaling a shift between paragraphs.
- Rearrange sentences to improve the logic and coherence of a complex paragraph.
- Add a sentence to introduce or conclude a fairly complex paragraph.
- Consider the need for introductory sentences or transitions, basing decisions on a thorough understanding of both the logic and rhetorical effect of the paragraph and essay.

E3 Word Choice in Terms of Style, Tone, Clarity, and Economy

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.
- Revise expressions that deviate from the style of an essay.
- Delete redundant material when information is repeated in different parts of speech (e.g., *alarmingly startled*).
- Use the word or phrase most consistent with the style and tone of a fairly straightforward essay.
- Determine the clearest and most logical conjunction to link clauses.
- Revise a phrase that is redundant in terms of the meaning and logic of the entire sentence.
- Identify and correct ambiguous pronoun references.
- Use the word or phrase most appropriate in terms of the content of the sentence and tone of the essay.
- Correct redundant material that involves sophisticated vocabulary and sounds acceptable as conversational English (e.g., *an aesthetic viewpoint* versus *the outlook of an aesthetic viewpoint*).
- Correct vague and wordy or clumsy and confusing writing containing sophisticated language.
- Delete redundant material that involves subtle concepts or that is redundant in terms of the paragraph as a whole.

E4 Sentence Structure and Formation

- Use conjunctions or punctuation to join simple clauses.
- Revise shifts in verb tense between simple clauses in a sentence or between simple adjoining sentences.
- Determine the need for punctuation and conjunctions to avoid awkward sounding sentence fragments and fused sentences.
- Decide the appropriate verb tense and voice by considering the meaning of the entire sentence.
- Recognize and correct marked disturbances of sentence flow and structure (e.g., participial phrase fragments, missing or incorrect relative pronouns, dangling or misplaced modifiers).
- Revise to avoid faulty placement of phrases and faulty coordination and subordination of clauses in sentences with subtle structural problems.
- Maintain consistent verb tense and pronoun person on the basis of the preceding clause or sentence.
- Use sentence-combining techniques, effectively avoiding problematic comma splices, run-on sentences, and sentence fragments, especially in sentences containing compound subjects or verbs.
- Maintain a consistent and logical use of verb tense and pronoun person on the basis of information in the paragraph or essay as a whole.

- Work comfortably with long sentences and complex clausal relationships within sentences, avoiding weak conjunctions between independent clauses and maintaining parallel structure between clauses.

E5 Conventions of Usage

- Solve such basic grammatical problems as how to form the past and past participle of irregular but commonly used verbs and how to form comparative and superlative adjectives.
- Solve such grammatical problems as whether to use an adverb or adjective form, how to ensure straightforward subject–verb and pronoun–antecedent agreement, and which preposition to use in simple contexts.
- Recognize and use the appropriate word in frequently confused pairs such as *there* and *their*, *past* and *passed*, and *led* and *lead*.
- Use idiomatically appropriate prepositions, especially in combination with verbs (e.g., *long for*, *appeal to*).
- Ensure that a verb agrees with its subject when there is some text between the two.
- Ensure that a pronoun agrees with its antecedent when the two occur in separate clauses or sentences.
- Identify the correct past and past participle forms of irregular and infrequently used verbs, and form present–perfect verbs by using *have* rather than *of*.
- Correctly use reflexive pronouns, the possessive pronouns *its* and *your*, and the relative pronouns *who* and *whom*.
- Ensure that a verb agrees with its subject in unusual situations (e.g., when the subject–verb order is inverted or when the subject is an indefinite pronoun).
- Provide idiomatically and contextually appropriate prepositions following verbs in situations involving sophisticated language or ideas.
- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.

- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

- Perform one-operation computation with whole numbers and decimals.
- Solve problems in one or two steps using whole numbers.
- Perform common conversions (e.g., inches to feet or hours to minutes).
- Solve routine one-step arithmetic problems (using whole numbers, fractions, and decimals) such as single-step percent.
- Solve some routine two-step arithmetic problems.
- Solve routine two-step or three-step arithmetic problems involving concepts such as rate and proportion, tax added, percentage off, and computing with a given average.
- Solve multistep arithmetic problems that involve planning or converting units of measure (e.g., feet per second to miles per hour).
- Solve word problems containing several rates, proportions, or percentages.
- Solve complex arithmetic problems involving percent of increase or decrease and problems requiring integration of several concepts from pre-algebra and/or pre-geometry (e.g., comparing percentages or averages, using several ratios, and finding ratios in geometry settings).

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.
- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*

- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3Numbers: Concepts and Properties

- Recognize equivalent fractions and fractions in lowest terms.
- Recognize one-digit factors of a number.
- Identify a digit's place value.
- Exhibit knowledge of elementary number concepts including rounding, the ordering of decimals, pattern identification, absolute value, primes, and greatest common factor.
- Find and use the least common multiple.
- Order fractions.
- Work with numerical factors.
- Work with scientific notation.
- Work with squares and square roots of numbers.
- Work problems involving positive integer exponents.*
- Work with cubes and cube roots of numbers.*
- Determine when an expression is undefined.*
- Exhibit some knowledge of the complex numbers.†
- Apply number properties involving prime factorization.
- Apply number properties involving even and odd numbers and factors and multiples.
- Apply number properties involving positive and negative numbers.
- Apply rules of exponents.
- Multiply two complex numbers.†
- Draw conclusions based on number concepts, algebraic properties, and/or relationships between expressions and numbers.
- Exhibit knowledge of logarithms and geometric sequences.
- Apply properties of complex numbers.

M4Expressions, Equations, and Inequalities

- Exhibit knowledge of basic expressions (e.g., identify an expression for a total as $b + g$).
- Solve equations in the form $x + a = b$, where a and b are whole numbers or decimals.
- Substitute whole numbers for unknown quantities to evaluate expressions.
- Solve one-step equations having integer or decimal answers.
- Combine like terms (e.g., $2x + 5x$).
- Evaluate algebraic expressions by substituting integers for unknown quantities.
- Add and subtract simple algebraic expressions.
- Solve routine first-degree equations.
- Perform straightforward word-to-symbol translations.

- Multiply two binomials.*
- Solve real-world problems using first-degree equations.
- Write expressions, equations, or inequalities with a single variable for common pre-algebra settings (e.g., rate and distance problems and problems that can be solved by using proportions).
- Identify solutions to simple quadratic equations.
- Add, subtract, and multiply polynomials.*
- Factor simple quadratics (e.g., the difference of squares and perfect square trinomials).*
- Solve first-degree inequalities that do not require reversing the inequality sign.*
- Manipulate expressions and equations.
- Write expressions, equations, and inequalities for common algebra settings.
- Solve linear inequalities that require reversing the inequality sign.
- Solve absolute value equations.
- Solve quadratic equations.
- Find solutions to systems of linear equations.
- Write expressions that require planning and/or manipulating to accurately model a situation.
- Write equations and inequalities that require planning, manipulating, and/or solving.
- Solve simple absolute value inequalities.

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as $y = ax^2 + c$.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

- Exhibit some knowledge of the angles associated with parallel lines.
- Find the measure of an angle using properties of parallel lines.
- Exhibit knowledge of basic angle properties and special sums of angle measures (e.g., 90° , 180° , and 360°).
- Use several angle properties to find an unknown angle measure.
- Recognize Pythagorean triples.*
- Use properties of isosceles triangles.*
- Apply properties of 30° - 60° - 90° , 45° - 45° - 90° , similar, and congruent triangles.
- Use the Pythagorean theorem.
- Draw conclusions based on a set of conditions.
- Solve multistep geometry problems that involve integrating concepts, planning, visualization, and/or making connections with other content areas.
- Use relationships among angles, arcs, and distances in a circle.

M7 Measurement

- Estimate or calculate the length of a line segment based on other lengths given on a geometric figure.
- Compute the perimeter of polygons when all side lengths are given.
- Compute the area of rectangles when whole number dimensions are given.
- Compute the area and perimeter of triangles and rectangles in simple problems.
- Use geometric formulas when all necessary information is given.
- Compute the area of triangles and rectangles when one or more additional simple steps are required.
- Compute the area and circumference of circles after identifying necessary information.
- Compute the perimeter of simple composite geometric figures with unknown side lengths.*
- Use relationships involving area, perimeter, and volume of geometric figures to compute another measure.
- Use scale factors to determine the magnitude of a size change.
- Compute the area of composite geometric figures when planning or visualization is required.

M8 Functions

- Evaluate quadratic functions, expressed in function notation, at integer values.
- Evaluate polynomial functions, expressed in function notation, at integer values.†
- Express the sine, cosine, and tangent of an angle in a right triangle as a ratio of given side lengths.†
- Evaluate composite functions at integer values.†
- Apply basic trigonometric ratios to solve right-triangle problems.†
- Write an expression for the composite of two simple functions.†
- Use trigonometric concepts and basic identities to solve problems.†
- Exhibit knowledge of unit circle trigonometry.†

- Match graphs of basic trigonometric functions with their equations.

Notes

- Students who score in the 1–12 range are most likely beginning to develop the knowledge and skills assessed in the other ranges.
- Standards followed by an asterisk (*) apply to the PLAN and ACT Mathematics tests only.
- Standards followed by a dagger (†) apply to the ACT Mathematics test only.

Reading

R1 Main Ideas and Author's Approach

- Recognize a clear intent of an author or narrator in uncomplicated literary narratives.
- Identify a clear main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Infer the main idea or purpose of straightforward paragraphs in uncomplicated literary narratives.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in uncomplicated passages.
- Identify a clear main idea or purpose of any paragraph or paragraphs in uncomplicated passages.
- Infer the main idea or purpose of straightforward paragraphs in more challenging passages.
- Summarize basic events and ideas in more challenging passages.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in more challenging passages.
- Infer the main idea or purpose of more challenging passages or their paragraphs.
- Summarize events and ideas in virtually any passage.
- Understand the overall approach taken by an author or narrator (e.g., point of view, kinds of evidence used) in virtually any passage.
- Identify clear main ideas or purposes of complex passages or their paragraphs.

R2 Supporting Details

- Locate basic facts (e.g., names, dates, events) clearly stated in a passage.
- Locate simple details at the sentence and paragraph level in uncomplicated passages.
- Recognize a clear function of a part of an uncomplicated passage.
- Locate important details in uncomplicated passages.
- Make simple inferences about how details are used in passages.
- Locate important details in more challenging passages.
- Locate and interpret minor or subtly stated details in uncomplicated passages.
- Discern which details, though they may appear in different sections throughout a passage, support important points in more challenging passages.
- Locate and interpret minor or subtly stated details in more challenging passages.

- Use details from different sections of some complex informational passages to support a specific point or argument.
- Locate and interpret details in complex passages.
- Understand the function of a part of a passage when the function is subtle or complex.

R3 Sequential, Comparative, and Cause–Effect Relationships

- Determine when (e.g., first, last, before, after) or if an event occurred in uncomplicated passages.
- Recognize clear cause–effect relationships described within a single sentence in a passage.
- Identify relationships between main characters in uncomplicated literary narratives.
- Recognize clear cause–effect relationships within a single paragraph in uncomplicated literary narratives.
- Order simple sequences of events in uncomplicated literary narratives.
- Identify clear relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear cause–effect relationships in uncomplicated passages.
- Order sequences of events in uncomplicated passages.
- Understand relationships between people, ideas, and so forth in uncomplicated passages.
- Identify clear relationships between characters, ideas, and so forth in more challenging literary narratives.
- Understand implied or subtly stated cause–effect relationships in uncomplicated passages.
- Identify clear cause–effect relationships in more challenging passages.
- Order sequences of events in more challenging passages.
- Understand the dynamics between people, ideas, and so forth in more challenging passages.
- Understand implied or subtly stated cause–effect relationships in more challenging passages.
- Order sequences of events in complex passages.
- Understand the subtleties in relationships between people, ideas, and so forth in virtually any passage.
- Understand implied, subtle, or complex cause–effect relationships in virtually any passage.

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.

- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

- Draw simple generalizations and conclusions about the main characters in uncomplicated literary narratives.
- Draw simple generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw generalizations and conclusions about people, ideas, and so forth in uncomplicated passages.
- Draw simple generalizations and conclusions using details that support the main points of more challenging passages.
- Draw subtle generalizations and conclusions about characters, ideas, and so forth in uncomplicated literary narratives.
- Draw generalizations and conclusions about people, ideas, and so forth in more challenging passages.
- Use information from one or more sections of a more challenging passage to draw generalizations and conclusions about people, ideas, and so forth.
- Draw complex or subtle generalizations and conclusions about people, ideas, and so forth, often by synthesizing information from different portions of the passage.
- Understand and generalize about portions of a complex literary narrative.

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or non-numerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.

- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment.
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.
- Understand the methods and tools used in a complex experiment.
- Understand a complex experimental design.
- Predict the results of an additional trial or measurement in an experiment.
- Determine the experimental conditions that would produce specified results.
- Determine the hypothesis for an experiment.
- Identify an alternate method for testing a hypothesis.
- Understand precision and accuracy issues.
- Predict how modifying the design or methods of an experiment will affect results.
- Identify an additional trial or experiment that could be performed to enhance or evaluate experimental results.

S3 Evaluation of Models, Inferences, and Experimental Results

- Select a simple hypothesis, prediction, or conclusion that is supported by a data presentation or a model.
- Identify key issues or assumptions in a model.
- Select a simple hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a simple hypothesis or conclusion and why.
- Identify strengths and weaknesses in one or more models.
- Identify similarities and differences between models.
- Determine which model(s) is/are supported or weakened by new information.

- Select a data presentation or a model that supports or contradicts a hypothesis, prediction, or conclusion.
- Select a complex hypothesis, prediction, or conclusion that is supported by a data presentation or model.
- Determine whether new information supports or weakens a model and why.
- Use new information to make a prediction based on a model.
- Select a complex hypothesis, prediction, or conclusion that is supported by two or more data presentations or models.
- Determine whether given information supports or contradicts a complex hypothesis or conclusion and why.

Writing

W1 Expressing Judgments

- Show a little understanding of the persuasive purpose of the task, but neglect to take or to maintain a position on the issue in the prompt.
- Show limited recognition of the complexity of the issue in the prompt.
- Show a basic understanding of the persuasive purpose of the task by taking a position on the issue in the prompt but may not maintain that position.
- Show a little recognition of the complexity of the issue in the prompt by acknowledging, but only briefly describing, a counterargument to the writer’s position.
- Show understanding of the persuasive purpose of the task by taking a position on the issue in the prompt.
- Show some recognition of the complexity of the issue in the prompt by doing the following:
 - Acknowledging counterarguments to the writer’s position
 - Providing some response to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a broad context for discussion.
- Show recognition of the complexity of the issue in the prompt by doing the following:
 - Partially evaluating implications and/or complications of the issue
 - Posing and partially responding to counterarguments to the writer’s position
- Show clear understanding of the persuasive purpose of the task by taking a position on the specific issue in the prompt and offering a critical context for discussion.
- Show understanding of the complexity of the issue in the prompt by doing the following:
 - Examining different perspectives
 - Evaluating implications or complications of the issue
 - Posing and fully discussing counterarguments to the writer’s position

W2 Focusing on the Topic

- Maintain a focus on the general topic in the prompt through most of the essay.
- Maintain a focus on the general topic in the prompt throughout the essay.
- Maintain a focus on the general topic in the prompt throughout the essay, and attempt a focus on the specific issue in the prompt.

- Present a thesis that establishes focus on the topic.
- Maintain a focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a thesis that establishes a focus on the writer’s position on the issue.
- Maintain a clear focus on discussion of the specific topic and issue in the prompt throughout the essay.
- Present a critical thesis that clearly establishes the focus on the writer’s position on the issue.

W3 Developing a Position

- Offer a little development, with one or two ideas; if examples are given, they are general and may not be clearly relevant; resort often to merely repeating ideas.
- Show little or no movement between general and specific ideas and examples.
- Offer limited development of ideas using a few general examples; resort sometimes to merely repeating ideas.
- Show little movement between general and specific ideas and examples.
- Develop ideas by using some specific reasons, details, and examples.
- Show some movement between general and specific ideas and examples.
- Develop most ideas fully, using some specific and relevant reasons, details, and examples.
- Show clear movement between general and specific ideas and examples.
- Develop several ideas fully, using specific and relevant reasons, details, and examples.
- Show effective movement between general and specific ideas and examples.

W4 Organizing Ideas

- Provide a discernible organization with some logical grouping of ideas in parts of the essay.
- Use a few simple and obvious transitions.
- Present a discernible, though minimally developed, introduction and conclusion.
- Provide a simple organization with logical grouping of ideas in parts of the essay.
- Use some simple and obvious transitional words, though they may at times be inappropriate or misleading.
- Present a discernible, though underdeveloped, introduction and conclusion.
- Provide an adequate but simple organization with logical grouping of ideas in parts of the essay but with little evidence of logical progression of ideas.
- Use some simple and obvious, but appropriate, transitional words and phrases.
- Present a discernible introduction and conclusion with a little development.
- Provide unity and coherence throughout the essay, sometimes with a logical progression of ideas.
- Use relevant, though at times simple and obvious, transitional words and phrases to convey logical relationships between ideas.
- Present a somewhat developed introduction and conclusion.

- Provide unity and coherence throughout the essay, often with a logical progression of ideas.
- Use relevant transitional words, phrases, and sentences to convey logical relationships between ideas.
- Present a well-developed introduction and conclusion.

W5 Using Language

- Show limited control of language by doing the following:
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes significantly impede understanding
 - Using simple vocabulary
 - Using simple sentence structure
 - Correctly employing some of the conventions of standard English grammar, usage, and mechanics but with distracting errors that sometimes impede understanding
 - Using simple but appropriate vocabulary
 - Using a little sentence variety, though most sentences are simple in structure
 - Correctly employing many of the conventions of standard English grammar, usage, and mechanics but with some distracting errors that may occasionally impede understanding
 - Using appropriate vocabulary
 - Using some varied kinds of sentence structures to vary pace
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with a few distracting errors but none that impede understanding
 - Using some precise and varied vocabulary
 - Using several kinds of sentence structures to vary pace and to support meaning
 - Correctly employing most conventions of standard English grammar, usage, and mechanics with just a few, if any, errors
 - Using precise and varied vocabulary
 - Using a variety of kinds of sentence structures to vary pace and to support meaning

Appendix D: Pathway Content Standards²

Automotive Service Brakes

ASB For every task in Brakes, the following safety requirement must be strictly enforced: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

- General Brake Systems Diagnosis
- Hydraulic System Diagnosis and Repair
- Drum Brake Diagnosis and Repair
- Disc Brake Diagnosis and Repair
- Power Assist Units Diagnosis and Repair
- Miscellaneous (Wheel Bearings, Parking Brakes, Electrical, Etc.) Diagnosis and Repair
- Antilock Brake and Traction Control Systems

Automotive Service Electrical/Electronics

ASE For every task in Electrical/Electronic Systems, the following safety requirement must be strictly enforced: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

- General Electrical System Diagnosis
- Battery Diagnosis and Service
- Starting System Diagnosis and Repair
- Charging System Diagnosis and Repair
- Lighting Systems Diagnosis and Repair
- Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair
- Horn and Wiper/Washer Diagnosis and Repair
- Accessories Diagnosis and Repair

Automotive Suspension/Steering

AST For every task in Suspension and Steering, the following safety requirement must be strictly enforced: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

² ASE/NATEF 2005 Automotive Service Program Standards. Retrieved December 3, 2007, from <http://www.natef.org>

- General Suspension and Steering Systems Diagnosis
- Steering Systems Diagnosis and Repair
- Suspension Systems Diagnosis and Repair
- Wheel Alignment Diagnosis, Adjustment, and Repair
- Wheel and Tire Diagnosis and Repair

Automotive Engine Performance

AEP For every task in Engine Performance, the following safety requirement must be strictly enforced: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with local, state, and federal safety and environmental regulations.

- General Engine Diagnosis
- Computerized Engine Controls Diagnosis and Repair
- Ignition System Diagnosis and Repair
- Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair
- Emissions Control Systems Diagnosis and Repair
- Engine-related Service

Appendix E: National Educational Technology Standards for Students

- T1** Creativity and Innovation
- T2** Communication and Collaboration
- T3** Research and Information Fluency
- T4** Critical Thinking, Problem Solving, and Decision Making
- T5** Digital Citizenship
- T6** Technology Operations and Concepts

T1 Creativity and Innovation

Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:

- a. Apply existing knowledge to generate new ideas, products, or processes.
- b. Create original works as a means of personal or group expression.
- c. Use models and simulations to explore complex systems and issues.
- d. Identify trends and forecast possibilities.

T2 Communication and Collaboration

Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:

- a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
- b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
- c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
- d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency

Students apply digital tools to gather, evaluate, and use information. Students do the following:

- a. Plan strategies to guide inquiry.
- b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
- c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.
- d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

- a. Identify and define authentic problems and significant questions for investigation.
- b. Plan and manage activities to develop a solution or complete a project.

- c. Collect and analyze data to identify solutions and/or make informed decisions.
- d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

- a. Advocate and practice safe, legal, and responsible use of information and technology.
- b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
- c. Demonstrate personal responsibility for lifelong learning.
- d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

- a. Understand and use technology systems.
- b. Select and use applications effectively and productively.
- c. Troubleshoot systems and applications.
- d. Transfer current knowledge to learning of new technologies.