

Title 7: Education K-12

Part 128 : Transportation Distribution and Logistics

2014 Automotive Service Technician

Mississippi Department of Education



Program CIP: 47.0604 – Automobile/Automotive Mechanic Technology/Technician

Direct inquiries to

Instructional Design Specialist
Research and Curriculum Unit
P.O. Drawer DX
Mississippi State, MS 39762
662.325.2510

Program Coordinator
Office of Career and Technical Education
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
601.359.3461

Published by

Office of Career and Technical Education
Mississippi Department of Education
Jackson, MS 39205

Research and Curriculum Unit
Mississippi State University
Mississippi State, MS 39762

Betsey Smith, Curriculum Manager
Scott Kolle, Project Manager
Jolanda Harris, Educational Technologist

The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

Table of Contents

Acknowledgments.....	3
Standards.....	4
Preface.....	5
Mississippi Teacher Professional Resources	6
Executive Summary	7
Course Outlines.....	9
Research Synopsis	13
Professional Organizations	18
Using This Document	19
Unit 1: Automotive Shop Operations	20
Unit 2: Engine Repair	23
Unit 3: Engine Transmission	25
Unit 4: Basic Electrical/Electronic Systems	27
Unit 5: Automotive Brakes	30
Unit 6: Automotive Shop Operations Review	34
Unit 7: Advanced Electrical/Electronic Systems.....	37
Unit 8: Engine Performance.....	39
Unit 9: Advanced Engine Performance	41
Unit 10: Suspension/Steering Systems	43
Unit 11: Automotive Heating and Air	45
Student Competency Profile	47
Appendix A: Unit References.....	50
Appendix B: Industry Standards.....	54
Appendix C: 21st Century Skills	57
Appendix D: Common Core Standards	60
Appendix E: National Educational Technology Standards for Students (NETS-S).....	93

Acknowledgments

The Automotive Service Technician curriculum was presented to the Mississippi Board of Education on November 14-15, 2013. The following persons were serving on the state board at the time:

Dr. Lynn House, Interim State Superintendent of Education
Dr. O. Wayne Gann, Chair
Mr. Howell “Hal” N. Gage, Vice Chair
Ms. Kami Bumgarner
Mr. William Harold Jones
Dr. John R. Kelly
Mr. Charles McClelland
Mr. Richard Morrison
Ms. Martha “Jackie” Murphy
Mr. Simon F. Weir, II

Jean Massey, Associate Superintendent of Education for the Office of Career and Technical Education at the Mississippi Department of Education, assembled a taskforce committee to provide input throughout the development of the Automotive Service Technician *Curriculum Framework and Supporting Materials*.

Lemond Irvin Instructional Design Specialist for the Research and Curriculum Unit at Mississippi State University researched and authored this framework.
lemond.irvin@rcu.msstate.edu

Also, special thanks are extended to the teachers who contributed teaching and assessment materials that are included in the framework and supporting materials:

Prentiss Fults, Hinds County Career and Technical Center, Jackson, MS
Dale Henry, EMCC, Mayhew, MS
Dale McCraw, Madison Career and Technical, Madison, MS
Charlie Melton, Clinton Career Complex, Clinton, MS
Danny Owen, Tippah County Technical Center, Ripley, MS
Jonathan Ridgeway, New Albany City Schools, New Albany, MS
Nic Wages, Jackson County Technology Center, Vancleave, MS

Appreciation is expressed to the following professional, who provided guidance and insight throughout the development process:

Bill McGrew, Program Coordinator, Office of Career and Technical Education and Workforce Development, Mississippi Department of Education, Jackson, MS
bmcgrew@mde.k12.ms.us

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the Automotive Service Technician *Curriculum Framework and Supporting Materials* are based on the following

Industry StandardsNational Automotive Technicians Education Foundation was founded in 1983 as an independent, nonprofit organization with a single mission: To evaluate technician training programs against standards developed by the automotive industry and recommend qualifying programs for certification (accreditation) by ASE, the National Institute for Automotive Service Excellence. For more information, visit <http://www.natef.org/>. Reprinted with permission.

Common Core State Standards Initiative

The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. All rights reserved. States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision, and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from <http://www.corestandards.org/>.

National Educational Technology Standards for Students

Reprinted with permission from *National Educational Technology Standards for Students: Connecting Curriculum and Technology*, Copyright 2007, International Society for Technology in Education (ISTE), 800.336.5191 (U.S. and Canada) or 541.302.3777 (International), iste@iste.org, www.iste.org. All rights reserved. Permission does not constitute an endorsement by ISTE.

21st Century Skills and Information and Communication Technologies Literacy Standards

In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and information and communication technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi face 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 IV, 2007; and No Child Left Behind Act of 2001).

Mississippi Teacher Professional Resources

The following are resources for Mississippi teachers.

Curriculum, Assessment, Professional Learning, and other program resources can be found at The Research and Curriculum Unit's website: <http://www.rcu.msstate.edu>

Learning Management System: An online resource

Learning Management System information can be found at the RCU's website, under Professional Learning.

Should you need additional instructions, please call 662.325.2510.

My PLC: An online registration for all professional-development sessions

To register for any session, teachers will need an account in the registration system, MyPLC, <https://myplc.rcu.msstate.edu>. To create an account, click on the link and navigate to the "Request a Guest ID" link. The ID should be the teacher's first initial and last name and the last four (4) digits of the social security number. Teachers should complete the entire form, which will then be sent to a secure server. Upon activation of the teacher's account, he or she will receive an e-mail with login instructions. The teacher may then browse for the available sessions and register for the desired courses.

Should you need additional instructions, please call 662.325.2510.

Executive Summary

Pathway Description

Automotive Service Technician is a pathway for students in the Transportation career cluster.

The following description is from the current Career–Technical Education career cluster website:

<http://www.careertech.org/career-clusters/resources/clusters/transporation.html>

“Careers in the Facility and Mobile Equipment Maintenance pathway include the maintenance, repair, and servicing of vehicles and transportation facilities, as well as the refueling of mobile equipment. All transportation relies on equipment which must function as designed, whenever needed. The people in this pathway keep the equipment and machinery running while looking for more efficient, safe, and cost-effective ways to do so.”

Industry Certification

The Automotive Service Technician pathway includes classroom and hands-on experiences that prepare students for continuing education or employment in the auto service industry. This program was written to incorporate the National Institute for Automotive Service Excellence (ASE) learning objectives/content and hours. Students who complete this program are encouraged to take the Maintenance and Light Repair (MLR) ASE exams. The MLR is a national certification program recognized throughout the automotive service industry. It is recommended that a district should implement a maximum student number due to the size of each lab with no more than 20 per instructor.

Assessment

The latest assessment blueprint for the curriculum can be found at

<http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx>

Student Prerequisites

In order for students to be able to experience success in the Automotive Service Technician program, the following student prerequisites are suggested:

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 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

None

Teacher Licensure

The latest teacher licensure information can be found at

<http://www.mde.k12.ms.us/educator-licensure>

Professional Learning

If you have specific questions about the content of any of training sessions provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for a professional-learning specialist.

Course Outlines

Option 1—Four One-Carnegie-Unit Courses

This curriculum consists of four one-credit courses, which should be completed in the following sequence:

- 1. Automotive Service Fundamentals I—Course Code: 997002**
- 2. Automotive Service Fundamentals II—Course Code: 997003**
- 3. Automotive Service Fundamentals III—Course Code: 997004**
- 4. Automotive Service Fundamentals IV—Course Code: 997005**

Course Description: Automotive Service Fundamentals I

The Automotive Service Fundamentals I course contains an introduction to shop operations, safety, tools and equipment, and preparing the vehicle for both service and the customer. The engine repair unit focuses on the overall internal combustion engine, cylinder and valve train, and lubrication and cooling systems.

Course Description: Automotive Service Fundamentals II

The Automotive Service Fundamentals II course is an introduction to both automatic and manual drive train and axles. This course also contains an introduction to electrical/electronic information and terminology including electrical/electronic system theory, battery systems, starting systems, and charging systems. It also contains an introduction to disc brakes, drum brakes, and anti-lock brakes.

Course Description: Automotive Service Fundamentals III

The Automotive Service Fundamentals III course contains a review on shop operations, safety, tools and equipment, and preparing the vehicle for both service and the customer. The Advanced Electrical/Electronic Systems unit contains information on lighting systems, concepts of gauges,

warning devices, driver information systems, horn system, wiper/washer system, and accessories system diagnostic repair. The Engine Performance unit contains information on fuel, air induction, and exhaust systems; concepts of emission control system; concepts of engine service.

Course Description: Automotive Service Fundamentals IV

The Automotive Service Fundamentals IV course contains general suspension/steering theory; steering system inspection, diagnosis, and repair; concepts of front, rear, and miscellaneous systems; and wheel/tire alignment concepts. It also includes information for the service and maintenance to the heating, ventilation, and engine cooling system.

Automotive Service Fundamentals I—Course Code: 997002

Unit	Title	Hours
1	Automotive Shop Operations	40
2	Engine Repair	60
3	Manual and Automotive Transmission	40
		140

Automotive Service Fundamentals II—Course Code: 997003

Unit	Title	Hours
4	Basic Electrical/Electronic Systems	70
5	Automotive Brakes	70
		140

Automotive Service Fundamentals III—Course Code: 997004

Unit	Title	Hours
6	Automotive Shop Operations Review	25
7	Advanced Electrical/Electronic Systems	75
8	Engine Performance	40
		140

Automotive Service Fundamentals IV—Course Code: 997005

Unit	Title	Hours
9	Advanced Engine Performance	40
10	Suspension/Steering Systems	50
11	Automotive Heating and Air	50
		140

- ✓ 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—Two Two-Carnegie-Unit Courses

This curriculum consists of two two-credit courses, which should be completed in the following sequence:

- 1. Automotive Service Technology I—Course Code: 997000**
- 2. Automotive Service Technology II— Course Code: 997001**

Course Description: Automotive Service Technology I

The Automotive Service Technology I course contains an introduction to shop operations, safety, tools and equipment, and preparing the vehicle for both service and the customer. The engine repair course focuses on the overall internal combustion engine, cylinder and valve train, and lubrication and cooling systems. The transmission course is an introduction to both automatic and manual drive train and axles. 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. It also contains an introduction to disc brakes, drum brakes, and antilock brakes.

Course Description: Automotive Service Technology II

The Engine Performance I course contains a review on shop operations, safety, tools and equipment, and preparing the vehicle for both service and the customer. 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. The Engine Performance 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. The Automotive Heating and Air information is for service and maintenance to the heating, ventilation, and engine cooling system.

Automotive Service Technology I—Course Code: 997000

Unit	Title	Hours
1	Automotive Shop Operations	40
2	Engine Repair	55
3	Engine Transmission	35
4	Basic Electrical/Electronic Systems	75
5	Automotive Brakes	75
		280

Automotive Service Technology II—Course Code: 997001

Unit	Title	Hours
6	Automotive Shop Operations Review	30
7	Advanced Electrical/Electronic Systems	70
8	Engine Performance	40
9	Advanced Engine Performance	40
10	Suspension/Steering Systems	50
11	Automotive Heating and Air	50
		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.
- ✓ 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.

Research Synopsis

Introduction

Data used to develop the Automotive Service Technician Pathway were collected from a variety of sources including industry surveys and interviews; occupational employment projections; national standards; Mississippi Department of Education, institutions of higher learning, and community and junior college requirements; and state and national certification requirements.

The pathway is designed to provide an overview of the automotive service area to prepare students for careers in occupations predicted to have a high number of available jobs in the next 10 years. These jobs are in the automotive service sector. Industry input was collected from automotive service businesses in the state of Mississippi to customize the pathway to meet the needs of Mississippi's employers. Employment projections were obtained from the Mississippi Economic Review and Outlook, Mississippi Department of Employment Security, and the *National Occupational Outlook Handbook*. Students who successfully master the curriculum should have the skills required to take the Automotive Service Excellence certification, which is based on industry-validated performance indicators. Students should also be prepared to enter programs for advanced education in the automotive fields. The pathway will articulate to automotive service programs offered in Mississippi's community and junior colleges.

Needs of the Future Workforce

Automotive service technician and mechanic occupations are projected to have about average growth over the projection date in Mississippi with a growth rate of 11.7%. The U.S. Bureau of Labor Statistics (2012) attributes this growth to the growing number of vehicles in the U.S. and the need for maintenance on these cars. With employers struggling to find qualified applicants, jobseekers who have completed postsecondary training programs in automotive technology will have the best job prospects. This field is growing throughout the U.S. which means there will be job opportunities within the state and across the nation.

Table 1.1: Current and Projected Occupation Report for Automotive Service

Description	Current Jobs (2008)	Projected Jobs (2018)	Change (Number)	Change (Percent)	Average Hourly Wage, 2011
Automotive Service Technicians and Mechanics	7,080	7,910	830	11.7	\$15.55

Source: Mississippi Department of Employment Security; www.mdes.ms.gov (accessed February 18, 2013).

Perkins IV Requirements

The Automotive Services Technician curriculum meets Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by introducing students to and preparing students for occupations. It also offers students a program of study including secondary, postsecondary, and IHL courses that will prepare them for occupations in these fields. Additionally, the Automotive Service Technician curriculum is integrated with academic common core standards. Lastly, the Automotive Service Technician curriculum focuses on ongoing and meaningful professional development for teachers as well as relationships with industry.

Curriculum Content

Summary of Standards

The standards to be included in the Automotive Service Technician curriculum are the Common Core Standards for Mathematics and Science, 21st Century Skills, and the National Educational Technology Standards (NETS) for Students. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter a secondary academic or career and technical program of study. They will also be prepared to academically compete nationally as the Common Core Standards are designed to prep students for success in community colleges, Institutions of Higher Learning and careers.

Academic Credit

If academic credit is awarded, please review the Research and Curriculum Unit link at

<https://www.rcu.msstate.edu/MDE/PathwaystoSuccess.aspx>.

Click “*Curriculum Enhancement List*”. Check this site often as it is updated frequently.

Transition to Postsecondary Education

The latest articulation information for Secondary to Postsecondary can be found at the

Mississippi Community College Board (MCCB) website <http://www.mccb.edu/>

Best Practices

Experiential Learning (SAE)

The Experiential Learning (SAE) has long been and continues to be the backbone of every automotive program. The experiential learning projects can be used in a variety of situations to reinforce and compliment classroom theory and content. The experiential learning project consists of entrepreneurship, placement, research/experimentation and exploratory.

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Automotive Service Technician teacher's goal should be to include teaching strategies that incorporate current technology. It is suggested that each classroom house a classroom set of desktop student computers and one teacher laptop. To make use of the latest online communication tools such as wikis, blogs, and podcasts, the classroom teacher is encouraged to use a learning management system, for example, the Automotive Teacher Learning Content Management System, that introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

Teachers should investigate opportunities to sponsor a student organization. There are several here in Mississippi that will foster the types of learning expected from the Automotive Service Technician curriculum. Skills USA is the student's organization for Automotive Service

Technician. Skills USA provides students with growth opportunities and competitive events. It also opens the doors to the world of automotive and scholarships opportunities.

Cooperative Learning

Cooperative learning can help students understand topics when independent learning cannot. Therefore, you will see several opportunities in the Automotive Service Technician curriculum for group work. To function in today's workforce, students need to be able to work collaboratively with others and solve problems without excessive conflict. The Automotive Service Technician curriculum provides opportunities for students to work together and help each other to complete complex tasks.

Conclusions

The Automotive Service Technician is one of Mississippi's most comprehensive automotive curriculums. Students that complete this program are well equipped for a variety of endeavors. Instructors are urged to encourage Automotive Service Technician students to pursue educational opportunities at community colleges and universities in Mississippi.

Professional Organizations

Association for Supervision and Curriculum Development (ASCD)
1703 North Beauregard Street
Alexandria, VA 22311-1714
(800) 933-ASCD
<http://www.ascd.org>

Association for Career and Technical Education (ACTE)
1410 King Street
Alexandria, VA 22314
(800) 826-9972
<http://www.acteonline.org>

Mississippi Association for Supervision and Curriculum Development (MASCD)
P.O. Box 13576
Jackson, MS 39236
(601) 591-2210
<http://www.mascd.com>

Mississippi Department of Education (MDE)
Office of Vocational Education and Workforce Development
P.O. Box 771
Jackson, MS 39205
(601) 359-3940
<http://www.mde.k12.ms.us/vocational/news/>

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703-777-8810
FAX: 703-777-8999
<http://www.skillsusa.org/>

Using This Document

Suggested Time on Task

This section indicates 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% 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.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students

This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

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.

Unit 1: Automotive Shop Operations

Competencies and Suggested Objectives
1. Describe local program and vocational/career technical center policies and procedures. DOK1, ASO a. Describe local program and vocational/career technical center policies and procedures including dress code, attendance, academic requirements, discipline, and transportation regulations.
2. Describe employment opportunities and responsibilities. DOK1, ASO a. Describe employment opportunities including potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements. b. Describe basic employee responsibilities.
3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA. DOK2, ASO a. Demonstrate effective team-building and leadership skills. b. Practice appropriate work ethics.
4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. DOK2, ASO a. Demonstrate following verbal and written instructions. b. Practice following verbal and written instructions. c. Communicate effectively with customers, colleagues, and employers.
5. Discuss the history of the automotive industry to include materials, terminology, and techniques. DOK2, ASO a. Discuss terminology related to the automotive industry. b. Explain and demonstrate techniques used in the automotive industry. c. Explore the history of the automotive industry.
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. DOK1, ASO a. Describe how to avoid on-site accidents. b. Explain the relationship between housekeeping and safety. c. Explain the importance of following all safety rules and company safety policies. d. Explain the importance of reporting all on-the-job injuries and accidents. e. Explain the need for evacuation policies and the importance of following them. f. Explain the employer's substances abuse policy and how it relates to safety. g. Explain the safety procedures when working near pressurized or high temperature. h. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm. 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). j. Locate service specifications and information, using both print and computerized service information references (VIN, certification, and calibration labels).

<ul style="list-style-type: none"> 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. l. Organize and maintain a systematic storage system for hand and power tools. m. Identify the different types of bolts, nuts, and washers and describe their appropriate uses. n. Identify bolts by grade, diameter, length, and thread pitch. o. Identify and describe the use of various glues and sealants. p. Restore internal and external threads.
<p>7. Identify and apply concepts regarding safety procedures and practices in and around automotive operations. <small>DOK2, ASO</small></p> <ul style="list-style-type: none"> a. Inspect and care for personal protective equipment. b. Identify and explain the procedures for lifting heavy objects. c. Explain the function of the MSDS. d. Interpret the requirements of the MSDS. e. Explain the process by which fires start. f. Explain fire prevention of various flammable liquids. g. Explain the classes of fire and the types of extinguishers. h. Explain injuries when electrical contact occurs.
<p>8. Explore general shop operations and safety. <small>DOK3, ASO</small></p> <ul style="list-style-type: none"> a. Complete a work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction. b. Research applicable vehicle and service information, such as brake system operation, vehicle service history, service precautions, and technical service bulletins. c. Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration details, and calibration decals). d. Identify and demonstrate the safe and proper use of common hand tools including wrenches, sockets, pliers, screwdrivers, striking tools, and so forth. e. Identify and demonstrate the safe and proper use of lifting and hoisting equipment. f. Identify and demonstrate the safe and proper use of cleaning equipment. g. Identify and demonstrate the safe and proper use of power equipment including impact wrenches, drills, grinders, and presses. h. Identify the different types of bolts, nuts, and washers, and describe their appropriate uses. i. Identify bolts by grade, diameter, length, and thread pitch. j. Identify different glues and sealants used in automotive service, and describe their appropriate uses. k. Restore internal and external threads. l. Locate service specifications and information, using both print and computerized service information references.

- m. Interpret and apply information to a specific job on a specific vehicle.
- n. Locate and interpret vehicle and major component identification numbers (VIN, certification, and calibration labels).
- o. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm.
- p. 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).
- q. Distinguish between accuracy and precision.

Scenario

Where You Work

Unit 1

Have students break into groups. Divide shop into equal sections and assign each group a section. Students are to identify potential safety hazards and precautions recommended to prevent accidents in each area. Research each MSDS and discuss actions recommended if contact occurs.

Attachments for Scenario

See the Group Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 2: Engine Repair

Competencies and Suggested Objectives	
1. Identify and describe general vehicle information and repairs. ^{DOK2, AER}	<ul style="list-style-type: none"> a. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. b. Verify operation of the instrument panel engine warning indicators. c. Inspect engine assembly for fuel, oil, coolant, and other leaks to determine necessary action. d. Install engine covers using gaskets, seals, and sealers as required. e. Perform common fastener and thread repair, to include: remove broken bolt, restore internal and external threads, and repair internal threads with thread insert. f. Identify hybrid vehicle internal combustion engine service precautions.
2. Identify and describe the major systems and components of an automobile. ^{DOK2, AER}	<ul style="list-style-type: none"> a. Identify the major components of the following major systems and describe their purposes and/or functions: <ul style="list-style-type: none"> 1. Power train 2. Chassis, steering, and suspension 3. Fuel 4. Electrical 5. Cooling 6. Exhaust b. Describe the operation of a four-cycle engine. c. Discuss power as $\text{Work/Time} = \text{Force} * \text{Distance/Time}$. d. Relate speed to power; as V increases, power = work/time = energy/time also increases, so fuel consumption increases with the car's speed. e. Research/plot graph of fuel consumption miles per gallon versus speed. f. Describe the use of electronics and computer control in modern automobiles.
3. Inspect, adjust, and/or repair cylinder head and valve train timing. ^{DOK2, AER}	<ul style="list-style-type: none"> a. Adjust valves (mechanical or hydraulic lifters). b. Remove and replace timing belt; verify correct camshaft timing.
4. Inspect, replace, and adjust lubrication and cooling systems. ^{DOK2, AER}	<ul style="list-style-type: none"> a. Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, and heater core; determine necessary action. b. Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment. c. Remove, inspect, and replace thermostat and gasket/seal. d. Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required.
5. Inspect and perform general maintenance (lubrication, oils, and fluids). ^{DOK2, AEP}	

- a. Discuss the importance of regularly scheduled maintenance procedures as outlined in the owner's manual and related to vehicle performance and longevity.
- b. Complete a work order and maintenance record for a given vehicle.
- c. Visually inspect the engine lubrication system for leaks, and determine needed repairs.
- d. Select proper lubricants and filters for lubrication service.
- e. Change engine oil and filter according to manufacturer's specifications and in accordance with disposal procedures.
- f. Perform a chassis and body lubrication.
- g. Inspect and service as needed other filters on the engine including air, fuel, PCV valve, crankcase vent filters, and so forth.
- 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.
- i. Clean and service a battery including case, cables, and connections, and check electrolyte level (if applicable). (Maintain electronic memory functions while cleaning.)

Scenario

Start Your Engines

Unit 2

The students will divide into small groups. Using automotive online technical resource ALLDATA or equivalent as a reference the groups will disassemble a complete engine. The groups will inspect and name each part. The students are to reassemble the engines using the correct procedures and torque specification. The students will use task sheets as a guide and the instructor will check off as the groups complete each step. (This activity requires extra lab time.)

Attachments for Scenario

See the Group Rubric and the Job Sheet Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 3: Engine Transmission

Competencies and Suggested Objectives

1. Identify, inspect, and perform general maintenance and repair of automatic transmissions, transaxles and related components. ^{DOK2, ATS}
 - a. Identify and describe the different types of automatic transmissions including theory and operation of transaxles, CVT (continually variable transmission), and hybrid drive trains.
 - b. Using a paper or electronic service manual find the applicable information for service history, service precautions, service bulletins, fluid types, and adjustment for dipstick and non-dipstick transmission fluid levels.
 - c. Complete inspection of transmission lines, fittings, connectors, external and internal coolers, mounts, and other external components.
 - d. Discuss regulations regarding proper collection and disposal of fluids in accordance with EPA and OSHA requirements.
 - e. Prepare and complete, fluid exchange, filter change, leak detection, gasket and seal replacement followed by adjustment and or replacement of the external manual valve shift linkage, transmission range switch, and park neutral position switch.
2. Identify, inspect, and perform general maintenance and repair of Manual Drive Trains, axles, transfer cases, and related components. ^{DOK2, ATS}
 - a. Identify and describe the different types of manual drive train components including transmissions, pilot bushing/bearings, throw out bearings, clutch and pressure plates, clutch master cylinders and slave cylinders, transaxles, electronically controlled versions, transfer case operation, and all-wheel drive functions.
 - b. Using a paper or electronic service manual find the vehicle service information needed in order to identify the fluid type, service history, service precautions, and service bulletins.
 - c. Determine transmission condition by inspection and adjustment of fluid levels, cables, linkages, clutch safety switch, and pedal operation.
 - d. Discuss regulations regarding proper collection and disposal of fluids in accordance with EPA and OSHA requirements.
 - e. Complete fluid removal and replacement of the transmission, clutch master cylinder and slave cylinder, final drive unit, transaxle, and or transfer case.
 - f. Inspect and replace drive shaft, U-joints, CV half shafts, bearings and races, hubs, seals, shafts, yokes, boots, axles, and wheel studs.
 - g. Inspect, adjust, and or replace four wheel drive locking hubs, vents, wheel bearings, and outer axle nut adjustments for tapered and one piece bearing sets.

Scenario

Instructions

Unit 3

Using the textbook or applicable internet resources students are to develop a user manual instruction guide describing procedures checking different types of automatic and manual transmission transfer case fluids. Students should list each of the different types of fluids used and characteristics of each and any suggested maintenance schedule.

Attachments for Scenario

See the Journal Assessment Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 4: Basic Electrical/Electronic Systems

Competencies and Suggested Objectives

1. Explore general electrical/electronic systems and theories of operation. DOK3, AEE
 - a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.
 - b. Identify and interpret electrical/electronic system concerns; determine necessary action.
 - c. Research applicable vehicle and service information, such as electrical/electronic system operation, vehicle service history, service precautions, and technical service bulletins.
 - d. Locate and interpret vehicle and major component identification numbers (e.g., VIN, vehicle certification labels, and calibration decals).
 - e. Diagnose electrical/electronic integrity of series, parallel, and series-parallel circuits using principles of electricity (Ohm's law).
 - f. Use wiring diagrams during diagnosis of electrical circuit problems.
 - g. Demonstrate the proper use of a digital multimeter (DMM) during diagnosis of electrical circuit problems.
 - h. Check electrical circuits with a test light; determine necessary action.
 - i. Measure source voltage and perform voltage drop tests in electrical/electronic circuits using a voltmeter; determine necessary action.
 - j. Measure current flow in electrical/electronic circuits and components using an ammeter; determine necessary action.
 - k. Check continuity and measure resistance in electrical/electronic circuits and components using an ohmmeter; determine necessary action.
 - l. Check electrical circuits using fused jumper wires; determine necessary action.
 - m. Locate shorts, grounds, opens, and resistance problems in electrical/electronic circuits; determine necessary action.
 - n. Measure and diagnose the cause(s) of excessive key-off battery drain (parasitic draw); determine necessary action.
 - o. Inspect and test fusible links, circuit breakers, and fuses; determine necessary action.
 - p. Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; perform necessary action.
 - q. Remove and replace terminal end from connector.
 - r. Repair connectors and terminal ends.
 - s. Perform solder repair of electrical wiring.
 - t. Identify safety procedures and location of hybrid vehicle high-voltage circuit disconnect (service plug).
 - u. Define current, resistance, and voltage, and discuss Ohm's law.
 - v. Define and contrast series and parallel circuits; sketch series and parallel circuits.

<ul style="list-style-type: none"> w. Define ground, short circuit, open circuit, and the resistance associated with short circuits and open circuits. x. Discuss the ground for an automobile and for a house. y. Discuss fuses and circuit breakers in parallel circuits where $I_{\text{total}} = I_{\text{fuse}} = I_1 + I_2 + I_3$.
<p>2. Apply concepts of battery systems by performing inspection, diagnosis, and repair, if needed. <small>DOK3, AEE</small></p> <ul style="list-style-type: none"> a. Perform battery state-of-charge test; determine necessary action. b. Perform battery capacity test (or conductance test), confirm proper battery capacity for vehicle application, and determine necessary action. c. Maintain or restore electronic memory functions. d. Inspect, clean, fill, and replace battery. e. Perform slow/fast battery charge. f. Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed. g. Inspect and clean battery cables, connectors, clamps, and hold-downs; repair or replace as needed. h. Start a vehicle using jumper cables and a battery or auxiliary power supply. i. Identify high-voltage circuits of electric or hybrid electric vehicle and related safety precautions. j. Identify hybrid vehicle auxiliary (12 V) battery service and repair and test procedures. 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).
<p>3. Apply concepts of starting systems by performing inspection, diagnosis, and repair, if needed. <small>DOK3, AEE</small></p> <ul style="list-style-type: none"> a. Perform starter current draw and circuit voltage drop tests; determine necessary repair. b. Inspect and test the starter components, relays, and solenoids; determine necessary repair. c. Remove and install the starter. d. Inspect test switches, connectors, and wires of starter control circuits; perform necessary action. e. Differentiate between electrical and engine mechanical problems that cause slow-crank or no-crank conditions. 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. 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.
<p>4. Apply concepts of charging systems by performing inspection, diagnosis, and repair, if needed. <small>DOK3, AEE</small></p>

- 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.
- b. Remove, inspect, adjust, and install the generator (alternator) and components.

Scenario

Circuit Testing

Unit 4

Have each student rotate through each section of the dial of a digital multimeter (DMM). Students are to give an example of an electrical component, circuit tested and reading observed in each position of the dial of a DMM.

Attachments for Scenario

None

Unit 5: Automotive Brakes

Competencies and Suggested Objectives

1. Explore general brake systems and theories of operation. ^{DOK3, ASB}
 - a. Identify and interpret brake system concern; determine necessary action.
 - b. Restore internal and external threads.
 - c. Locate service specifications and information, using both print and computerized service information references.
 - d. Interpret and apply information to a specific job on a specific vehicle.
 - e. Locate and interpret vehicle and major component identification numbers (e.g., VIN, certification, and calibration labels).
 - f. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm.
 - g. Measure the inside diameter, outside diameter, and/or depth to the nearest 0.001 in. and nearest 0.1 mm, using precision measuring instruments (e.g., micrometers, calipers, and dial indicators).
 - h. Distinguish between accuracy and precision.
 - i. Determine when an instrument is out of calibration.
 - j. Determines factors that affect stopping distance?
 - k. Define friction and which factors affect the size of the force of friction.
 - l. Discuss kinetic energy and the work–energy theorem.
 - m. Define work, and relate work as it applies to stopping a car in motion.
2. Apply concepts of hydraulic brake systems by performing inspection, diagnosis, and repair, if needed. ^{DOK2, ASB}
 - a. Diagnose pressure concerns in the brake system using hydraulic principles (Pascal’s law).
 - b. Measure brake pedal height; determine necessary action.
 - c. Check master cylinder for internal and external leaks and proper operation; determine necessary action.
 - d. Remove, bench bleed, and reinstall master cylinder.
 - e. Diagnose poor stopping, pulling, or dragging concerns caused by malfunctions in the hydraulic system; determine necessary action.
 - 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.
 - g. Fabricate and/or install brake lines (double flare and ISO types); replace hoses, fittings, and supports as needed.
 - h. Select, handle, store, and fill brake fluids to proper level.
 - i. Inspect, test, and/or replace metering (hold-off), proportioning (balance), pressure differential, and combination valves.
 - j. Inspect, test, and/or replace components of brake warning light system.
 - k. Bleed (manual, pressure, vacuum, or surge) brake system.

<ul style="list-style-type: none"> l. Flush hydraulic system. m. Discuss floor jack as a type of hydraulic system employing Pascal's principle.
<ul style="list-style-type: none"> 3. Apply concepts of disc brake systems by performing inspection, diagnosis, and repair, if needed. <small>DOK2, ASB</small> <ul style="list-style-type: none"> a. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pedal pulsation concerns; determine necessary action. b. Remove caliper assembly from mountings; clean and inspect for leaks and damage to caliper housing; determine necessary action. c. Clean and inspect caliper mounting and slides for wear and damage; determine necessary action. d. Remove, clean, and inspect pads and retaining hardware; determine necessary action. e. Disassemble and clean caliper assembly; inspect parts for wear, rust, scoring, and damage; replace seal, boot, and damaged or worn parts. f. Reassemble, lubricate, and reinstall caliper, pads, and related hardware; seat pads, and inspect for leaks. g. Clean, inspect, and measure rotor with a dial indicator and a micrometer; follow manufacturer's recommendations in determining need to machine or replace. h. Remove and reinstall rotor. i. Refinish rotor off vehicle. j. Adjust calipers equipped with an integrated parking brake system. k. Install wheel, torque lug nuts, and make final checks and adjustments.
<ul style="list-style-type: none"> 4. Apply concepts of drum brake systems by performing inspection, diagnosis, and repair, if needed. <small>DOK3, ASB</small> <ul style="list-style-type: none"> a. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pedal pulsation concerns; determine necessary action. b. Remove, clean (using proper safety procedures), inspect, and measure brake drums; determine necessary action. c. Refinish brake drum. 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. e. Remove, inspect, and install wheel cylinders. f. Pre-adjust brake shoes and parking brake before installing brake drums or drum/hub assemblies and wheel bearings. g. Install wheel, torque lug nuts, and make final checks and adjustments. h. Discuss torque = perpendicular X length of torque arm. i. Discuss the effect of length on the amount of torque extended and why an extension handle is used to increase torque.
<ul style="list-style-type: none"> 5. Apply concepts of power assist unit systems by performing inspection, diagnosis, and repair, if needed. <small>DOK3, ASB</small> <ul style="list-style-type: none"> a. Test pedal-free travel with and without engine running; check power assist operation.

<ul style="list-style-type: none"> b. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster. c. Inspect the vacuum-type power booster unit for vacuum leaks; inspect the check valve for proper operation; determine necessary action. d. Inspect and test hydraulically assisted power brake system for leaks and proper operation; determine necessary action. e. Measure and adjust master cylinder pushrod length
<p>6. Apply concepts of miscellaneous systems by performing inspection, diagnosis, and repair, if needed. ^{DOK2, ASB}</p> <ul style="list-style-type: none"> a. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine necessary action. b. Remove, clean, inspect, repack, and install wheel bearings, and replace seals; install hub and adjust wheel bearings. c. Check parking brake cables and components for wear, rusting, binding, and corrosion; clean, lubricate, or replace as needed. d. Check parking brake operation; determine necessary action. e. Check operation of parking brake indicator light system. f. Check operation of brake stoplight system; determine necessary action. g. Replace wheel bearing and race. h. Inspect and replace wheel studs. i. Remove and reinstall sealed wheel bearing assembly. j. Discuss ways to reduce friction by lubrication. Discuss rolling friction versus sliding friction.
<p>7. Apply concepts of antilock brake, traction control systems, and vehicle stability control systems by performing inspection, diagnosis, and repair, if needed. ^{DOK3, ASB}</p> <ul style="list-style-type: none"> a. Identify and inspect antilock brake system (ABS) components; determine necessary action. b. Diagnose poor stopping, wheel lockup, abnormal pedal feel or pulsation, and noise concerns caused by the antilock brake system (ABS); determine necessary action. c. Diagnose antilock brake system (ABS) electronic control(s) and components using self-diagnosis and/or recommended test equipment; determine necessary action. d. Depressurize high-pressure components of the antilock brake system (ABS). e. Diagnose antilock brake system (ABS) braking concerns caused by vehicle modifications (e.g., tire size, curb height, final drive ratio, etc.). f. Identify traction control/vehicle stability control system components. 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.

Scenario

Those Are the Brakes

Unit 5

A customer entered J & J Auto Repair Shop. The customer described that his 2002 pick-up under hard braking would pull to the right and he also noticed smoke coming from the right front wheel area. Previously, the customer has added brake fluid to the brake reservoir. The students are to diagnose the problem and repair the problem found.

Attachments for Scenario

See the Group Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 6: Automotive Shop Operations Review

Competencies and Suggested Objectives
<p>1. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. ^{DOK2, ASO}</p> <ul style="list-style-type: none">a. Demonstrate following verbal and written instructions.b. Communicate effectively with customers, colleagues, and employers.
<p>2. Identify and describe general safety rules, components of an automobile, tools/equipment, measurement practices, and fasteners for working in a shop/lab and industry. ^{DOK1, ASO}</p> <ul style="list-style-type: none">a. Describe how to avoid on-site accidents.b. Explain the relationship between housekeeping and safety.c. Explain the importance of following all safety rules and company safety policies.d. Explain the importance of reporting all on-the-job injuries and accidents.e. Explain the need for evacuation policies and the importance of following them.f. Explain the employer's substances abuse policy and how it relates to safety.g. Explain the safety procedures when working near pressurized or high temperature.h. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm.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 (e.g., micrometers, calipers, and dial indicators).j. Locate service specifications and information, using both print and computerized service information references (e.g., VIN, certification, and calibration labels).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.l. Organize and maintain a systematic storage system for hand and power tools.m. Identify the different types of bolts, nuts, and washers and describe their appropriate uses.n. Identify bolts by grade, diameter, length, and thread pitch.o. Identify and describe the use of various glues and sealants.p. Restore internal and external threads.
<p>3. Identify and apply concepts regarding safety procedures and practices in and around automotive operations. ^{DOK2, ASO}</p> <ul style="list-style-type: none">a. Inspect and care for personal protective equipment.b. Identify and explain the procedures for lifting heavy objects.c. Explain the function of the MSDS.d. Interpret the requirements of the MSDS.e. Explain the process by which fires start.f. Explain fire prevention of various flammable liquids.

- g. Explain the classes of fire and the types of extinguishers.
- h. Explain injuries when electrical contact occurs.

4. Explore general shop operations and safety. ^{DOK3, ASO}
- a. Complete a work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.
 - b. Research applicable vehicle and service information, such as brake system operation, vehicle service history, service precautions, and technical service bulletins.
 - c. Locate and interpret vehicle and major component identification numbers (e.g., VIN, vehicle certification labels, calibration details, and calibration decals).
 - d. Identify and demonstrate the safe and proper use of common hand tools including wrenches, sockets, pliers, screwdrivers, striking tools, and so forth.
 - e. Identify and demonstrate the safe and proper use of lifting and hoisting equipment.
 - f. Identify and demonstrate the safe and proper use of cleaning equipment.
 - g. Identify and demonstrate the safe and proper use of power equipment including impact wrenches, drills, grinders, and presses.
 - h. Identify the different types of bolts, nuts, and washers, and describe their appropriate uses.
 - i. Identify bolts by grade, diameter, length, and thread pitch.
 - j. Identify different glues and sealants used in automotive service, and, describe their appropriate uses.
 - k. Restore internal and external threads.
 - l. Locate service specifications and information, using both print and computerized service information references.
 - m. Interpret and apply information to a specific job on a specific vehicle.
 - n. Locate and interpret vehicle and major component identification numbers (e.g., VIN, certification, and calibration labels).
 - o. Measure the length of an object using a rule to the nearest 1/16 in. and 1 mm.
 - p. 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).
 - q. Distinguish between accuracy and precision.

Scenario

Have You Seen This Before?

Unit 6

Have students break into groups. Divide shop into equal sections and assign each group a section. Students are to identify potential safety hazards and precautions recommended to prevent accidents in each area. Research each MSDS and discuss actions recommended if contact occurs.

Attachments for Scenario

None

Unit 7: Advanced Electrical/Electronic Systems

Competencies and Suggested Objectives	
1. Explore lighting systems and theories of operation. ^{DOK3, AEE}	<ol style="list-style-type: none">a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.b. Diagnose lighting system problems related to brighter than normal, intermittent, dim, or no light operation; determine necessary actions.c. Inspect, replace, and aim headlights and bulbs.d. Inspect and diagnose incorrect turn and hazard lighting systems; determine necessary actions.e. Identify system voltage and safety precautions associated with high-intensity discharge headlights.f. Discuss parabolic reflections such as headlights.g. Relate the location of the filament to high beam and low beam operation.h. Discuss rearview mirrors as convex mirrors and why objects appear smaller than they actually are.i. Discuss how “night view” device was on the interior rear-view mirror.
2. Apply concepts of gauges, warning devices, and driver information systems by performing inspection, diagnosis, and repair, if needed. ^{DOK3, AEE}	<ol style="list-style-type: none">a. Inspect and test gauges and gauge sending units for cause of intermittent, high, low, or no gauge readings; determine necessary action.b. Inspect and test connectors, wires, and printed circuit boards of gauge circuits; determine necessary action.c. Diagnose the cause of incorrect operation of warning devices and other driver information systems; determine necessary action.d. Discuss blinker operation and wiper speed control in terms of capacitors and resistors.
3. Apply concepts of horn and wiper/washer systems by performing inspection, diagnosis, and repair, if needed. ^{DOK3, AEE}	<ol style="list-style-type: none">a. Diagnose incorrect horn operation; determine necessary action.b. Diagnose incorrect wiper/washer operation; perform necessary action.c. Diagnose wiper speed control and park problems; perform necessary action.
4. Apply concepts of accessories by performing inspection, diagnosis, and repair, if needed. ^{DOK2, AEE}	<ol style="list-style-type: none">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.b. Disarm and enable the air bag system for vehicle service.c. Diagnose body electronic system circuits using a scan tool; determine necessary action.d. Diagnose incorrect heated glass, mirror, or seat operation; determine necessary action.

e. Remove and install door panels.

Scenario

Find the Fault

Unit 7

Have students utilize the textbook or online education source for identifying all components involved in automotive electrical circuitry. Choose a schematic from your online resource for a specific car in the shop. Have students trace in different colors the power and ground circuits along with the switching and relay circuits if involved. In the shop have the students find all components including power supply, fuses, breakers, fusible links, wiring, relays, grounds, diodes (rectifier, zener, and/or clamping), transistors, resistors, and loads for the circuit utilized. Have students explain the function of each part. Once all parts are found on the car have students run tests of the circuit using test lights when applicable or digital volt ohm meters for voltage, amperage, and resistance of circuit components. After the instructor creates a fault in the circuit students should utilize proper testing procedures to identify the problem.

Attachments for Scenario

See the Group Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 8: Engine Performance

Competencies and Suggested Objectives	
1. Explore general engine components and theories of operation. ^{DOK2, AEP}	
a. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.	
b. Identify and interpret engine performance concern; determine necessary action.	
c. Research applicable vehicle and service information, such as engine management system operation, vehicle service history, service precautions, and technical service bulletins.	
d. Locate and interpret vehicle and major component identification numbers (e.g., VIN, vehicle certification labels, and calibration decals).	
e. Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action.	
f. Perform cylinder power balance test; determine necessary action.	
g. Perform cylinder cranking compression tests; determine necessary action.	
h. Perform engine running compression test; determine necessary action.	
i. Perform cylinder leakage test; determine necessary action.	
j. Verify engine operating temperature; determine necessary action.	
2. Apply concepts of computerized engine controls by performing inspection, diagnosis, and repair, if needed. ^{DOK3, AEP}	
a. Retrieve and record diagnostic trouble codes, OBD monitor status, and freeze frame data; clear codes when applicable.	
b. Describe the importance of operating all OBDII monitors for repair verification.	
3. Apply concepts of ignition systems by performing inspection, diagnosis, and repair, if needed. ^{DOK3, AEP}	
a. Discuss theory and operation of ignition systems.	
b. Remove, inspect, and replace spark plugs, and inspect secondary ignition components for wear and damage.	

Scenario

The Best Answer?

Unit 8

Utilizing the online resource, www.autoshop.101, or other similar sites, pull up the engine performance test section and display it on the board. Read each test question scenario for the automobile in question. Carefully look at any diagnostic live data stream information charts or readings and then have students discuss in groups the best answer to be relayed to the instructor. Each answer will be chosen as per group's decision. If the answer is not the most correct the explanation is related in the answer as to why it is not the best choice. The students will continue to analyze their next choice in a group discussion and choose again until the best answer is found. The instructor can further enhance this learning experience by intentionally faulting the engine performance of a car in the shop and utilize live data stream information for analysis.

Attachments for Scenario

See the Group Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 9: Advanced Engine Performance

Competencies and Suggested Objectives

1. Apply concepts of fuel, air induction, and exhaust systems by performing inspection, diagnosis, and repair, if needed. ^{DOK2, AEP}
 - a. Discuss theory and operation of fuel systems.
 - b. Diagnose drivability problems related to fuel systems; determine necessary action.
 - c. Replace components related to fuel systems; make required adjustments.
 - d. Test electronic fuel, air induction, and fuel-delivery components and circuits; determine necessary action.
 - e. Inspect and test the exhaust systems; determine and perform necessary action.
 - f. Discuss the causes of atmospheric pressure (weight of the air above a location) and the effect of altitude on pressure and automotive performance.
2. Apply concepts of Fuel, Air Induction, and Exhaust Systems by performing inspection, diagnosis, and repair, if needed. ^{DOK3, AEP}
 - a. Replace fuel filter(s).
 - b. Inspect, service, or replace air filters, filter housings, and intake duct work.
 - c. Inspect integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields; determine necessary action.
 - d. Inspect condition of exhaust system hangers, brackets, clamps, and heat shields; repair or replace as needed.
 - e. Check and refill diesel exhaust fluid (DEF).
3. Apply concepts of Emissions Control Systems by performing inspection, diagnosis, and repair, if needed. ^{DOK3, AEP}
 - a. Inspect, test, and service positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; perform necessary action.

Scenario

The Best Answer?

Unit 9

Utilizing online resource, www.autoshop.101, or other similar site, pull up the engine performance test section and display it on the board. Read each test question scenario for the automobile in question. Carefully look at any diagnostic live data stream information charts or readings and then have students discuss in groups the best answer to be relayed to the instructor. Each answer will be chosen as per group's decision. If the answer is not the most correct the explanation is related in the answer as to why it is not the best choice. The students will continue to analyze their next choice in a group discussion and choose again until the best answer is found. The instructor can further enhance this learning experience by intentionally faulting the engine performance of a car in the shop and utilize live data stream information for analysis.

Attachments for Scenario

See the Group Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 10: Suspension/Steering Systems

Competencies and Suggested Objectives	
1.	Explore general suspension and steering systems and theories of operation. ^{DOK3, AST} <ol style="list-style-type: none">Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.Identify and interpret suspension and steering concern; determine necessary action.Research applicable vehicle and service information, such as suspension and steering system operation, vehicle service history, service precautions, and technical service bulletins.
2.	Apply concepts of steering systems by performing inspection, diagnosis, and repair, if needed. ^{DOK2, AST} <ol style="list-style-type: none">Disable and enable supplemental restraint system (SRS).Inspect rack and pinion steering gear inner tie rod ends (sockets) and bellows boots.Determine proper power steering fluid type; inspect fluid level and condition.Flush, fill, and bleed power steering system.Inspect for power steering fluid leakage; determine necessary action.Remove, inspect, replace, and adjust power steering pump drive belt.Inspect and replace power steering hoses and fittings.Replace power steering pump filter(s).Inspect pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper.Inspect tie rod ends (sockets), tie rod sleeves, and clamps.Inspect upper and lower control arms, bushings, and shafts.Inspect and replace rebound and jounce bumpers.Inspect track bar, strut rods/radius arms, and related mounts and bushings.Inspect upper and lower ball joints (with or without wear indicators).Inspect suspension system coil springs and spring insulators (silencers).Inspect suspension system torsion bars and mounts.Inspect and replace front stabilizer bar (sway bar) bushings, brackets, and links.Inspect strut cartridge or assembly.Inspect front strut bearing and mount.Inspect rear suspension system lateral links/arms (track bars), control (trailing) arms.Inspect rear suspension system leaf spring(s), spring insulators (silencers), shackles, brackets, bushings, center pins/bolts, and mounts.Inspect, remove, and replace shock absorbers; inspect mounts and bushings.Inspect electric power-assisted steering.Identify hybrid vehicle power steering system electrical circuits and safety precautions.Describe the function of the power steering pressure switch.
3.	Apply concepts of wheel alignment. ^{DOK2, AST}

<p>a. Perform prealignment inspection and measure vehicle ride height; determine necessary action.</p>
<p>4. Perform tire and wheel diagnosis and repair. ^{DOK2, AST} Inspect tire condition; identify tire wear patterns; check for correct size and application (load and speed ratings) and adjust air pressure; determine necessary action.</p> <p>a. Rotate tires according to manufacturer’s recommendations.</p> <p>b. Dismount, inspect, and remount tire on wheel; balance wheel and tire assembly (static and dynamic).</p> <p>c. Dismount, inspect, and remount tire on wheel equipped with tire pressure monitoring system sensor.</p> <p>d. Inspect tire and wheel assembly for air loss; perform necessary action.</p> <p>e. Repair tire using internal patch.</p> <p>f. Identify and test tire pressure monitoring systems (indirect and direct) for operation; verify operation of instrument panel lamps.</p> <p>g. Demonstrate knowledge of steps required to remove and replace sensors in a tire pressure monitoring system.</p>

Scenario

Unit 10

Wearing Out Your Wallet

In the shop, students will record the tire size from whatever vehicle is available. They will then go to an online resource and estimate the cost of tire replacement. The instructor will display on the board tire wear pictures or utilize the text book showing the different tire wear patterns that can occur due to broken parts, lack of tire rotation, or misadjusted front end values. The students will need to decide what part on the automobile would be at fault. After finding the part to be repaired the students would then utilize an online resource or online shop manual to estimate repairs. The students would then compare the cost of tire replacement versus the cost of a front end alignment. Students will then present their cost analysis to the group. To further enhance this project the instructor can have students find vehicles with larger or modified tires and compare the added expense of aftermarket changes to original equipment.

Attachments for Scenario

See the Presentation Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Unit 11: Automotive Heating and Air

Competencies and Suggested Objectives

1. Identify, inspect, and perform cooling system, heating system, and related components general maintenance and repair. DOK 2, AHC
 - a. Discuss theory and operation of the cooling system including heat absorption, heat dissipation, coolant type, coolant condition, coolant levels, and proper operation.
 - b. Using paper or electronic service manual find the vehicle service information, service history, service precautions, and technical service bulletins.
 - c. Discuss regulations regarding proper collection and disposal of fluids in accordance with EPA and OSHA requirements.
 - d. Inspect, adjust, and/or replace, hoses, thermostat and gasket, radiator cap, coolant, and other components affecting heat exchange.
 - e. Inspect, adjust, and or replace, heater ducts, doors, cabin filters, outlets, and perform necessary actions.
2. Identify, inspect, and perform air conditioning and related components general maintenance and repair. DOK 2, AHC
 - a. Discuss theory and operation of the air conditioning system including, drive belts, compressors, lines and hoses, dryers and accumulators, desiccant, condenser, evaporator, thermal expansion valves, orifice tubes, and high and low pressure cutoff switches.
 - b. Discuss EPA and OSHA regulations and requirements for handling, removal, storage, and replacement of refrigerants.
 - c. Inspect, adjust, or replace drive belts, compressor, lines and hoses, dryer and or accumulator, condenser, evaporator, thermal expansion valves, orifice tube, and high and low pressure cutoff switches.
 - d. Inspect, adjust, or replace, ducts, doors, cabin filters, outlets, actuators, switches, resistors, electronic control components, vents, and other interior components.
 - e. Reclaim, vacuum, test, and refill system refrigerant, oil, and add leak detecting dye.
 - f. Check system for leaks utilizing UV glasses and black light or sniffer type detectors.

Scenario

Drawing to Conclusions

Unit 11

In the classroom, students will be put into groups of two and given poster boards, markers, rulers, and other drawing materials needed to produce a poster. The student will choose between heating and or air conditioning (Thermal expansion, or Orifice tube) systems and draw the complete system. Suggest that students use different colors when keeping track of the changes of state for refrigerant or for temperature changes of liquid. Display posters in the classroom for others to see. This can be further enhanced by having students make cue cards for the parts involved and then place them on the correct components on an appropriate automobile in the shop.

Attachments for Scenario

See the Group Rubric and the Poster Rubric in the teacher resources document found on the RCU Curriculum Download page: www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Automotive Shop Operations	
	1. Describe local program and vocational/career technical center policies and procedures.
	2. Describe employment opportunities and responsibilities.
	3. Explore leadership skills and personal development opportunities provided students by student organizations to include SkillsUSA.
	4. Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	5. Discuss the history of the automotive industry to include materials, terminology, and techniques.
	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.
	7. Identify and apply concepts regarding safety procedures and practices in and around automotive operations.
	8. Explore general shop operations and safety.
Unit 2: Engine Repair	
	1. Identify and describe general vehicle information and repairs.
	2. Identify and describe the major systems and components of an automobile.
	3. Inspect, adjust, and/or repair cylinder head and valve train timing.
	4. Inspect, replace, and adjust lubrication and cooling systems.
	5. Inspect and perform general maintenance (lubrication, oils, and fluids).
Unit 3: Engine Transmission	
	1. Identify, inspect, and perform general maintenance and repair of automatic transmissions, transaxles and related components.
	2. Identify, inspect, and perform general maintenance and repair of Manual Drive Trains, axles, transfer cases, and related components.
Unit 4: Basic Electrical/Electronic Systems	

	1.	Explore general electrical/electronic systems and theories of operation.
	2.	Apply concepts of battery systems by performing inspection, diagnosis, and repair, if needed.
	3.	Apply concepts of starting systems by performing inspection, diagnosis, and repair, if needed.
	4.	Apply concepts of charging systems by performing inspection, diagnosis, and repair, if needed.
Unit 5: Automotive Brakes		
	1.	Explore general brake systems and theories of operation.
	2.	Apply concepts of hydraulic brake systems by performing inspection, diagnosis, and repair, if needed.
	3.	Apply concepts of disc brake systems by performing inspection, diagnosis, and repair, if needed.
	4.	Apply concepts of drum brake systems by performing inspection, diagnosis, and repair, if needed.
	5.	Apply concepts of power assist unit systems by performing inspection, diagnosis, and repair, if needed.
	6.	Apply concepts of miscellaneous systems by performing inspection, diagnosis, and repair, if needed.
	7.	Apply concepts of antilock brake, traction control systems, and vehicle stability control systems by performing inspection, diagnosis, and repair, if needed.
Unit 6: Automotive Shop Operations Review		
	1.	Demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations.
	2.	Identify and describe general safety rules, components of an automobile, tools / equipment, measurement practices, and fasteners for working in a shop/lab and industry.
	3.	Identify and apply concepts regarding safety procedures and practices in and around automotive operations.
	4.	Explore general shop operations and safety.
Unit 7: Advanced Electrical/Electronic Systems		
	1.	Explore lighting systems and theories of operation.
	2.	Apply concepts of gauges, warning devices, and driver information systems by performing inspection, diagnosis, and repair, if needed.
	3.	Apply concepts of horn and wiper/washer systems by performing inspection, diagnosis, and repair, if needed.
	4.	Apply concepts of accessories by performing inspection, diagnosis, and repair, if needed.
Unit 8: Engine Performance		

	1.	Explore general engine components and theories of operation.
	2.	Apply concepts of computerized engine controls by performing inspection, diagnosis, and repair, if needed.
	3.	Apply concepts of ignition systems by performing inspection, diagnosis, and repair, if needed.
Unit 9: Advanced Engine Performance		
	1.	Apply concepts of fuel, air induction, and exhaust systems by performing inspection, diagnosis, and repair, if needed.
	2.	Apply concepts of Fuel, Air Induction, and Exhaust Systems by performing inspection, diagnosis, and repair, if needed.
	3.	Apply concepts of Emissions Control Systems by performing inspection, diagnosis, and repair, if needed.
Unit 10: Suspension/Steering Systems		
	1.	Explore general suspension and steering systems and theories of operation.
	2.	Apply concepts of steering systems by performing inspection, diagnosis, and repair, if needed.
	3.	Apply concepts of wheel alignment.
	4.	Perform tire and wheel diagnosis and repair.
Unit 11: Automotive Heating and Air		
	1.	Identify, inspect, and perform cooling system, heating system, and related components general maintenance and repair.
	2.	Identify, inspect, and perform air conditioning and related components general maintenance and repair.

Appendix A: Unit References

All of the Automotive Service Technician units use the same resources for each unit. You will find suggested resources listed below.

Brain Pop. (n.d.). Retrieved April 24, 2013, from <http://www.brainpop.com/>

Mississippi Association for Career and Technical Education. (n.d.). Retrieved April 24, 2013, from <https://www.acteonline.org/stateprofiles/>

Mississippi Department of Education. (n.d.). Retrieved April 24, 2013, from <http://www.mde.k12.ms.us/>

Mississippi Department of Education Office of Career and Technical Education. (n.d.). Retrieved April 24, 2013, from <http://www.mde.k12.ms.us/career-and-technical-education>

Mississippi Institutions of Higher Learning. (n.d.). Retrieved April 24, 2013, from <http://www.ihl.state.ms.us/>

Mississippi SkillsUSA. (n.d.). Retrieved April 24, 2013, from <http://www.mde.k12.ms.us/career-and-technical-education/career-and-technical-student-organizations/skillsusa>

Research and Curriculum Unit. (n.d.). Retrieved April 24, 2013, from <http://info.rcu.msstate.edu/>

SkillsUSA. (n.d.). Retrieved April 24, 2013, from <http://www.skillsusa.org/>

State Board for Community and Junior Colleges. (n.d.). Retrieved April 24, 2013, from <http://www.sbcjc.cc.ms.us/>

Vocational Information Center. (n.d.). *Career and technical–vocational education*. Retrieved April 24, 2013, from <http://www.khake.com/page50.html>

Journals

Automotive Service Association. (n.d.). *Automotive Inc*. Retrieved August 15, 2007, from <http://www.autoinc.org/>

Babcox Publications. (n.d.). *Tomorrow's technician*. Retrieved August 15, 2007, from <http://www.tomorrowstechnician.com/>

Texts

Automotive technology: The electronic classroom—basic automotive. (2004). Upper Saddle River, NJ: Pearson Education. (Text and DVD available)

Automotive technology: The electronic classroom—brakes. (2004). Upper Saddle River, NJ: Pearson Education. (Text and DVD available)

- Automotive technology: The electronic classroom—electrical/electronics.* (2004). Upper Saddle River, NJ: Pearson Education. (Text and DVD available)
- Automotive technology: The electronic classroom—engine performance.* (2004). Upper Saddle River, NJ: Pearson Education. (Text and DVD available)
- Automotive technology: The electronic classroom—steering and suspension.* (2004). Upper Saddle River, NJ: Pearson Education. (Text and DVD available)
- Automotive technology curriculum—basic automotive.* (2003). Columbia, MO: Instructional Materials Laboratory. (Instructor guide, student guide, workbook, CD-ROM, student task list, and transparencies available)
- Automotive technology curriculum—brakes.* (2003). Columbia, MO: Instructional Materials Laboratory. (Instructor guide, student guide, workbook, CD-ROM, student task list, and transparencies available)
- Automotive technology curriculum—electrical/Electronics.* (2003). Columbia, MO: Instructional Materials Laboratory. (Instructor guide, student guide, workbook, CD-ROM, student task list, and transparencies available)
- Automotive technology curriculum—engine performance.* (2003). Columbia, MO: Instructional Materials Laboratory. (Instructor guide, student guide, workbook, CD-ROM, student task list, and transparencies available)
- Automotive technology curriculum—steering and suspension.* (2003). Columbia, MO: Instructional Materials Laboratory. (Instructor guide, student guide, workbook, CD-ROM, student task list, and transparencies available)
- Duffy, J. E. (2004). *Modern automotive technology.* Tinleypark, IL: Goodheart-Wilcox. (Instructor guide, student guide, and workbook available)
- Erjavrc, J. (2004). *Automotive technology.* Clifton Park, NY: Thomson Delmar Learning. (Instructor guide and e-resource available)
- Glencoe McGraw-Hill. (2004). *Automotive excellence* (Vol. 1). Peoria, IL: Author. (Instructor guide, student guide, CD-ROM, transparency unit, and technical application guide available)
- Glencoe McGraw-Hill. (2004). *Automotive excellence* (Vol. 2). Peoria, IL: Author. (Instructor guide, student guide, CD-ROM, transparency unit, and technical application guide available)

Videos

Shopware.films.com

Web Sites

AAI Car Auto Repair Diagnosis Help. (n.d.). Retrieved April 24, 2013, from <http://www.aalcar.com/>

Alldata. Retrieved April 24, 2013, from <http://www.alldata.com/>

Automotive-links. (n.d.). Retrieved April 24, 2013, from <http://www.automotive-links.com/>

AutoZone. (n.d.). Retrieved April 24, 2013, from <http://www.autozone.com/home.htm>

Battery Stuff. (n.d.). Read our tutorials. In *Battery Stuff*. Retrieved April 24, 2013, from http://www.batterystuff.com/tutorials_index.html

Carquest. (n.d.). Retrieved April 24, 2013, from <http://www.carquest.com/>

Delmar Cengage Learning. (n.d.). Web links. In *Resources*. Retrieved April 24, 2013, from http://www.autoed.com/resources/links/links_index.aspx

Electronics Teacher. (n.d.). Retrieved April 24, 2013, from <http://www.electronicsteacher.com/>

Electronics Zone. (n.d.). *Electronics tutorials—learn how to build an electronic circuit.* Retrieved April 24, 2013, from <http://www.electronic-circuits-diagrams.com/tutorials.shtml>

The Family Car. (n.d.). Understanding your car. In *The Family Car Learning Center*. Retrieved April 24, 2013, from <http://www.familycar.com/Classroom>

GM Performance Parts. (n.d.). Retrieved April 24, 2013, from <http://www.gmperformanceparts.com/home.jsp>

Goodheart-Willcox Publisher. (n.d.). Retrieved April 24, 2013, from <http://www.g-w.com/>

How stuff works. (n.d.). Retrieved April 24, 2013, from <http://www.howstuffworks.com/>

Live for Speed. (n.d.). Mechanics of steering and suspension and suspension types. In *Technical Reference*. Retrieved April 24, 2013, from [http://en.lfsmanual.net/wiki/Technical Reference](http://en.lfsmanual.net/wiki/Technical_Reference)

Melior, Inc. (n.d.). *Today's class*. Retrieved December 16, 2007, from <http://www.todaysclass.com/>

Napa. (n.d.). Retrieved April 24, 2013, from <http://www.napaonline.com/>

National Automotive Technicians Education Foundation. (n.d.). Retrieved April 24, 2013, from <http://www.natef.org/>

National Institute for Automotive Service Excellence. (n.d.). Retrieved April 24, 2013, from <http://www.asecert.org/>

O'Reilly Auto Parts. (n.d.). Retrieved April 24, 2013, from <http://www.oreillyauto.com/>

Sullivan, K. (n.d.). *Autoshop101: Automotive training and resources site for automotive electronics*. Retrieved April 24, 2013, from www.autoshop101.com

For additional references, activities, and Web resources, please refer to the Information and Computer Technology B.R.I.D.G.E. Web site: <http://www.rcu.blackboard.com> (available only to registered users).

Appendix B: Industry Standards

AUTOMOTIVE SERVICE TECHNICIAN (AST) PATHWAY CONTENT STANDARDS AND PERFORMANCE ELEMENTS

Crosswalk for Automotive Service Technician											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
ASO – Automotive Shop Operations		X					X				
AER - Automotive Engine Repair			X								
ATS - Automotive Transmission Service				X							
AEE - Automotive Electrical/Electronics					X			X			
ASB - Automotive Service Brakes						X					
AEP - Automotive Engine Performance									X		
AST - Automotive Suspension/Steering										X	
AHC - Automotive Heating and Cooling											X

Automotive Shop Operations

ASO

- Shop and Personal Safety
- Tools and Equipment
- Preparing Vehicle for Service
- Preparing Vehicle for Customer

Automotive Engine Repair

AER

- 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
- Cylinder Head and Valve Train
- Lubrication and Cooling Systems

Automotive Transmission Service

ATS

- 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
- Automatic Transmission/Transaxle
 - General
 - In-Vehicle Transmission/Transaxle
 - Off-Vehicle Transmission and Transaxle

- Manual Drive Train and Axles
 - General
 - Clutch
 - Transmission/Transaxle
 - Drive Shaft, Half Shafts, Universal and Constant-Velocity (CV) Joints
 - Differential Case Assembly
 - Drive Axles
 - Four-wheel Drive/All-wheel Drive

Automotive Service Electrical/Electronics

ASE

- 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: Electric 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 Service Brakes

ASB

- 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.)
- Electronic Brakes, and Traction and Stability Control Systems Diagnosis and Repair

Automotive Engine Performance

AEP

- 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

Automotive Suspension/Steering

AST

- 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 Suspension and Steering Systems Diagnosis
- General
- Steering Systems Diagnosis and Repair
- Suspension Systems Diagnosis and Repair
- Related Suspension and Steering Service
- Wheel Alignment Diagnosis, Adjustment, and Repair
- Wheels and Tires Diagnosis and Repair

Automotive Heating and Air Conditioning

AHC

- 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: A/C System Diagnosis and Repair
- Refrigeration System Component Diagnosis and Repair
- Heating, Ventilation, and Engine Cooling Systems Diagnosis and Repair
- Operating Systems and Related Controls Diagnosis and Repair
- Refrigerant Recovery, Recycling, and Handling

Appendix C: 21st Century Skills¹

21st Century Crosswalk for Automotive Service Technician											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
21 st Century Standards											
CS1		X					X				
CS2		X					X				
CS3		X					X				
CS4		X	X	X	X	X	X	X	X	X	X
CS5		X	X	X	X	X	X	X	X	X	X
CS6		X	X	X	X	X	X	X	X	X	X
CS7		X	X	X	X	X	X	X	X	X	X
CS8		X	X	X	X	X	X	X	X	X	X
CS9		X	X	X	X	X	X	X	X	X	X
CS10		X	X	X	X	X	X	X	X	X	X
CS11		X	X	X	X	X	X	X	X	X	X
CS12		X	X	X	X	X	X	X	X	X	X
CS13		X	X	X	X	X	X	X	X	X	X
CS14		X	X	X	X	X	X	X	X	X	X
CS15		X	X	X	X	X	X	X	X	X	X
CS16		X	X	X	X	X	X	X	X	X	X

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

¹ *21st century skills*. (n.d.). Washington, DC: Partnership for 21st Century Skills.

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 toward 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 D: Common Core Standards

Common Core Crosswalk for English/Language Arts (11-12)											
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
RL.11.1.		X	X	X	X	X	X	X	X	X	X
RL.11.2.		X	X	X	X	X	X	X	X	X	X
RL.11.3.											
RL.11.4.		X	X	X	X	X	X	X	X	X	X
RL.11.5.		X	X	X	X	X	X	X	X	X	X
RL.11.6.											
RL.11.7.											
RL.11.8.											
RL.11.9.											
RL.11.10.											
RI.11.1.		X	X	X	X	X	X	X	X	X	X
RI.11.2.		X	X	X	X	X	X	X	X	X	X
RI.11.3.		X	X	X	X	X	X	X	X	X	X
RI.11.4.		X	X	X	X	X	X	X	X	X	X
RI.11.5.		X	X	X	X	X	X	X	X	X	X
RI.11.6.											
RI.11.7.		X	X	X	X	X	X	X	X	X	X
RI.11.8.											
RI.11.9.											
RI.11.10.		X	X	X	X	X	X	X	X	X	X
W.11.1.		X	X	X	X	X	X	X	X	X	X
W.11.2.		X	X	X	X	X	X	X	X	X	X
W.11.3.		X	X	X	X	X	X	X	X	X	X
W.11.4.		X	X	X	X	X	X	X	X	X	X
W.11.5.		X	X	X	X	X	X	X	X	X	X
W.11.6.		X	X	X	X	X	X	X	X	X	X
W.11.7.		X	X	X	X	X	X	X	X	X	X
W.11.8.		X	X	X	X	X	X	X	X	X	X
W.11.9.		X	X	X	X	X	X	X	X	X	X
W.11.10.		X	X	X	X	X	X	X	X	X	X
SL.11.1.											
SL.11.2.		X	X	X	X	X	X	X	X	X	X
SL.11.3.		X	X	X	X	X	X	X	X	X	X
SL.11.4.		X	X	X	X	X	X	X	X	X	X
SL.11.5.		X	X	X	X	X	X	X	X	X	X
SL.11.6.											
L.11.1.		X	X	X	X	X	X	X	X	X	X
L.11.2.		X	X	X	X	X	X	X	X	X	X
L.11.3.		X	X	X	X	X	X	X	X	X	X
L.11.4.		X	X	X	X	X	X	X	X	X	X
L.11.5.		X	X	X	X	X	X	X	X	X	X
L.11.6.		X	X	X	X	X	X	X	X	X	X
RH.11.1.		X	X	X	X	X	X	X	X	X	X
RH.11.2.		X	X	X	X	X	X	X	X	X	X
RH.11.3.		X	X	X	X	X	X	X	X	X	X
RH.11.4.		X	X	X	X	X	X	X	X	X	X
RH.11.5.		X	X	X	X	X	X	X	X	X	X
RH.11.6.											
RH.11.7.		X	X	X	X	X	X	X	X	X	X
RH.11.8.		X	X	X	X	X	X	X	X	X	X
RH.11.9.		X	X	X	X	X	X	X	X	X	X
RH.11.10.											
RST.11.1.		X	X	X	X	X	X	X	X	X	X
RST.11.2.		X	X	X	X	X	X	X	X	X	X
RST.11.3.		X	X	X	X	X	X	X	X	X	X

RST.11.4.		X	X	X	X	X	X	X	X	X	X	X
RST.11.5.		X	X	X	X	X	X	X	X	X	X	X
RST.11.6.		X	X	X	X	X	X	X	X	X	X	X
RST.11.7.		X	X	X	X	X	X	X	X	X	X	X
RST.11.8.		X	X	X	X	X	X	X	X	X	X	X
RST.11.9.		X	X	X	X	X	X	X	X	X	X	X
RST.11.10.		X	X	X	X	X	X	X	X	X	X	X
WHST.11.1.												
WHST.11.2.		X	X	X	X	X	X	X	X	X	X	X
WHST.11.3.												
WHST.11.4.												
WHST.11.5.												
WHST.11.6.		X	X	X	X	X	X	X	X	X	X	X
WHST.11.7.		X	X	X	X	X	X	X	X	X	X	X
WHST.11.8.		X	X	X	X	X	X	X	X	X	X	X
WHST.11.9.		X	X	X	X	X	X	X	X	X	X	X
WHST.11.10.												

Reading Standards for Literature (11-12)

College and Career Readiness Anchor Standards for *Reading Literature*

Key Ideas and Details

RL.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RL.11.2. Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

RL.11.3. Analyze the impact of the author’s choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).

Craft and Structure

RL.11.4. Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including words with multiple meanings or language that is particularly fresh, engaging, or beautiful. (Include Shakespeare as well as other authors.)

RL.11.5. Analyze how an author’s choices concerning how to structure specific parts of a text (e.g., the choice of where to begin or end a story, the choice to provide a comedic or tragic resolution) contribute to its overall structure and meaning as well as its aesthetic impact.

RL.11.6. Analyze a case in which grasping point of view requires distinguishing what is directly stated in a text from what is really meant (e.g., satire, sarcasm, irony, or understatement).

Integration of Knowledge and Ideas

RL.11.7. Analyze multiple interpretations of a story, drama, or poem (e.g., recorded or live production of a play or recorded novel or poetry), evaluating how each version interprets the source text. (Include at least one play by Shakespeare and one play by an American dramatist.)

RL.11.8. (Not applicable to literature)

RL.11.9. Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics.

Range of Reading and Level of Text Complexity

RL.11.10. By the end of grade 11, read and comprehend literature, including stories, dramas, and poems, in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

By the end of grade 12, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Informational Text (11-12)

College and Career Readiness Anchor Standards for *Informational Text*

Key Ideas and Details

RI.11.1. Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

RI.11.2. Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

RI.11.3. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text.

Craft and Structure

RI.11.4. Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RI.11.5. Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.

RI.11.6. Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text.

Integration of Knowledge and Ideas

RI.11.7. Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

RI.11.8. Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., *The Federalist*, presidential addresses).

RI.11.9. Analyze seventeenth-, eighteenth-, and nineteenth-century foundational U.S. documents of historical and literary significance (including *The Declaration of Independence*, the Preamble to the Constitution, the Bill of Rights, and Lincoln's Second Inaugural Address) for their themes, purposes, and rhetorical features.

Range of Reading and Level of Text Complexity

RI.11.10. By the end of grade 11, read and comprehend literary nonfiction in the grades 11–CCR text complexity band proficiently, with scaffolding as needed at the high end of the range.

By the end of grade 12, read and comprehend literary nonfiction at the high end of the grades 11–CCR text complexity band independently and proficiently.

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

W.11.1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.

b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.

c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.

d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

e. Provide a concluding statement or section that follows from and supports the argument presented.

W.11.2. Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

c. Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

d. Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic.

e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

W.11.3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

- a. Engage and orient the reader by setting out a problem, situation, or observation and its significance, establishing one or multiple point(s) of view, and introducing a narrator and/or characters; create a smooth progression of experiences or events.
- b. Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters
- c. Use a variety of techniques to sequence events so that they build on one another to create a coherent whole and build toward a particular tone and outcome (e.g., a sense of mystery, suspense, growth, or resolution).
- d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.
- e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

Production and Distribution of Writing

W.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

W.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1–3 up to and including grades 11–12 on page 54.)

W.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

W.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

W.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

W.11.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

a. Apply grades 11–12 Reading standards to literature (e.g., “Demonstrate knowledge of eighteenth-, nineteenth- and early-twentieth-century foundational works of American literature, including how two or more texts from the same period treat similar themes or topics”).

b. Apply grades 11–12 Reading standards to literary nonfiction (e.g., “Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning [e.g., in U.S. Supreme Court Case majority opinions and dissents] and the premises, purposes, and arguments in works of public advocacy [e.g., *The Federalist*, presidential addresses]”).

Range of Writing

W.11.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

SL.11.1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively.

a. Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

b. Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

d. Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.

SL.11.2. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

SL.11.3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

Presentation of Knowledge and Ideas

SL.11.4. Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11.5. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11.6. Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate. (See grades 11–12 Language standards 1 and 3 on page 54 for specific expectations.)

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

L.11.1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

a. Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

b. Resolve issues of complex or contested usage, consulting references (e.g., Merriam-Webster's Dictionary of English Usage, Garner's Modern American Usage) as needed.

L.11.2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

a. Observe hyphenation conventions.

b. Spell correctly.

Knowledge of Language

L.11.3. Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

- a. Vary syntax for effect, consulting references (e.g., Tufte’s *Artful Sentences*) for guidance as needed; apply an understanding of syntax to the study of complex texts when reading.

Vocabulary Acquisition and Use

L.11.4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.

- a. Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word’s position or function in a sentence) as a clue to the meaning of a word or phrase.
- b. Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).
- c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.
- d. Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

L.11.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

- a. Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.
- b. Analyze nuances in the meaning of words with similar denotations.

L.11.6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Reading Standards for Literacy in History/Social Studies (11-12)

Key Ideas and Details

RH.11.1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole.

RH.11.2. Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas

RH.11.3. Evaluate various explanations for actions or events and determine which explanation best accords with textual evidence, acknowledging where the text leaves matters uncertain

Craft and Structure

RH.11.4. Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

RH.11.5. Analyze in detail how a complex primary source is structured, including how key sentences, paragraphs, and larger portions of the text contribute to the whole.

RH.11.6. Evaluate authors' differing points of view on the same historical event or issue by assessing the authors' claims, reasoning, and evidence.

Integration of Knowledge and Ideas

RH.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.11.8. Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

RH.11.9. Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Range of Reading and Level of Text Complexity

RH.11.10. By the end of grade 12, read and comprehend history/social studies texts in the grades 11–CCR text complexity band independently and proficiently.

Reading Standards for Literacy in Science and Technical Subjects (11-12)

Key Ideas and Details

RST.11.1. Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11.2. Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11.3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure

RST.11.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.

RST.11.5. Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11.6. Analyze the author’s purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

RST.11.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11.8. Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

RST.11.9. Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

RST.11.10. By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects (11-12)

Text Types and Purposes

WHST.11.1. Write arguments focused on discipline-specific content.

- a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience’s knowledge level, concerns, values, and possible biases.
- c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
- d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
- e. Provide a concluding statement or section that follows from or supports the argument presented.

WHST.11.2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

- a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
- b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic.

- c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.
- d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style that responds to the discipline and context as well as to the expertise of likely readers.
- e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11.3. (Not applicable as a separate requirement)

Production and Distribution of Writing

WHST.11.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11.6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

Research to Build and Present Knowledge

WHST.11.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

WHST.11.8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11.9. Draw evidence from informational texts to support analysis, reflection, and research.

Range of Writing

WHST.11.10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Common Core Crosswalk for Mathematics (11-12)

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
Common Core Standards											
N-RN.1.			X	X	X	X		X	X	X	X
N-RN.2.			X	X	X	X		X	X	X	X
N-RN.3.			X	X	X	X		X	X	X	X
N-Q.1.			X	X	X	X		X	X	X	X
N-Q.2.			X	X	X	X		X	X	X	X
N-Q.3.			X	X	X	X		X	X	X	X
N-CN.1.											
N-CN.2.											
N-CN.3.											
N-CN.4.											
N-CN.5.			X	X	X		X	X	X	X	X
N-CN.6.											
N-CN.7.											
N-CN.8.											
N-CN.9.											
N-VM.1.											
N-VM.2.											
N-VM.3.					X						
N-VM.4.					X						
N-VM.5.											
N-VM.6.											
N-VM.7.											
N-VM.8.											
N-VM.9.											
N-VM.10.											
N-VM.11.											
N-VM.12.											
A-SSE.1.		X	X	X	X	X	X	X	X	X	X
A-SSE.2.		X	X	X	X	X	X	X	X	X	X
A-SSE.3.		X	X	X	X	X	X	X	X	X	X
A-SSE.4.			X		X	X					
A-APR.1.											
A-APR.2.											
A-APR.3.											
A-APR.4.											
A-APR.5.											
A-APR.6.											
A-APR.7.											
A-CED.1.											
A-CED.2.											
A-CED.3.		X					X				
A-CED.4.					X			X			
A-REI.1.											
A-REI.2.											
A-REI.3.											
A-REI.4.											
A-REI.5.											
A-REI.6.											
A-REI.7.											
A-REI.8.											
A-REI.9.											
A-REI.10.									X		
A-REI.11.									X		
A-REI.12.											
F-IF.1.											
F-IF.2.											
F-BF.1.						X					

F-BF.2.												
F-BF.3.												
F-BF.4.												
F-LE.1.									X			
F-LE.2.												
F-LE.3.												
F-LE.4.												
F-LE.5.												
F-TF.1.												
F-TF.2.												
F-TF.3.												
F-TF.4.												
F-TF.5.												
F-TF.6.												
F-TF.7.												
F-TF.8.												
F-TF.9.												
G-CO.1.			X									
G-CO.2.			X									
G-CO.3.												
G-CO.4.			X						X			
G-CO.5.												
G-CO.6.												
G-CO.7.												
G-CO.8.												
G-CO.9.												
G-CO.10.												
G-CO.11.												
G-CO.12.												
G-CO.13.												
G-SRT.1.												
G-SRT.2.												
G-SRT.3.												
G-SRT.4.												
G-SRT.5.												
G-SRT.6.												
G-SRT.7.												
G-SRT.8.												
G-SRT.9.												
G-SRT.10.												
G-SRT.11.												
G-C.1.			X						X			
G-C.2.												
G-C.3.												
G-C.4.												
G-C.5.												
G-GPE.1.			X							X		
G-GPE.2.												
G-GPE.3.												
G-GPE.4.												
G-GPE.5.												
G-GPE.6.												
G-GPE.7.												
G-GMD.1.			X									
G-GMD.2.			X									
G-GMD.3.												
G-GMD.4.												
G-MG.1.			X									
G-MG.2.			X									X
G-MG.3.												
S-ID.1.												
S-ID.2.												
S-ID.3.												
S-ID.4.												
S-ID.5.												

The Complex Number System

N-CN.1. Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.

N-CN.2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.

N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}i)^3 = 8$ because $(-1 + \sqrt{3}i)$ has modulus 2 and argument 120° .

N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.

N-CN.7. Solve quadratic equations with real coefficients that have complex solutions.

N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.

N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

Vector and Matrix Quantities

N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., \mathbf{v} , $|\mathbf{v}|$, $\|\mathbf{v}\|$, v).

N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

N-VM.4. (+) Add and subtract vectors

N-VM.4.a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

N-VM.4.b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

N-VM.4.c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w , with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

N-VM.5. (+) Multiply a vector by a scalar.

N-VM.5.a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.

N-VM.5.b. Compute the magnitude of a scalar multiple cv using $\|cv\| = |c|v\|$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).

N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions.

N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties

N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

N-VM.12. (+) Work with 2×2 matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

Algebra

Seeing Structure in Expressions

A-SSE.1. Interpret expressions that represent a quantity in terms of its context.

A-SSE.1.a. Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.1.b. Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P .

A-SSE.2. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-SSE.3.a. Factor a quadratic expression to reveal the zeros of the function it defines.

A-SSE.3.b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-SSE.3.c. Use the properties of exponents to transform expressions for exponential functions.

A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.

Arithmetic with Polynomials and Rational Expressions

A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials

A-APR.2. Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a , the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.

A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-APR.4. Prove polynomial identities and use them to describe numerical relationships.

A-APR.5. (+) Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer n , where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

A-APR.6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.

A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

Creating Equations

A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law $V = IR$ to highlight resistance R .

Reasoning with Equations and Inequalities

A-REI.1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

A-REI.3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

A-REI.4. Solve quadratic equations in one variable.

A-REI.4.a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

A-REI.4.b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b .

A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.

A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.

A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater).

A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.11. Explain why the x -coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

A-REI.12. Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Functions

Interpreting Functions

F-IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x . The graph of f is the graph of the equation $y = f(x)$.

F-IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n+1) = f(n) + f(n-1)$ for $n \geq 1$.

F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F-IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function $h(n)$ gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-IF.7.a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

F-IF.7.b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.7.c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

F-IF.7.d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

F-IF.7.e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.

F-IF.8.a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

F-IF.8.b. Use the properties of exponents to interpret expressions for exponential functions.

F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

Building Functions

F-BF.1. Write a function that describes a relationship between two quantities.

F-BF.1.a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF.1.b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.

F-BF.1.c. (+) Compose functions. For example, if $T(y)$ is the temperature in the atmosphere as a function of height, and $h(t)$ is the height of a weather balloon as a function of time, then $T(h(t))$ is the temperature at the location of the weather balloon as a function of time.

F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-BF.3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

F-BF.4. Find inverse functions.

F-BF.4.a. Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse.

F-BF.4.b. (+) Verify by composition that one function is the inverse of another.

F-BF.4.c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.

F-BF.4.d. (+) Produce an invertible function from a non-invertible function by restricting the domain.

F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Linear, Quadratic, and Exponential Models

F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

F-LE.1.a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.

F-LE.1.b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

F-LE.1.c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.

F-LE.4. For exponential models, express as a logarithm the solution to $ab^ct = d$ where a , c , and d are numbers and the base b is 2, 10, or e ; evaluate the logarithm using technology.

F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.

Trigonometric Functions

F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

F-TF.2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.

F-TF.3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for $\pi-x$, $\pi+x$, and $2\pi-x$ in terms of their values for x , where x is any real number.

F-TF.4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.

F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.

F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

Geometry

Congruence

G-CO.1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.

G-CO.2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

G-CO.3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.

G-CO.4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.

G-CO.5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

G-CO.6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

G-CO.7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

G-CO.8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.

G-CO.9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

G-CO.10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180° ; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

G-CO.11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

G-CO.12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

G-CO.13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

Similarity, Right Triangles, and Trigonometry

G-SRT.1. Verify experimentally the properties of dilations given by a center and a scale factor:

G-SRT.1.a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.

G-SRT.1.b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

G-SRT.2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.

G-SRT.3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

G-SRT.4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

G-SRT.5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

G-SRT.6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.

G-SRT.7. Explain and use the relationship between the sine and cosine of complementary angles.

G-SRT.8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

G-SRT.9. (+) Derive the formula $A = \frac{1}{2} ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

G-SRT.10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.

G-SRT.11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).

Circles

G-C.1. Prove that all circles are similar.

G-C.2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

G-C.3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.

G-C.4. (+) Construct a tangent line from a point outside a given circle to the circle.

G-C.5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.

Expressing Geometric Properties with Equations

G-GPE.1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.

G-GPE.2. Derive the equation of a parabola given a focus and directrix.

G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

G-GPE.4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point $(1, \sqrt{3})$ lies on the circle centered at the origin and containing the point $(0, 2)$.

G-GPE.5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).

G-GPE.6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

G-GPE.7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

Geometric Measurement and Dimension

G-GMD.1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

G-GMD.2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

G-GMD.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

G-GMD.4. Identify the shapes of two-dimensional cross-sections of three dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

Modeling with Geometry

G-MG.1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

G-MG.2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Statistics and Probability

Interpreting Categorical and Quantitative Data

S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots).

S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.

Use calculators, spreadsheets, and tables to estimate areas under the normal curve.

S-ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.

S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S-ID.6.a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

S-ID.6.b. Informally assess the fit of a function by plotting and analyzing residuals.

S-ID.6.c. Fit a linear function for a scatter plot that suggests a linear association.

S-ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

S-ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit.

S-ID.9. Distinguish between correlation and causation.

Making Inferences and Justifying Conclusions

S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?

S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC.6. Evaluate reports based on data.

Conditional Probability and the Rules of Probability

S-CP.1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).

S-CP.2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

S-CP.3. Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$, and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

S-CP.4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.

S-CP.5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

S-CP.6. Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model.

S-CP.7. Apply the Addition Rule, $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$, and interpret the answer in terms of the model.

S-CP.8. (+) Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$, and interpret the answer in terms of the model.

S-CP.9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Using Probability to Make Decisions

S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.

S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.

S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.

S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?

S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

S-MD.5.a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.

S-MD.5.b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).

S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Appendix E: National Educational Technology Standards for Students (NETS-S)

NETS Crosswalk for Automotive Service Technician											
	Course	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Unit 10
NETS Standards											
T1		X	X	X	X	X	X	X	X	X	X
T2		X	X	X	X	X	X	X	X	X	X
T3		X	X	X	X	X	X	X	X	X	X
T4		X	X	X	X	X	X	X	X	X	X
T5		X					X				
T6		X					X				

- 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.