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Welding Technology

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Research and Curriculum Unit for Workforce Development
Vocational and Technical Education
Attention: Reference Room and Media Center Coordinator
P.O. Drawer DX
Mississippi State, MS 39762
www.rcu.msstate.edu/curriculum/download/
662.325.2510

Direct inquiries to

Doug Ferguson
Instructional Design Specialist
P.O. Drawer DX
Mississippi State, MS 39762
662.325.2510
E-mail: doug.ferguson@rcu.msstate.edu

Andy Sims
Program Coordinator
Office of Vocational Education and Workforce Development
Mississippi Department of Education
P.O. Box 771
Jackson, MS 39205
601.359.3479
E-mail: asims@mde.k12.ms.us

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Doug Ferguson, Author
Robin Parker, EdD, Coordinator of Workforce Education
Jolanda Harris, Educational Technologist
Amy Johnson, Multimedia Specialist
Johnny Jones, Digital Print Specialist
Louis Randle, Binding Specialist
Kelly Agee, Editor
Kim Harris, Graphic Artist

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.

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Finally, standards in the *Welding Curriculum Framework and Supporting Materials* are based on the following:

Contren Learning Series from the National Center for Construction Education and Research
Reprinted with permission from Contren Learning Series, Copyright © 2008, National Center for Construction Education and Research, 352.334.0920, http://www.nccer.org/index.asp

Applied Academic Credit Benchmarks
Mississippi Department of Education 2007 Mississippi Mathematics Framework Revised

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.

National Educational Technology Standards for Students
Reprinted with permission from *National Educational Technology Standards for Students: Connecting Curriculum and Technology*, Copyright © 2007, ISTE (International Society for Technology in Education), 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.

ACT College Readiness Standards

The College Readiness Standards are sets of statements intended to help students understand what is expected of them in preparation for the ACT. These standards are integrated into teaching and assessment strategies throughout the curriculum framework.

Preface

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

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Welding Executive Summary

Program Description

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

Industry Certification

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

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

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

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

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

Articulation

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

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

Assessment

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

Student Prerequisites

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

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)

   or
3. Instructor Approval and TABE Reading Score (eighth grade or higher)

   or
4. Instructor Approval

Proposed Applied Academic Credit

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

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

Licensure Requirements

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

1. Applicant must hold a 2-year college degree (associate's degree) or higher from an accredited institution of higher education.
2. Applicant with an associate's degree must have at least 2 years of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught. Applicant with a bachelor's or higher degree must have at least 1 year of verifiable occupational experience in the past 10 years. Experience must be appropriate to the subject to be taught.
3. Applicant must enroll immediately in the Vocational Instructor Preparation (VIP) or the *Redesign* Education Program (REP).

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

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

Professional Learning

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

Course Outlines

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

Option 1

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

Introduction to Welding .....(Course Code: 993300)
Advanced Welding .....(Course Code: 993301)

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

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

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

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

Introduction to Welding (Course Code: 993300)

Unit		Title	Hours
1		Orientation, Leadership, and Safety	35
2		Welding Math	35
3		Introduction to Blueprints (Welding Symbols), Hand and Power Tools, and Basic Rigging	40
4		Base Metal Preparation, Weld Quality, Oxy-fuel Cutting	45
5		Introduction to Shielded Metal Arc Welding (SMAW) (Equipment and Setup, Electrodes, Beads and Fillet Welds)	125
			280

Advanced Welding (Course Code: 993301)

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	35
5		Introduction to Shielded Metal Arc Welding (SMAW) (Equipment and Setup, Electrodes, Beads and Fillet Welds)	105
7		Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	100
8		Gas Tungsten Arc Welding (GTAW)	40
			280

Option 2

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

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

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

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

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

Course Description: Production Welding Processes (Course Code: 993305) includes an overview of Resistance Welding, Robotic Welding, Frictional Stir Welding, and Induction Welding. This one-Carnegie-unit course should only be taken after students successfully pass Orientation and Cutting and Gas Metal, Flux Core, and Gas Tungsten Welding.

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

Orientation and Cutting (Course Code: 993302)

Unit		Title	Hours
1		Orientation, Leadership, and Safety	35
2		Welding Math	40
3		Introduction to Blueprints(Welding Symbols), Hand and Power Tools, and Basic Rigging	65
			140

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

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	5
4		Base Metal Preparation and Weld Quality, Oxy-fuel Cutting, Plasma Arc Cutting, and Carbon Arc Cutting	65
5		Shielded Metal Arc Welding (SMAW)	135
			140

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

Unit		Title	Hours
6		Orientation and Safety (Review and Reinforcement of Unit 1)	5
7		Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW)	95
8		Gas Tungsten Arc Welding (GTAW)	40
			140

Production Welding Processes (Course Code: 993305)

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

Using This Document

Unit Number and Title

Suggested Time on Task
An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Objectives
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested objectives represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Suggested Teaching Strategies
This section of each unit indicates research-based strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies that reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.

Suggested Assessment Strategies
This section indicates research-based strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

Integrated Academic Topics, 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.

Welding

Unit 1: Orientation, Leadership, and Safety

Competency 1: Describe local program and vocational/career–technical center policies and procedures. (CONTREN Module: 00107-09 and 00108-09) (DOK 1) COM, EMP

Suggested Enduring Understandings

1. Safety is an integral part of daily life.
2. Rules and regulations are essential to a safe work environment.

Suggested Essential Questions

1. What would happen if there were no rules and regulations?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe local program and vocational/career–technical center policies and procedures. (DOK 1)	a. Discuss school policy, dress code, attendance, academic requirements, discipline, transportation regulations, and MS-CPAS2 requirements using the school handbook, and discuss the history of the occupational skill and how it relates to today's technology. Then have a student with higher reading ability partner with a student who has lower reading ability to read the course syllabus and career center rules. Once the students have read the syllabus and rules, have students discuss the ramifications of breaking rules and regulations set forth by the school, department, and/or instructor. To determine if the students understand the school rules, use a "hook" to get the students involved in the classroom exercise. Start by giving the students scenarios that set up a rule violation, and then call on a student to discuss what may happen as a result of rule breaking. Have students act out punishment scenarios. Assign one student to be a school director or principal, and have another student act as a student offender. The student offender should give a defense of the rule violation about why he or she broke the school regulation. The mock principal should evaluate the offense using the school rules and regulations and then make a decision regarding punishment. After the role-play activity, ask students in the class to give their opinions about the seriousness of the offense and if they think the punishment given by the thespian principal is fair. Make sure to reinforce the school rules and regulations before moving on to another topic. CS3, CS4, CS5, E1, E2, E3, E4	a. The role-play will be evaluated by students answering questions about the topics presented and by using the **Role-Play or Skit Rubric**. Then give an electronic test on local school rules and regulations using the Blackboard class Web site. Have students complete a form verifying that they have received instructions on local school rules and policies. Parents/guardians should also sign to acknowledge rules and policies. This should be kept in a student folder.

Competency 2: Describe employment opportunities and responsibilities of the welder. (CONTREN Module: 00107-09, 00108-09) (DOK 1) COM, EMP

Suggested Enduring Understandings

1. Employers are looking for specific skills and abilities in employees.
2. Stay aware of job opportunities in your field.

Suggested Essential Questions

1. What would the nation and world be like without welders?
2. How can I make myself more employable for jobs in welding?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe employer expectations in the workplace. (DOK 1)	a. Relate employment opportunities including the following: • Potential earnings, employee benefits, job availability, place of employment, working conditions, and educational requirements to students' success in a secondary or postsecondary manufacturing curriculum • Describe basic employee responsibilities; demonstrate the ability to follow verbal and written instructions and communicate effectively in on-the-job situations. • Explain the service industry, the role of the companies that make up the industry, and the role of individual professionals in the industry. • Demonstrate critical-thinking skills and the ability to solve problems using those skills. • Demonstrate knowledge of computer systems, and explain common uses for computers in industry. • Demonstrate effective relationship skills with teammates and supervisors, the ability to work on a team, and appropriate leadership skills. • Be aware of workplace issues such as sexual harassment, stress, and substance abuse. Afterward, get the students to discuss what their expectations are from their high school degrees and how they plan to use their high school diplomas. Ask the students if they plan to attend a community or senior college after graduating high school. Let the students interact with one another and discuss what they want to do with their skills. Discuss how the skills learned in your classroom relate to postsecondary courses available in higher education; give a brief history of the county/city school district, when the career–technical center was built, and why it was built. Tell the students who the vocational complex is intended to serve (industry needs). Then have students research area job opportunities that are available within the local industry relating to the craft. Allow students to	a. Have students submit the article for a daily grade. Have students write a report on what the former student talked about and how they can use the information to attain a potential job. Use the **Writing Rubric** to evaluate the student's work.

use any media available to them so that they are focused on job availability by using the most desirable method to them. After initially discussing what each student plans to do after graduation, have students perform Internet research on community colleges that offer degrees and certificates in the craft.

Have students relate how their course relates to postsecondary courses that are available to them at their nearest local community college or university. Overall, encourage the students to pursue a career, and guide them in college programs that are offered after high school graduation. Then have students research and verbally report on job opportunities found in a newspaper, journal, or other publications and media sources. Have students tape the article to a piece of paper and then write several points the article mentions. CS1, CS2, CS3, CS4, CS5, E1

Have a former student who works in the industry visit and talk about employment opportunities in the craft area, specifically addressing the following: CS2, CS3, CS4, CS5

- Relevancy of the course material to the job
- Working conditions
- Job pay
- Employment benefits
- Problems faced in the craft area

Competency 3: Explore leadership skills and personal development opportunities. (CONTREN Module: 00107-09 and 00108-09) (DOK 1) COM, EMP

Suggested Enduring Understandings

1. Leadership and team-building skills are needed to be successful in a career.
2. Student involvement in SkillsUSA develops and enhances the skills employers are looking for.

Suggested Essential Questions

1. What leadership and team-building skills are necessary for success in any career?
2. What are some strategies you could use to make yourself more employable?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Demonstrate effective team-building and leadership skills. (DOK 1)	a. Use PowerPoint demonstrations and information retrieved from the SkillsUSA Web site, and/or show videos on past state level or national level SkillsUSA competitions. The National SkillsUSA Web site is http://www.skillsusa.org/, and the Mississippi SkillsUSA Web site is http://www.mde.k12.ms.us/vocational/SkillsUSA/. If your school has historical video with past students attending the state competition, you may show that to the students to try to peak their interest in SkillsUSA. Ask students to elaborate on how they value leadership, what makes a good leader, and why	a. Have students write a short essay (1/2-page minimum) about how SkillsUSA is an important organization and how it can benefit the craft program by preparing leadership in the world of work. The essay should include how the organization incorporates leadership skills (soft skills) with tangible career

	they think they would be good leaders. Ask about the accomplishments of the students in other areas such as athletics, academics, and so forth. CS1, CS2, CS3, CS5, T1, T2, R1, R2	skills taught in the craft. Use the **Writing Rubric** to evaluate student writings. Monitor the class for participation.
b. Demonstrate through practice appropriate work ethics. (DOK 1)	b. Discuss the advantages of joining SkillsUSA, and elaborate on how the students should value what SkillsUSA means to students, schools, and industry. After explaining what SkillsUSA encompasses, ask the students how membership in SkillsUSA would personally benefit them. CS1, CS2, CS3, CS4, CS5, T1, T2	b. Use interclass student competition. Have one class compete against other classes. For example, have the morning class compete against the afternoon class. Assign team tasks to groups within the classroom so that students have the opportunity to grow their leadership abilities. Develop cleanup crews that are responsible for areas of the classroom/shop areas. Award points per team per 9 weeks to encourage team competition among project groups. Use team-building concepts to create student cooperation and teamwork. As the semester progresses, assign projects to individuals or to teams, and have them compete for first, second, and third place just as SkillsUSA individuals and teams compete. Evaluate each team using an average grade point and the SkillsUSA competition rubrics. Each grade is used for a percentage of the individual's grade assessment. The **Work Ethics and Values Rubric** may be used to evaluate the student.

Competency 4: Describe general safety rules for working in a shop/lab and industry. (CONTREN Module: 00101-09) (DOK 1) SAF, WSS

Suggested Enduring Understandings	Suggested Essential Questions
1. Safe use and proper choice of tools is important to safely complete a welding job.	1. Why do we have safety rules and regulations? 2. How do fires happen, and how do you extinguish

2. Understanding common safety violations and the consequences of committing unsafe acts is important in the workplace.

a fire?

3. What happens when you choose the improper tool for the job or use a tool in an incorrect manner?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Appraise safety issues and prevention associated tools, equipment, and housekeeping found in the school shop area. (DOK 1)	a. Explain the relationship between housekeeping and safety in reducing on-site accidents; explain the importance of reporting all on-the-job injuries and accidents, evacuation policies, substance abuse policy, and safety around high pressure or high temperature; recognize, explain, inspect, and care for personal protective equipment; identify and explain the procedures for lifting heavy objects; inspect and safely work with various ladders and scaffolds; explain the function of the material safety data sheet (MSDS); and interpret the MSDS. Use PowerPoint presentations from the Contren Learning Series (NCCER). These should prepare the students for school shop safety and NCCER examinations. Show safety videos such as the Farm Bureau Safety Video. Then discuss the school shop/lab safety rules that pertain to the school premise, and explain that the student must pass the class safety test with 100% competency in order to work in the school shop/lab. Instruct the students that they will not be allowed to work in the shop area unless they learn the school and shop safety rules and regulations. Discuss personal protection devices such as safety glasses, face shields, steel-toed boots, lanyards, safety harness, gloves, aprons, and so forth. Show proper safety equipment and damaged equipment so that students know what defects look like. Explain and demonstrate proper lifting procedures, and explain the importance of safety when lifting tall or long workpieces. CS4, T1, T2, T4	a. After administering a Contren Learning Series (NCCER) safety test that students must pass with 100% mastery, have the students go to the shop area and demonstrate how to safely operate a hand tool such as a hacksaw. Be very critical of the students to make sure that they follow safe practices. Use the **Shop Safety Checklist Rubric** to help determine if the students fully understand shop procedures and safety. The student should research the terms found on the **Safety Term Worksheet,** and a grade should be recorded for accuracy of terms. Have students explain verbally or in writing the emergency procedures as described on the MSDS of a specific product. Have students use Inspiration to document the emergency procedures and properly interpret an MSDS chemical sheet. The students should be able to locate emergency contact phone numbers, the chemical name, properties, flash point, reactivity, and other important information. Have students explain emergency procedures in the event of a chemical spill. For example, locate the

			emergency exits, telephone numbers, eye wash and showers, spill kits, and emergency evacuation routes. The **Interpret MSDS Rubric** may be used to assess the student's understanding of the material safety data sheet.
b. Implement fire safety and prevention techniques. (DOK 2)	b. Discuss how fires start, the three things needed to produce a fire, fire suppression practices, and fire prevention of flammable liquids; list and explain the classes of fire extinguishers; identify and explain use of various barriers and confinements, electrical safety issues, and lock out/tag out safety procedures. Explain the fire triangle—fuel, oxygen, and heat—and then explain what flash point is for various shop materials, and then explain and discuss the various types of fires with students such as wood, grease, electrical, and metal. Explain the classes of fire extinguishers and with what types of fires to use them; then demonstrate the proper use of a fire extinguisher. The following is a great video clip that illustrates how a fire extinguisher works and how to use it to put out fires: http://videos.howstuffworks.com/howstuffworks/34-how-a-fire-extinguisher-works-video.htm. CS1, CS2, CS5, T1, T2, T3, T4	b. Have students do a simulated OSHA inspection to locate mock (teacher-made) safety violations. Place air hoses across walkways to create trip hazards, pressurize a leaky air hose, open breaker panel doors to expose breakers, lay out an extension cord that has frayed wiring, block fire extinguishers so that it is difficult to access them in the event of fire, block emergency exits with trash bins to inhibit escape, and so forth. Have students walk around the shop and locate safety violations, document the violation, and propose a remedy for the safety issue. The student should photograph the violation and document in the Blackboard E-Portfolio. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment. The student should also present her or his findings in the classroom. The **Presentation Assessment Rubric** can be used to evaluate the student's work.

Standards

Industry Standards

CONTREN CORE

SAF	Basic Safety (Module 00101-09)
COM	Basic Communication Skills (Module 00107-09)
EMP	Basic Employability Skills (Module 00108-09)

CONTREN WELDING LEVEL ONE

WSS	Welding Safety (Module 29101-09)

21st Century Learning Standards

CS1	Flexibility and Adaptability
CS2	Initiative and Self-Direction
CS3	Social and Cross-Cultural Skills
CS4	Productivity and Accountability
CS5	Leadership and Responsibility

National Educational Technology Standards for Students

T1	Creativity and Innovation
T2	Communication and Collaboration
T3	Research and Information Fluency
T4	Critical Thinking, Problem Solving, and Decision Making

ACT College Readiness Standards

E1	Topic Development in Terms of Purpose and Focus
E2	Organization, Unity, and Coherence
E3	Word Choice in Terms of Style, Tone, Clarity, and Economy
E4	Sentence Structure and Formation
R1	Main Ideas and Author's Approach
R2	Supporting Details
R3	Sequential, Comparative, and Cause–Effect Relationships
W1	Expressing Judgments
W2	Focusing on the Topic

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

Suggested Rubrics and Checklists

Interpret MSDS Rubric

Role-Play or Skit Rubric

Presentation Assessment Rubric

Shop Safety Checklist Rubric

Writing Rubric

Work Ethics and Values Rubric

Blackboard E-Portfolio Checklist

Safety Terms Worksheet

Name: _____

Date: _____

Period: _____

Interpret MSDS Rubric

Your instructor will furnish you with the name of a chemical that is commonly used in agricultural and natural resources occupations. You are to conduct a search of the Internet to locate a material safety data sheet (MSDS) for this material and use it to answer the following questions.

1. What is the Web address of the Internet site on which you found this information?

2. If you accidentally drank some of this material, what first aid procedure would you do first?

3. What special precautions should be taken in storing this material?

4. What is the flash point of this material?

5. If you spilled a small amount of this product, how would you clean it up?

6. What immediate effects would likely happen if you spilled some of this material on your skin?

Name: _____

Date: _____

Period: _____

Role-Play or Skit Rubric

Behavior/Skill	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1	Total Score
ACCURACY	All information was accurate.	Almost all information was accurate.	Most information was accurate.	Very little information was accurate.	
ROLE	Excellent character development; student contributed in a significant manner.	Good character development; student contributed in a cooperative manner.	Fair character development; student might have contributed.	Little or no character development; student did not contribute much at all.	
KNOWLEDGE GAINED	Can clearly explain several ways in which his or her character "saw" things differently than other characters and can explain why	Can clearly explain several ways in which his or her character "saw" things differently than other characters	Can clearly explain one way in which his or her character "saw" things differently than other characters	Cannot explain any way in which his or her character "saw" things differently than other characters	
PROPS	Used several props and showed considerable creativity	Used one or two appropriate props that made the presentation better	Used one or two props that made the presentation better	Used no props to make the presentation better	
REQUIRED ELEMENTS	Included more information than required	Included all required information	Included most required information	Included less information than required	

Comments:

Name: _____

Date: _____

Period: _____

Presentation Assessment Rubric

Behavior/Skill	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1	Total Score
CONTENT	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
CLARITY	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
PRESENTATION	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
VISUAL AIDS	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
LENGTH	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
EYE CONTACT	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				Total	

Comments:

Name: _____

Date: _____

Period: _____

Shop Safety Checklist Rubric

	Scoring Criteria			
The student	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1
Selects appropriate PPE.				
Wears protective clothing and eye protection.				
Demonstrates fire extinguisher operation.				
Subtotal for safety equipment				
Maintains clean facility				
Cleans area after tasks are complete.				
Stores materials properly.				
Subtotal for facility cleanliness				
Models appropriate behavior				
Observes safety rules.				
Follows written directions.				
Follows oral directions.				
Observes surroundings.				
Subtotal for appropriate behaviors				

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting sequence that reader can follow.	
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	
				Total Points	

Name: _____

Date: _____

Period: _____

Work Ethics and Values Rubric

Behavior/Skill	**Exemplary 4 Points**	**Accomplished 3 Points**	**Developing 2 Points**	**Beginning 1 Point**	**Score**
Punctuality (arrives on time)					
Preparation (completes pre-assignments and brings necessary materials)					
Respects other students/workers					
Listens to supervisor and follows directions					
Accepts responsibility for actions					
Demonstrates positive personality traits (kindness, trustworthiness, honesty)					
Demonstrates productivity (patience, thoroughness, hardworking)					
Demonstrates a concern for others					
Remains on task and allows others to remain on task					
Takes initiative as appropriate					
				Total Score	

Name: _____

Date: _____

Period: _____

Blackboard E-Portfolio Checklist

The student should initial the box to the right of the task when completed.

Description of Task	Student's Initial
Create and upload a cover letter explaining the topic of the portfolio entry.	
Include proper documentation for the assignment.	
Documentation includes an explanation of the purpose of the E-Portfolio entry.	
Include photographs, video, and/or audio as required by the assignment.	
Photographs, video, and audio DO NOT include other students' faces. (Use of student likenesses requires parental approval).	
DO NOT include any information about the school, town, or any other geographic information that would create bias in a third-party assessor.	
Upload a student self-assessment of the work.	

Name: _____

Date: _____

Period: _____

Safety Term Worksheet (Page 1 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. Acclimatization –
2. Acute health effect –
3. Air-purifying respirator –
4. Air-supplied respirator –
5. Alkali –
6. ANSI –
7. Asbestosis –
8. Asphyxia –
9. Atmospheric pressure –
10. Audible range –
11. Audiogram –
12. Autoignition temperature –
13. Benign –
14. Benzene –
15. Biohazard –

Safety Term Worksheet (Page 2 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

16. Body burden –

17. Boiling point –

18. Breathing zone sample –

19. Carcinogenic –

20. Carpal tunnel syndrome –

21. CAS number –

22. Catalyst –

23. Caustic –

24. CFR –

25. Chemical absorption cartridge –

26. Chronic –

27. CNS –

28. Combustible liquids –

29. Combustible material –

30. Confined Space –

31. Corrosive –

32. Cyanosis –

33. Decibel –

Safety Term Worksheet (Page 3 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

34. Decontaminate –

35. Density –

36. Dermatitis –

37. Dyspnea –

38. Eczema –

39. Edema –

40. Electron –

41. Electrocution –

42. EPA –

43. Filter, HEPA –

44. Flammable limits –

45. Flammable liquid –

46. Flash point –

47. Foot candle –

48. Fume –

49. Fume fever –

50. Gage pressure –

51. Galvanizing –

Safety Term Worksheet (Page 4 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

52. Hazardous material –

53. Hearing conservation –

54. Heat stress –

55. Hydrocarbons –

56. IDLH –

57. Inert –

58. Inorganic –

59. Latent period –

60. LC50 –

61. LD50 –

62. Lead poisoning –

63. Local exhaust ventilation –

64. Makeup air –

65. Malignant –

66. Melting point –

67. Microbe –

68. Milligram (mg) –

69. Milliliter (mL) –

Safety Term Worksheet (Page 5 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

70. Mixture –

71. MSDS –

72. Nephrotoxin –

73. Neurotoxin –

74. NFPA –

75. NIOSH –

76. OSHA –

77. Particulate –

78. Pathogen –

79. Permissible exposure limit (PEL) –

80. Personal protective equipment (PPE) –

81. pH –

82. PPB –

83. PPM –

84. Pulmonary –

85. Reactivity –

86. Renal –

87. Respirator –

Safety Term Worksheet (Page 6 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

88. Routes of entry (the paths by which chemicals can enter the body) –

89. SCBA –

90. Sensitizer –

91. Shakes –

92. Shielding –

93. Shock –

94. Silicosis –

95. Short-term exposure limit –

96. Solvent –

97. Sterile –

98. Symptom –

99. Tinnitus –

100. TLV (Threshold Limit Value) –

101. Toxic ceiling limit –

102. Toxemia –

103. Toxicant –

104. Toxin –

105. Vertigo –

Safety Term Worksheet (Page 7 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

106. Vapors –

107. Ventilation –

108. Volatility –

109. Wavelength –

110. X-Ray –

Unit 2: Math for Welding Applications

Competency 1: Apply the four basic math skills with whole numbers, fractions, and percents. (CONTREN Module: 00102-09, 00105-09) (DOK 1) MAT, BLU, WWS

Suggested Enduring Understandings

1. Math is essential in welding craft when selecting the properly sized tools, screws, bolts, and other materials.
2. Math skills are required to select replacement parts and provide service to machinery.

Suggested Essential Questions

1. Why is it necessary for a welder to have basic math skills?
2. What could happen if a welder did not have basic math skills?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Perform mathematic calculations relating to the welding trade. (DOK 1) SGM1, SGM2, SGM4	a. Demonstrate how to calculate problems and how they relate to job tasks in the welding trade. Add, subtract, multiply, and divide whole numbers, decimals, and fractions; convert whole numbers to fractions and convert fractions to whole numbers; convert decimals to percents and percents to decimals; convert fractions to decimals; compare fractions; and convert fractions to percents. Give a sample math test to assess student abilities. Once the test is graded, evaluate the level of knowledge. Pair the students so that a student with weak math skills works with a student who has greater math skills. Have students solve word problems related to welding trades. For example, a piece of round stock is used to make a steel bushing. The inside diameter is 7/32 in. The outside radius is 1/2 in. Using these measurements, what is the bushing wall thickness? T6, M1, M2, M3, M4, M5, M7, R4, R5. Have students solve word problems related to welding trade such as the following. Katie needs to find various lengths of square key stock: 1/2 + 1-1/4, 3/4 + 7/8, + 4-5/16. Convert the sums to mixed numbers so that she will know where to find them on her tape measure. T6, M1, M2, M3, M4, M5, M7, R4, R5 Demonstrate how to convert calculated fractions to use on a tape measure. Give the students several pieces of precut straight metal bars. Have students give the measurement in 1/4-, 1/8-, and 1/16-in. measurements for the same piece of material.	a. Students should explain the increments of the tape measure by measuring something in the room that is common to all students. For example, give the students a standard household tape measure, and have them measure a door height. If the standard interior main door is 80 in. tall, that could be illustrated as being 6 ft 6 in., 2,560 1/32nd of an inch, and 5,120 1/64ths of an inch. Also, percentage can be illustrated such as one half (50%) of the door's height is 1,280 1/32nd of an inch. Explain that all measures can be represented in many incremental measures. The **Measurement Rubric** may be used to assess the student's work. Use a tap and drill chart to convert decimals to fractions and vice versa. Have students convert fractional drill sizes to decimal equivalents and vice versa. Have students then relate the drill size to various fractions'

The students should learn the relationship between incremental measurements. T6, M1, M2, M3, M4, M5, M7, R4, R5, W1

Grab the students' attention by demonstrating how to convert fractions to decimals and percents. Cut a round piece (disc) from plate steel. Then cut the circular piece into pie-shaped pieces. If possible, cut the disc into 32 equal pieces. Give each student a piece of metal until the pieces are gone. Then start collecting pieces of metal one at a time. Illustrate how eight 1/32 pieces (8/32 = 0.250 or 25% of the circle) of the pie equals 1/4 of the total circle. Elaborate by collecting more pieces (16/32 = 0.500 or 50% of the circle). Allow the students to practice using the circle while calculating fractions and decimals. You may make other shapes such as squares and linear bars by doing the same exercise. You may also relate the 100ths, halves, quarters, tenths, and twentieths into dollar values. T6, M1, M2, M3, M4, M5, M7, R4, R5

representations. For example, a 3/8-in. drill bit will drill a hole that is 12/32nds of an inch, 24/64th of an inch, or 0.375 thousandths of an inch. This can be replicated throughout the drill size selection. Once they have a grasp on drill diameter, have the students calculate the radius for the same drill sizes. A 3/8ths drill size has a radius of 6/32nds of an inch, which is also 3/16ths of an inch. Many combinations can be used by simply changing drill sizes to bigger or smaller diameters. The **Measurement Rubric** may be used to assess the student's work.

Have the students demonstrate how to measure a piece of stock using a tape measure. The students should record the measurement in three different fractional measures: 1/8, 1/16, and decimal equivalent. The **Measurement Rubric** may be used to assess the student's work.

The students should begin defining the terms found in the **Welding Math Terms Worksheet** found at the end of this unit. The worksheet will allow them to get a head start on understanding math terms used in measuring and blueprint reading.

Competency 2: Perform basic mathematical calculations related to industrial maintenance shop operations. (CONTREN Module: 00102-09, 00105-09) (DOK 1) MAT, BLU, WWS

Suggested Enduring Understandings

1. Knowledge and application of both the metric system and the English measurement system are important in welding.

Suggested Essential Questions

1. Why are there two different systems of measure?
2. Why is it important that you know how to convert an English measurement to its metric equivalent and vice versa?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Use the metric system in craft applications. (DOK 1) SGM1, SGM2, SGM3, SGM4, SGM5, TTA4, TTA5	a. Recognize and use metric units of length, weight, volume, and temperature. Convert metric measurements to English measurements to solve basic linear measures, angles, and sides. Discuss the metric system and its relevance to the global manufacturing market by laying out English and metric wrenches on a table for show and tell, and let the students see how the wrenches differ. Most students may see little difference in the wrenches until they are allowed to use them on a bolt head. Drill holes in a board, and screw standard SAE and metric hex head bolts in the holes. Let the students use the wrenches to turn the bolt heads. Allow the students to associate the proper wrench with the proper bolt size. CS1, T1, T4, T6, M1, M3, M4, M5, M7 Have students complete a simple layout project on paper, poster board, or sheet metal using a machinist protractor to find angles given by the instructor. Have students cut out simple objects. Start with a 4-in. square, 2-in. square, and 1-in. square. Then progress to more difficult shapes such as circles, arcs, and triangles. Measure the objects, and give the students feedback regarding the quality of the cuts, shape dimension, and cutting safety. T1, T2, M1, M7, R1, W1	a. Give a written assessment on lecture material regarding global markets that use the metric system and how the metric system is used in the United States. The **Writing Rubric** may be used to assess this assignment. Label 20 bolts of various sizes including English and metric measurements installed into a board. Allow the students to choose the properly sized wrench to adjust the bolt head. The students should be allowed to make their own tool selections. Assess a grade by how many correctly sized wrenches they used. Use the following Web site to help reinforce reading measurement devices: http://www.rickyspears.com/rulergame/.
b. Compute distances according to a drawn plan, and then calculate the amount of material for a given project. (DOK 2) SGM1, SGM2, SGM3, SGM4, SGM5, TTA4, TTA5	b. Have students create a material list from a given blueprint to calculate the minimum amount of material needed to complete a project. M1, R1, R2, R3, W1,W2, W4, W5 Demonstrate how to solve for missing dimensions on a blueprint. Create a simple blueprint with four dimensions. Provide the students with three of the dimensions, and require them to solve for the missing data. M1,	b. Have students solve for missing dimensions on a given blueprint, and then have students cut the proper angles used in the layout project. Give students a piece of poster board, and assign angled cuts that should be made. The **Measurement Rubric**

	M7, R1, R2, R3, W1,W2, W4, W5	may be used to assess the student's work. Have students use measurement tools to lay out the angles and mark prior to making the cuts. The Pythagorean theorem is a great way to teach angles and cuts. Pythagorean theorem measures may be as follows: $A^2 + B^2 = C^2$, or a 3-in. (opposite side), 4-in. (adjacent), and 5-in. (hypotenuse) right triangle will result in a 30°, 60°, and 90° angle at the three points of the triangle. 6, 8, and 10 are also easy numbers to use with the Pythagorean theorem. Inspect the final project to determine if the students correctly calculated the material list needed to properly complete a project.

Competency 3: Identify and perform functions using various measuring tools and instruments (CONTREN Module: 00102-09). (DOK 2) MAT

Suggested Enduring Understandings

1. Basic measuring skills are a necessity in all areas of craft related careers.
2. Identifying the different measurements associated with different trades, as in sheet metal gauge and electrical wire gauge, is important in welding.

Suggested Essential Questions

1. Why is it important that a welder be able to measure precisely? To what degree of precision should a welder be able to measure?
2. Why is there more than one standard of measure associated with different trades?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Read a ruler and layout lines to the nearest 1/16 in. (DOK 1) SGM3, SGM4, TTA4	a. Demonstrate how to read a rule to the nearest 1/16 in. Demonstrate using an ordinary metal tape so the students who own a measuring tape can practice at home. Have students measure something commonly found in the classroom such as a dry erase marker. The measurement should be made on an item that is less than 1 in. in diameter or in length. Once students grasp measuring items less than 1 in., you may gradually increase the lengths so the students will have to include inch measures. M1, M7, R1, W1	a. Have students measure lengths of the project assigned by the instructor to determine the length of material to the nearest 1/16 in. The **Measurement Rubric** may be used to assess the student's work. Have the students demonstrate how to measure a given piece of

	Reference the following Web sites to help illustrate how to read a ruler: • http://www.youtube.com/watch?v=lZ3Ec1p93PA&feature=related • http://www.youtube.com/watch?v=Xb3tH9kx7PY&feature=related • http://www.youtube.com/watch?v=ACRA2r03QT4&feature=related • http://www.rickyspears.com/rulergame/ Use a straight rule to draw lines on paper, poster board, or sheet metal for layout. Give the students a shape to draw that includes dimensions. Have students lay out the part on paper first before progressing to sheet metal or sheet steel. M1, R1, W1	stock. The students should measure pieces of varying lengths and accurately read the ruler measurement. The **Measurement Rubric** may be used to assess the student's work.

Standards

Industry Standards

CONTREN CORE

SAF Basic Safety (Module 00101-09)
MAT Introduction to Construction Math (Module 00102-09)
HTO Introduction to Hand Tools (Module 00103-09)
PTO Introduction to Power Tools (Module 00104-09)
BLU Introduction to Blueprints (Module 00105-09)

CONTREN WELDING LEVEL ONE

WSS Welding Safety (Module 29101-09)

CONTREN WELDING LEVEL TWO

WWS Welding Symbols (Module 29204-09)

Applied Academic Credit Standards

SEVENTH-GRADE MATH

SGM1 Apply concepts of rational numbers, and perform basic operations emphasizing the concepts of ratio, proportion, and percent with and without the use of calculators.
SGM2 Develop and apply the basic operations of rational numbers to algebraic and numerical tasks. Create and apply algebraic expressions and equations.
SGM3 Apply geometric relationships of angles, two- and three-dimensional shapes, and transformations.
SGM4 Apply appropriate techniques, tools, and formulas to determine measurements with a focus on real-world problems. Recognize that formulas in mathematics are generalized statements about rules, equations, principles, or other logical mathematical relationships.
SGM5 Organize and interpret data. Analyze data to make predictions.

TRANSITION TO ALGEBRA

TTA4 Demonstrate and apply various formulas in problem-solving situations.
TTA5 Interpret data.

21st Century Learning Standards

CS1 Flexibility and Adaptability

National Educational Technology Standards for Students

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

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
M1 Basic Operations and Applications
M2 Probability, Statistics, and Data Analysis
M3 Numbers: Concepts and Properties
M4 Expressions, Equations, and Inequalities

M5	Graphical Representations
M7	Measurement
R1	Main Ideas and Author's Approach
R2	Supporting Details
R3	Sequential, Comparative, and Cause–Effect Relationships
W1	Expressing Judgments
W2	Focusing on the Topic
W4	Organizing Ideas
W5	Using Language

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

Suggested Rubrics and Checklists

Measurement Rubric

Presentation Assessment Rubric

Teamwork Rubric

Writing Rubric

Welding Math Terms Worksheet

Name: _____

Date: _____

Period: _____

Measurement Rubric

Object to be measured:_____

Measuring instrument: _____
Record measurements below (length, depth, width, internal, external, etc.):

Rate the ability of the student to perform measurement tasks shown below using the following scale:

4 Proficient – Can perform consistently and independently with proficiency of an incumbent worker
3 Intermediate – Can perform the task but may require further practice to become as proficient as an incumbent worker
2 Introductory – Can perform the task, but some coaching and further training are required.
1 Limited – Can perform the task with extensive coaching. Further training and practice are required.

Task	**Rating**
Safety procedures	
Uses proper measuring instrument	
Understands how to measure	
Records proper measurements	
Total Score	

Comments:

Name: _____

Date: _____

Period: _____

Presentation Assessment Rubric

Behavior/Skill	**Exemplary 4 Points**	**Accomplished 3 Points**	**Developing 2 Points**	**Beginning 1 Point**	**Score**
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Teamwork Rubric

Behavior/Skill	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Total Score
Sharing	Shared ideas with others	Occasionally shared ideas with others	Seldom shared ideas with others	
Listening	Always listened to peers	Occasionally listened to peers	Ignored ideas of peers	
Respecting	Interacted with, encouraged, and supported ideas of others	Occasionally encouraged and supported others	Seldom encouraged and supported others	
Participating	Shared task equally with group members	Did most of the task	Did very little of the task	
			TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	
				Total Points	

Name: _____

Date: _____

Period: _____

Welding Math Term Worksheet (Page 1 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. Absolute value –
2. Acute angle –
3. Acute triangle –
4. Adjacent angle –
5. Angle –
6. Arc –
7. Area –
8. Average –
9. Base –
10. Bisect –
11. Cartesian coordinates –
12. Central angle –
13. Circle –
14. Circumference –
15. Coefficient –

Name: _____

Welding Math Term Worksheet (Page 2 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

16. Constant –

17. Cube –

18. Cylinder –

19. Data –

20. Decimal number –

21. Degree –

22. Denominator –

23. Diagonal –

24. Diameter –

25. Difference –

26. Digit –

27. Dividend –

28. Divisor –

29. Ellipse –

30. Equation –

31. Equilateral triangle –

32. Equivalent equations –

33. Equivalent fractions –

Name: _____

Welding Math Term Worksheet (Page 3 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

34. Factor –

35. Factorial –

36. Formula –

37. Fraction –

38. Frequency –

39. Graph –

40. Greatest common factor (GCF) –

41. Horizontal –

42. Hypotenuse –

43. Improper fraction –

44. Infinity –

45. Integers –

46. Intercept –

47. Interpolation –

48. Intersecting lines –

49. Inverse –

50. Inverse operations –

Name: _____

Welding Math Term Worksheet (Page 4 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

51. Equivalent fractions –

52. Isosceles triangle –

53. Least common denominator –

54. Least common multiple –

55. Like fractions –

56. Line –

57. Line of symmetry –

58. Line segment –

59. Lowest terms –

60. Mean –

61. Median –

62. Midpoint –

63. Mixed number –

64. Mode –

65. Natural numbers –

66. Negative number –

67. Number line –

68. Numerator –

Name: _____

Welding Math Term Worksheet (Page 5 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

69. Irrational numbers –

70. Equivalent fractions –

71. Obtuse angle –

72. Obtuse triangle–

73. Octagon –

74. Odd number –

75. Operation –

76. Opposites –

77. Ordered pair –

78. Origin –

79. parallel –

80. Pentagon –

81. Percent –

82. Perimeter –

83. Perpendicular –

84. Pi (π) –

85. Plane –

86. Point –

Name: _____

Welding Math Term Worksheet (Page 6 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

87. Positive number –

88. Product –

89. Proper fraction –

90. Proportion –

91. Protractor –

92. Pyramid –

93. Pythagorean theorem –

94. Quadrant –

95. Quadrilateral –

96. Quotient –

97. Radius –

98. Range –

99. Rate –

100. Ratio –

101. Reciprocal –

102. Rectangle –

103. Right angle –

104. Right triangle –

Name: _____

Welding Math Term Worksheet (Page 7 of 7)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

105. Rotation –

106. Scale drawing –

107. Scalene triangle –

108. Simplifying –

109. Slope –

110. Sphere –

111. Square –

112. Square root –

113. Statistics –

114. Straight angle –

115. Supplementary angle –

116. Surface area –

117. Triangle –

118. Vertex –

119. Vertical angles –

120. Volume –

121. Whole number –

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

Competency 1: Read, analyze, and design a blueprint. (CONTREN Module: 00105-09) (DOK 2) BLU, MAT, WWS

Suggested Enduring Understandings

1. A blueprint is the plan designed to attain a goal using specific drawings and instructions for completion.
2. Welders should be able to interpret the goal of a project using a blueprint.

Suggested Essential Questions

1. Why are blueprints important in planned structures and equipment?
2. Why is it important that a welder be able to determine what symbols represent on a blueprint?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and interpret terms and symbols commonly used on blueprints. (DOK 1) SGM5, TTA4, TTA5	a. Relate information on prints to real parts/models, describe the information in a title block, and design a blueprint. Have students use a word processing document, a digital camera, and classroom resources to identify, define, and illustrate terms and symbols with students and show them examples on a blueprint: lines, circles, hidden lines, centerlines, tangents, arcs, and so forth. M1, M7, R1, R2, W1 Bring in an object with multiple parts that can be disassembled, and show how parts align. T1, T2, T3, T4, T5, T6, R1, R2, R3 Show students an example of a finished part that has been made from a blueprint. Allow the students to compare the physical object with the blueprint. T1, T2, T3, T4, T5, T6, R1, R2, R3, W1 Discuss the parts of the blueprint: legend, title block, border, drawing area, and the revision block. Give students a sample drawing for reference. M1, M7, R1, R2, R3, W1 Explain what the title block and parts list encompass. Explain the scale that applies to the physical part as compared to the paper blueprint. M1, M7, R1, R2, R3, W1 Show and explain lines found on a blueprint (i.e., centerline, dimension, hidden line, object lines, extension line, break lines, etc.) that represent how a part is visualized. M1, M7, R1, R2, R3, W1	a. Have students locate var terms and symbols from teacher-assigned bluepri Evaluate student work us teacher observation. If a student does not locate a correct term or symbol, r teach and re-evaluate. Have students draw a blueprint of a simple obj assigned by the teacher. common soft drink can is good item to blueprint. T blueprint should include title block, material list, auxiliary views, and deta drawings of each part of whole object. The studer should make drawings th encompass orthographic and isometric drawings. Evaluate the blueprint fo accuracy. Give students a print wit missing measurements a dimensions. Have studer identify whether or not t could make the part with the information given an what information they n to complete the print. Th **Measurement Rubric** ma be used to assess the student's work.

		Give students a blueprint with missing data, words, and symbols using a blackboard, smart board, overhead projector, or activity sheet. Then let the students debate what is missing and how the blueprint can be corrected. Be sure that there are enough blueprints and enough missing data on the blueprints to allow every student an opportunity to solve a problem. As the semester progresses, give students a blueprint, and have the students build an assigned part using shop equipment. A shape can be created using 1/2-in. PVC piping and fittings. Provide the students with a complete length of pipe, fittings, and a blueprint. Allow students to select hand tools to perform the task. Using the blueprint, the students should cut the proper length of tubing and fit them together with the PVC fitting to create the shape shown on the blueprint. The fitting may be saved and used again next year as long as the pieces are not permanently glued and fitted with pipe.

Competency 2: Demonstrate the use and maintenance of various hand and power tools found in the craft trade. (CONTREN Module: 00101-09, 00103-09, 00104-09) (DOK 2) SAF, HTO, PTO, WSS

Suggested Enduring Understandings	Suggested Essential Questions
1. Safe use and proper choice of tools are important to completing a job in welding.	1. How do I determine which tool is used for a specific job? 2. Why are specific tools important in the industrial trades? 3. What is the difference between power tools and hand tools?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies

a. Identify and discuss the proper safe use of common hand and power tools. (DOK 1)	a. Lay shop hand tools on a table, and discuss the proper identification and use of the tools. Have the students log the tools in their journals so that they can look at the description at a later date. The students should be encouraged to make a sketch of the tool so they can reference the appearance of the tool. Assign each student a hand tool, and then have students use the Internet, books, or magazines to find uses of the shop hand tools. Also have students research names for tools that often relate to slang or name brand. For example, a pair of Channel Lock name-brand pliers are often used in industry but are technically referred to as pump pliers. The pump pliers are also referred to as "slip-joint pliers," which is a slang term. After giving the students time to locate reference materials, ask them to share their findings with the class. Allow students to interject their personal experience using various hand tools such as adjustable wrenches, screwdrivers, and pump pliers. E1, R1, W1, W2 Explain the appropriate personal protective equipment (PPE) when using hand and power tools. Have students record what each device is used for in their journals. The students should be encouraged to make a sketch of the PPE so they can reference the appearance of the device at a later date. Let students practice using PPE and also locating the items in the shop storage area. E1, R1, R2, W1, W2 Discuss the proper care for hand and power tools. Have students write the care for each tool in their journals, and have them perform the cleanup on the tool. Assign students different tools, and have the students use the Internet, sale catalogs, or other periodicals to determine the cost of the shop tools. One common item used in metal trade professions is a 120-V electric hand drill with a 1/2-in. keyed chuck. Have students research several media to find average pricing for the hand tools they are using. Once the research is concluded, create a tool list on the chalk/dry erase board. Let each student write the cost of each tool, and have a student volunteer to tally the tool costs for	a. Label and identify tools found in the shop. The students should give the proper name and slang name, if applicable. Grade the students on the number of correct responses. While students are using an oxy-fuel torch, grade them on the use of personal protection equipment such as face shields, goggles, leather gloves, proper clothing, and so forth. Have the student evaluate hand tools that have safety hazards such as frayed cords, cut or nicked wiring, ladders with cracked rails, chisels with mushroomed heads, and screwdrivers with chipped tips. Have the students select a drill for drilling holes in concrete. The students should justify why they suggest a particular drill, how much the drill costs, and where the tool can be bought. The students should present their findings to the class. The **Presentation Assessment Rubric** may be used to assess the student's presentation. Form a two member student team. Have the students perform a drilling project. The students should select the proper drill size for a 1/4-in. hole, the proper drill speed, and type of bit used. The students should also be graded on the safe use of the handheld power drill. Use the **Teamwork Rubric**

	the shop. This exercise should give the students an understanding of the expensive equipment they will be responsible for using and maintaining. E1, R1, R2, R3, W1 Demonstrate proper use and safe procedures for using hand and power tools. You may begin by demonstrating how to properly drill a hole in a 1/2-in. piece of flat steel. Show the students how to use a ball-peen hammer and a center punch properly to mark the drill location. Next, demonstrate how to select the proper drill bit to bore through steel plate. Show the students how to load and tighten the drill bit in the drill chuck. One of the most important steps of drilling a hole is to make sure the bit is rotating in the correct direction. Students often overlook bit rotation and ruin drill bits while trying to bore holes. Demonstrate how to set the center of the bit into the center punch crater and then begin drilling. Finally, show the students how to properly feed the bit through the metal and finish the hole. E1, R1, R2, R3, W1	to assess the student team.
b. Select and demonstrate the use of tools, and explain the procedures for maintaining hand and power tools. (DOK 2)	b. Lay out an assortment of tools on a work bench. Demonstrate how to select the proper tool to accomplish a given task. Demonstrate how to clean and oil tools as well as how to store tools. E1, R1, R2, R3, W1	b. Lay out dirty hand tools on the work bench. Have the students properly clean and store the hand tools.

Competency 3: Demonstrate how to read and comprehend welding blueprints. (Module 29110-09, Module 29202-09) (DOK 2) WWS, WDD

Suggested Enduring Understandings

1. Understanding common welding blueprint symbols and their uses is essential for welders.
2. A working knowledge of tools and how to use them when welding and rigging material is imperative in the welding craft.

Suggested Essential Questions

1. How can you find weld jobs in the state of Mississippi?
2. Why should welders be able to read blueprints and understand common rigging practices?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
• Read a basic welding blueprint found in industry and construction. (DOK 1)	a. Discuss welding blueprint symbols. Illustrate how to hand draw common symbols using the multimedia presentation board in the classroom. The following Web sites may be useful: • http://www.unified-eng.com/scitech/weld/weld.html • http://www.welding.com/weld_symbols_welding_symbols.asp • http://www.metallicfusion.com/symbols_and_definitions.htm	a. Have the students decipher a welding blueprint and solve for welding position, angles, and weld pad width and/or depth. The students should be prepared to discuss their research of blueprint reading

	• http://files.aws.org/technical/errata/A2.4errata.pdf Once the students have had an opportunity to research what blueprint symbols are used in welding, discuss welding symbols and how they are drawing representations of cuts, angles, welds, and tangible pieces of metal that are to be joined. E1, M1, M5, M6, M7	and how a drawing relates to tangible items in the workplace. Use the **Presentation Assessment Rubric** to evaluate the student.

Competency 2: Identify and use tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (CONTREN: 00103-09, 00104-09) (DOK 2) HTO, PTO

Suggested Enduring Understandings

1. It is important that welders understand how to properly select and use the fastener needed for a particular job and what tool is used to install or remove the fastener.

Suggested Essential Questions

1. Where are fasteners used?
2. Why are fasteners important in the welding craft?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Illustrate the use of tools used in the welding craft. (DOK 1) SGM1, TTA3, TTA4	a. Describe and explain the purpose of each of the tools commonly used by welding craft workers and how to maintain each of the tools used by welding craft workers, and demonstrate the proper use and basic maintenance of selected welding tools and the use and maintenance of hand and power tools. Lay out common hand tools on a work bench such as screwdrivers, pliers, saws, wrenches, and hammers. Discuss and demonstrate how each tool is safely used in the craft area. T1, T3, T4, T6, E1, M7 Use the Internet to search for sites depicting misuse of hand tools such as the following: • http://findarticles.com/p/articles/mi_hb5645/is_/ai_n23674427 • http://www.ncbi.nlm.nih.gov/pubmed/8899580 • http://www.safetytoolboxtalks.com/index.php?option=com_content&task=view&id=105&Itemid=2	a. Divide students into groups, and give each group a scenario or case study (written or on video) involving an accident. Have each group identify safety mistakes in each situation, determine correct procedures, and present the scenario, mistakes found, and procedures that should have been used to the class. For example, never use a slotted screwdriver as a chisel. This is a common misuse of hand tools found in the real-world industrial setting. Evaluate the case study for content using the **Team-Building and Participation Skills Rubric** or the **Teamwork Rubric**.
b. Identify and use	b. Select tools and demonstrate and explain the safe	• Assign each student a

common hand and power tools used in the welding trade. (DOK 1) SGM1, TTA3, TTA4	use of tools and the procedures for maintenance. Discuss types and sizes of screwdrivers, and demonstrate how to properly use hand screw driving devices. This can be reinforced by setting up a lab table with various sizes and shapes of screwdrivers. The following suggestions may aid in explaining what various screwdrivers are used for and where they are applied. T1, T3, T4, T6, E1, M7 • Locate screws that require various sizes of screwdrivers such as a slotted screw head in 3/16 in., 1/4 in., 5/16 in., and 3/8 in. • Locate screws that require the use of a No. 1, No. 2, and No. 3 Phillips head screwdriver. • Locate equipment that requires tools of various shank lengths to demonstrate the use of 3-in., 4-in., 6-in., and 8-in. shank lengths.	specific set of tools (i.e., hammers, power saws, wrenches, etc.). Have students use the Internet to research and write or type (if technology resources are available) a report on the proper procedures for maintenance of the assigned set of tools. Use the **Writing Rubric** to assess the student's work.

Competency 3: Identify and use basic rigging tools found in the welding trade, describe how each is used, and discuss proper care and maintenance of the tools. (CONTREN Module: 00106-09) (DOK 3) RIG

Suggested Enduring Understandings

1. Welders must be able to recognize and use common rigging hardware and be able to discuss applications of rigging in the welding craft.

Suggested Essential Questions

1. Why is rigging important in the welding profession?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. While identifying rigging equipment, describe how to perform safety inspections and use slings and common rigging hardware. (DOK 1)	a. Using industry pictures of safe rigging from the Contren Core Text Basic Rigging Unit, trade publications, and overheads of rigging equipment, identify, inspect, and explain the techniques of safe rigging. Demonstrate how to make rigging knots for moving equipment. E1 Take students on a field trip to a local industry to observe rigging procedures. Students will be divided into groups. They should take pictures of rigging, write or type an individual report describing their pictures, and present their report to the class. E1, E2, E5	a. Lay out good and BROKEN pieces of rigging equipment. The students should inspect and then identify the broken or worn pieces of equipment. The student should prepare a poster depicting the broken equipment and what good equipment should look like. The student will then present the poster to the class for a safety discussion. Use the **Poster Assessment Rubric** to assess the student's work. Using the Blackboard Web site, the student should select one piece of equipment and write a description of what

			the part looks like and how it is used in rigging as a short essay assignment. The **Writing Rubric** may be used to evaluate the student's essay. Lay out jacks, come-along, chain hoists, and block and tackles on a workbench. Label each with a letter or number. Have students number or label a sheet of paper corresponding with the labels used for the devices. Have each student name and write a short paragraph about the use and maintenance of each device on the table. The **Writing Rubric** may be used to evaluate the student's essay.
b. Describe basic load-handling practices and basic hitch configurations and their proper connections. (DOK 2) SGM1	b. Demonstrate how to use hitches found in rigging. Using shop material and equipment, rig a block and tackle from a hoist beam or other load-bearing structure. Allow the student to lift a 50-lb object such as a bucket of sand or gravel. Use a single-pulley system first. Then rig a double- or triple-pulley block and tackle so that the student can differentiate lifting using multiple pulley systems. Demonstrate how to tie rigging knots used in lifting heavy pieces of materials and equipment. Use Web sites to demonstrate knot tying such as the following: • http://www.sailfree.com/Knots/knots.htm • http://www.camping-canada.com/tips_knots_e.asp • http://www.troop7.org/Knots/ • http://en.wikipedia.org/wiki/List_of_knots • http://www.tollesburysc.co.uk/Knots/Knots_gallery.htm	b. Give the student an object to lift that is greater than his or her own weight. Have the student calculate the pulley system needed to lift the weight using only 1/4 of the weight to be lifted by a solo operator. Using pulleys, rope, and an inline scale, the student should prove her or his calculations true. The **Measurement Rubric** may be used to assess the student's work. Give the students a 6-ft length of 3/8-in. rope. Have the students practice tying different types of knots such as a double overhand, half hitch, square, chain hitch, and a sailor's

			knot.
c.	Identify basic rigging procedures, and demonstrate proper use of American National Standards Institute (ANSI) hand signals. (DOK 2)	c. Demonstrate proper hand signals when using lifting equipment such as forklifts and cranes. Hand signals can be found at the following Web site: http://www.msha.gov/accident_prevention/Tips/HandSignals.pdf. Use a fishing rod and reel, demonstrate hand signals. Erect a piece of board, cardboard, or tarp so that the student operating the rod and reel cannot see what is to be lifted. Place a small bucket on the floor in a location behind the blind so that the operator cannot see the bucket handle. Have a second student stand off to the side and give hand signals to the student with the rod and reel (**no talking allowed**; simulate setting of an exhaust fan, air conditioner, or piece of equipment on the roof of a building). Once the pair has worked together to get the hook in the proper location, have a third student place the hook on the bucket handle. Finally, have the signal person give the crane operator directions via hand signals for lifting the bucket. T6, M7, R1, R2, R3, R4, R5, W1, W2, W3, W4, W5	c. Have each student demonstrate what each hand signal is used for by allowing student groups to perform proper crane signals. Use the rod and reel to allow them to demonstrate their hand signaling ability.

Standards

Industry Standards

CONTREN CORE

HTO Introduction to Hand Tools (Module 00103-09)
PTO Introduction to Power Tools (Module 00104-09)
RIG Basic Rigging (Module 00106-09)

CONTREN WELDING LEVEL TWO

WWS Welding Symbols (Module 29201-09)
WDD Reading Welding Detail Drawings (Module 29202-09)

Applied Academic Credit Standards

SEVENTH-GRADE MATH

SGM1 Apply concepts of rational numbers, and perform basic operations emphasizing the concepts of ratio, proportion, and percent with and without the use of calculators.

TRANSITION TO ALGEBRA

TTA3 Understand geometric principles of polygons, angles, and figures.
TTA4 Demonstrate and apply various formulas in problem-solving situations.

21st Century Learning Standards

CS1 Flexibility and Adaptability
CS2 Initiative and Self-Direction
CS3 Social and Cross-Cultural Skills
CS4 Productivity and Accountability
CS5 Leadership and Responsibility

National Educational Technology Standards for Students

T1 Creativity and Innovation
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T6 Technology Operations and Concepts

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
E3 Word Choice in Terms of Style, Tone, Clarity, and Economy
M3 Numbers: Concepts and Properties
M6 Properties of Plane Figures
M7 Measurement
R2 Supporting Details
R3 Sequential, Comparative, and Cause–Effect Relationships
R4 Meaning of Words
R5 Generalizations and Conclusions
W1 Expressing Judgments

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

Suggested Rubrics and Checklists

Measurement Rubric

Poster Assessment Rubric

Presentation Assessment Rubric

Team-Building and Participation Skills Rubric

Teamwork Rubric

Writing Rubric

Name: _____

Date: _____

Period: _____

Measurement Rubric

Object to be measured:_____

Measuring instrument: _____
Record measurements below (length, depth, width, internal, external, etc.):

Rate the ability of the student to perform measurement tasks shown below using the following scale:

4 Proficient – Can perform consistently and independently with proficiency of an incumbent worker
3 Intermediate – Can perform the task but may require further practice to become as proficient as an incumbent worker
2 Introductory – Can perform the task, but some coaching and further training are required.
1 Limited – Can perform the task with extensive coaching. Further training and practice are required.

Task	**Rating**
Safety procedures	
Uses proper measuring instrument	
Understands how to measure	
Records proper measurements	
Total Score	

Comments:

Name: _____

Date: _____

Period: _____

Poster Assessment Rubric

Behavior/Skill	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1	Total Score
CONTENT	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
CLARITY	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
VISUAL AIDS	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
LENGTH	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Presentation Assessment Rubric

Behavior/Skill	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Team-Building and Participation Skills Rubric

The student	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Actively participates in team discussions and activities.					
Encourages other team members to participate in discussions and activities.					
Works with other members to keep the activity on schedule and task.					
Shares ideas and thoughts.					
Offers constructive recommendations.					
Credits others for their contributions and ideas.					
Empathizes with other members.					
Requests input from others to reach an agreement.					
Expresses ideas and thoughts.					
Actively listens to other team members.					
				Total	

Notes:

Name: _____

Date: _____

Period: _____

Teamwork Rubric

Behavior/Skill	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Total Score
Sharing	Shared ideas with others	Occasionally shared ideas with others	Seldom shared ideas with others	
Listening	Always listened to peers	Occasionally listened to peers	Ignored ideas of peers	
Respecting	Interacted with, encouraged, and supported ideas of others	Occasionally encouraged and supported others	Seldom encouraged and supported others	
Participating	Shared task equally with group members	Did most of the task	Did very little of the task	

Comments:

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	
				Total Points	

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

Competency 1: Explore regulations and codes for welding, base metal cleaning, joint designs and their purpose. (CONTREN Module: 29105-09 ,26106-09, and 29110-09) (DOK 2) BMP, WQT, JFA, WSS

Suggested Enduring Understandings

1. Welders must have a working knowledge of welding code in manufacturing applications.
2. Welders should be able to perform base metal preparation on malleable iron and aluminum and be able to describe various weld joints.

Suggested Essential Questions

1. Why are there governmental codes and regulations in welding applications?
2. Why remove rust and dirt in a weld when there is so much destructive electricity anyway?
3. How many joints are there and where are they used in welding applications?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Discuss codes governing welding, the causes of weld imperfections, welder qualification tests, and the importance of quality of skill. (DOK 1)	a. Have students research national AWS regulations regarding proper welding of 4-in. ferrous metal pipe. Students should follow proper procedures for aligning and welding two pieces of 4-in. pipe that will withstand 100 psi. After properly fitting and welding the butt welded pipe, cut a coupon from the pipe welded joint and perform a destructive test to determine that the coupon meets the proper quality specifications of the piping industry. Have students view a video supporting welding standards: http://www.youtube.com/watch?v=PASEG5xLlRo (Written by Herman Phillips, Noxubee County Career Technical Center, Macon, MS).	a. Collect the weld coupons and perform quality tests using pressure tests and destructive tensile tests on the student's welds. After determining the destructive value of the coupon, have the student write a short essay about weld quality, welding skill, and quality control improvement used in their project. Evaluate the essay using the **Writing Rubric**. The student should reflect on difficulty determining weld quality and weld skill use. Have the student place written documentation in her or his Blackboard E-Portfolio. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment.
b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld. (DOK 2)	b. Select and use a nondestructive examination practice and a destructive test method to test a student-made weld.	b. The student should weld a flat butt weld on two pieces of scrap sheet steel. The **Nondestructive and Destructive Rubric** should be used to evaluate the student's welding ability.

c. Explain joint fit and joint measurement while fitting plate and pipe. (DOK 2)	c. Using precut material, lay the pieces of metal on a table in the classroom or shop area. Show the students what each of the basic weld joints looks like and the acceptable joint gap between each parent metal. Students can view the following Web site to learn more about welding symbols and joints: http://www.mydiscounttools.com/estore/articles/welding/WeldingJOINTS.html.	c. The students will use the **Welding Joint Worksheet** drawing exercise sheet to hand draw each joint. The drawing is to be copied or scanned into a word image or PDF and loaded onto the student's Blackboard E-Portfolio. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment.

Competency 2: Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (CONTREN Module: 29102-09 Oxy-Fuel Cutting) (DOK 2) [WOC, WSS]

Suggested Enduring Understandings

1. Typical applications of oxy-fuel welding and brazing are important.
2. Safety procedures must be followed in oxy-fuel cutting.

Suggested Essential Questions

1. What is the difference between oxy-fuel and oxy-acetylene?
2. How and where is oxy-fuel used in the welding area?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and explain the use of oxy-fuel cutting equipment. (DOK 1)	a. Using oxy-fuel cutting equipment, provide the students with a list of safety rules stating the safety precautions for using oxy-fuel equipment. Have the students discuss the rules and quiz each other in preparation for the safety test. Provide the students with a list of written safety rules involved in oxy-fuel cutting. Provide the students with an illustration or diagram of the components of the oxy-fuel equipment. Following discussion and demonstration of the parts, the students will label the parts of the illustration. [T4, T6, E2, E3] The following Web sites are excellent references for oxy-fuel applications, torch illustrations, and torch adjustment: • http://www.virginia.edu/art/studio/safety/sculpture/mstools/oxyactelyene.htm • http://ezinearticles.com/?Acetylene-and-Oxygen-Cutting-Torch---OSHA-Says-Oxyfuel-Safety-is-Part-of-Welding-Safety&id=1253287 • http://www.weldguru.com/OxyFuelCutting.html • http://www.esabna.com/us/en/education/knowledge/cutting/basics-oxy-fuel-cutting.cfm	a. Using a teacher assessment, test the students on the safety rules associated with oxy-fuel cutting (students should earn a 100% safety score before operating a shop torch). Provide an unlabeled diagram of the oxy-fuel equipment, and ensure the students correctly identify the components of the equipment. The student should present her or his diagram to the class and explain the parts of the diagram. Use the **Presentation Assessment Rubric** to grade the student's work. The students should define parts of the oxy-fuel cutting process using the **Oxy-Fuel Word List**

		• http://www.weldreality.com/gasdata.htm	**Worksheet.**
b.	Demonstrate how to use an oxy-fuel torch. (DOK 2)	b. Set up oxy-fuel cutting equipment, light and adjust an oxy-fuel torch, shut down oxy-fuel cutting equipment, disassemble oxy-fuel cutting equipment, and change an empty cylinder. The teacher will demonstrate and discuss the assembly, operation, and disassembly of the oxy-fuel equipment. Following discussion of flames, the teacher will demonstrate the various flame types, flashbacks, and backfires resulting from improper adjustment of the torch. Following the demonstration, the students will perform the entire exercise individually. These Web sites may prove useful in demonstrating and discussing properly using oxy-fuel equipment: T4, T6, E2, E3 • http://www.virginia.edu/art/studio/safety/sculpture/mstools/oxyactelyene.htm • http://www.wikihow.com/Use-a-Cutting-Torch • http://ezinearticles.com/?Acetylene-and-Oxygen-Cutting-Torch---OSHA-Says-Oxyfuel-Safety-is-Part-of-Welding-Safety&id=1253287	b. Have students demonstrate the assembly, operation, and disassembly of the oxy-fuel equipment. Have students demonstrate a neutral, oxidizing, and carbonizing flame. Use the **Oxy-Fuel Assembly and Demonstration Rubric** to grade torch demonstration and assembly.
c.	Perform oxy-fuel cutting: • Straight line and square shapes • Piercing and slot cutting • Bevels • Washing • Gouging (DOK 3)	c. Explain and demonstrate how to cut straight lines and square shapes, piercing, and slot cutting. Using a coffee can, framing square, and soapstone, have the students trace a square and circle with soapstone on a piece of flat, hot rolled steel. • The students should use a framing square and soapstone to draw a 5-in. by 5-in. square blank. The students should practice properly cutting out blank pieces of steel before proceeding with the circle project. • Next, using the coffee can bottom, the students should outline and cut out a circle making sure to keep within 1/16 in. from the drawn line. Following this class activity, the students will practice performing the operations (http://www.wikihow.com/Use-a-Cutting-Torch). T6, E2	c. Have students demonstrate how to cut shapes that include straight lines, squares, piercing, and slots. Use the **Oxy-Fuel Cutting Rubric** to grade student achievement.
d.	Set up and operate a motorized, portable oxy-fuel gas cutting machine. (DOK 3)	d. Demonstrate how to set up and use the motorized cutting machine. Using a piece of 1/4-in. plate steel, align the machine to cut a piece 2 in. wide and as long as the sheet steel will allow. Save the cut pieces of metal for projects to be produced in Unit 7, Competency 1, Assessment C.	d. Students should bring a shoebox from home for storing cut piece of metal for future projects. Using the motorized cutting machine, have the student cut strips of plate steel 2 in. wide. Using the shop horizontal saw, cut the strips into 4-in. lengths. Accurate measurement is critical so that future projects are built to

		specifications. The students should use the strips in welding projects to practice weld joints (See Unit 7, Competency 1, Assessment C).

Competency 3: Identify and describe the basic equipment, setup, use, and safety rules for proper use of equipment, and prepare base metal for plasma arc cutting. (CONTREN Module: 29103-09 Plasma Arc Cutting) (DOK 2) [PAC, WSS]

Suggested Enduring Understandings

1. A welder should be able to perform typical applications of plasma cutting devices.
2. Safety procedures must be followed when using plasma cutting devices.

Suggested Essential Questions

1. What is the difference between plasma and oxy-fuel cutting processes?
2. How is plasma cutting used in the welding craft?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify and understand plasma arc cutting processes. (DOK 1)	a. Provide the students with a list of safety rules stating the safety precautions for using plasma cutting equipment. Have the students discuss the rules and quiz each other in preparation for the safety test. Provide the students with a list of written safety rules involved in plasma cutting. Provide the students with an illustration or diagram of the components of the plasma equipment. Following discussion and demonstration of the parts, the students will label the parts of the illustration. [T4, T6, E2, E3]	a. Using a teacher assessment, test the students on the safety rules associated with plasma cutting (students should earn a 100% safety score before operating a shop plasma torch). Provide an unlabeled diagram of the plasma equipment, and ensure the students correctly identify the components of the equipment. The student should present his or her diagram to the class and explain the parts of the diagram. Use the **Presentation Assessment Rubric** and the **Plasma Equipment Assembly and Demonstration Rubric** to grade the student's work. The students should define parts of the plasma cutting process using the **Plasma Word List Worksheet.**
b. Demonstrate how to set up and perform horizontal and vertical cuts in mild plate steel, pipe, and angled steel using a	b. Set up the plasma equipment and adjust. Demonstrate and discuss the assembly, operation, and disassembly of the plasma equipment. Following discussion of flames, demonstrate the various flame types, flashbacks, and backfires resulting from improper adjustment	b. Have students demonstrate the assembly, operation, and disassembly of the plasma equipment. Have students demonstrate a plasma

plasma torch to cut hot rolled mild steel. (DOK 1)	of the torch. Following the demonstration, the students will perform the entire exercise individually. T4, T6, E2, E3	cutting technique. Use the **Plasma Equipment Assembly and Demonstration Rubric** to grade torch demonstration and assembly.

Competency 4: Explore the selection, setup, and operation of carbon arc cutting equipment. (CONTREN Module: 29104-09 Air Carbon Arc Cutting and Gouging) (DOK 2) CAC, WSS

Suggested Enduring Understandings

1. A welder should be able to perform typical applications of air carbon arc cutting devices.
2. Safety procedures must be followed when using air carbon arc cutting devices.

Suggested Essential Questions

1. What is the difference between plasma, oxy-fuel, and air carbon arc cutting processes?
2. How is air carbon arc cutting used in the welding craft?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify air carbon arc cutting processes. (DOK 1)	a. Using air carbon arc cutting equipment, provide the students with a list of safety rules stating the safety precautions for using this specialized equipment. Have the students discuss the rules and quiz each other in preparation for the safety test. Provide the students with a list of written safety rules involved in air carbon arc cutting. Provide the students with an illustration or diagram of the components of the air carbon arc cutting equipment. Following discussion and demonstration of the parts, the students will label the parts of the illustration. T4, T6, E2, E3	a. Using a teacher assessment, test the students on the safety rules associated with air carbon arc cutting (students should earn a 100% safety score before operating an air carbon arc cutting torch). Provide an unlabeled diagram of the air carbon arc cutting equipment, and ensure the students correctly identify the components of the equipment. The student should present her or his diagram to the class and explain the parts of the diagram. Use the **Presentation Assessment Rubric** and the **Carbon Arc Equipment Assembly and Demonstration Rubric** to grade the student's work. The students should define parts of the air carbon arc cutting process using the **Air Carbon Arc Cutting Word List Worksheet.**
b. Demonstrate how to set up and perform washing and gouging	b. Set up the air carbon arc cutting equipment and adjust. Demonstrate and discuss the assembly, operation, and disassembly of the air carbon arc	b. Have students demonstrate the assembly, operation, and disassembly

cuts in mild plate steel, pipe, and angled steel using an air carbon arc torch to cut hot rolled mild steel. (DOK 3)	cutting equipment. Following discussion of flames, demonstrate the various flame types, flashbacks, and backfires resulting from improper adjustment of the torch. Following the demonstration, the students will perform the entire exercise individually. T4, T6, E2, E3	of the air carbon arc cutting equipment. Have students demonstrate an air carbon arc cutting technique. Use the **Air Carbon Arc Equipment Assembly and Demonstration Rubric** to grade torch demonstration and assembly.

Standards

Industry Standards

CONTREN WELDING LEVEL ONE

WSS Welding Safety (Module 29101-09)
WOC Oxyfuel Cutting (Module 29102-09)
PAC Plasma Arc Cutting (Module 29103-09)
CAC Carbon Arc Cutting and Gouging (Module 29104-09)
BMP Base Metal Prep (Module 29105-09)
WQT Weld Quality (Module 29106-09)
JFA Joint Fit-Up and Alignment (Module 29110-09)

Applied Academic Credit Standards

SEVENTH-GRADE MATH

SGM1 Apply concepts of rational numbers, and perform basic operations emphasizing the concepts of ratio, proportion, and percent with and without the use of calculators.

TRANSITION TO ALGEBRA

TTA3 Understand geometric principles of polygons, angles, and figures.
TTA4 Demonstrate and apply various formulas in problem-solving situations.

21st Century Learning Standards

CS1 Flexibility and Adaptability
CS2 Initiative and Self-Direction
CS3 Social and Cross-Cultural Skills
CS4 Productivity and Accountability
CS5 Leadership and Responsibility

National Educational Technology Standards for Students

T1 Creativity and Innovation
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T6 Technology Operations and Concepts

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
E3 Word Choice in Terms of Style, Tone, Clarity, and Economy
M3 Numbers: Concepts and Properties
M6 Properties of Plane Figures
M7 Measurement
R2 Supporting Details
R3 Sequential, Comparative, and Cause–Effect Relationships
R4 Meaning of Words
R5 Generalizations and Conclusions
W1 Expressing Judgments

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

Suggested Rubrics and Checklists

Carbon Arc Equipment Assembly and Demonstration Rubric

Destructive and Non- Destructive Weld Test Rubric

Oxy-Fuel Assembly and Demonstration Rubric

Oxy-Fuel Cutting Rubric

Plasma Equipment Assembly and Demonstration Rubric

Presentation Assessment Rubric

Writing Rubric

Black Board E-Portfolio Checklist

Weld Joint Worksheet

Plasma Word List Worksheet

Oxy-Fuel Word List Worksheet

Air Carbon Arc Cutting Word List Worksheet

Name: _____

Date: _____

Period: _____

Carbon Arc Equipment Assembly and Demonstration Rubric

Behavior/Skill	**Exemplary 4 Points**	**Accomplished 3 Points**	**Developing 2 Points**	**Beginning 1 Point**	**Score**
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
Torch Assembly	Assembled torch using correct thread direction; torque on fittings	Assembled torch using correct thread direction	Assembled torch but with some difficulty	Assembled torch but with instructor or peer help	
Torch Terminology	Explained all parts of the torch, purpose, and thread direction	Explained parts and purposes of the torch parts	Knew most of the torch parts and their purposes	Knew few parts and their purposes	
TOTAL					

Name: _____

Date: _____

Period: _____

Destructive and Non- Destructive Weld Test Rubric

Any weld not passing visual inspection will not be destructively tested.

Criteria		
Non-Destructive Test: Visually inspected and measured.	**PASS**	**FAIL**
Joint properly aligned		
Welds fill joint completely as project requires		
Weld made within minimum and maximum pad length		
Weld made within minimum and maximum pad width		
Weld made within minimum and maximum height requirements		
Visible penetration along entire length of weld		
Weld flow consistent with no cold flow		
No cracks, undercuts, or porosity visible		
Any weld not passing visual inspection will not be destructively tested.		
Destructive Test: Clamped and bend multiple times until cracking or break occurs.	**PASS**	**FAIL**
Parent metal fatigue occurs with no weld breakage		
Complete penetration along the length of weld		

Partially modified from
http://hawaii.hawaii.edu/assessment/Resources/Assessment%20Rubrics/ABRP%20Rubric%20PLO%201%20GMAW%20Performance%20Evaluation.pdf

Comments:

Name: _____

Date: _____

Period: _____

Oxy-Fuel Assembly and Demonstration Rubric

Behavior/Skill	**Exemplary 4 Points**	**Accomplished 3 Points**	**Developing 2 Points**	**Beginning 1 Point**	**Score**
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
Torch Assembly	Assembled torch using correct thread direction; torque on fittings	Assembled torch using correct thread direction	Assembled torch but with some difficulty	Assembled torch but with instructor or peer help	
Torch Terminology	Explained all parts of the torch, purpose, and thread direction	Explained parts and purposes of the torch parts	Knew most of the torch parts and their purposes	Knew few parts and their purposes	
TOTAL					

Name: _____

Date: _____

Period: _____

Oxy-Fuel Cutting Rubric

Behavior/Skill	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Torch Ignition	Demonstrates the proper technique and sequence of lighting the torch	Demonstrates proper technique of lighting the torch	Demonstrates lighting torch with irregular gas adjustment	Demonstrates lighting the torch with assistance from the instructor or peers	
Flame Adjustment	Demonstrates how to properly adjust the torch flame	Demonstrates how to adjust the flame but is slightly an oxidizing flame	Demonstrates how to adjust the flame but flame is slightly rich	Must have supervision to adjust the flame	
Cutting Technique	Displays very good cutting technique and hand control	Displays adequate cutting technique and hand control	Displays rough cutting technique and poor hand control	Displays difficulty using the torch and has poor hand control	
Cutting Speed	Uses excellent speed control to create a smooth cut	Uses good speed control to make cuts and has proper slag amount	Has difficulty regulating speed control and produces excessive slag	Has difficulty regulating torch cutting speed and kerf backfills with slag	
TOTAL					

Name: _____

Date: _____

Period: _____

Plasma Equipment Assembly and Demonstration Rubric

Behavior/Skill	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
Plasma Torch Assembly	Assembled torch using correct thread direction; torque on fittings	Assembled torch using correct thread direction	Assembled torch but with some difficulty	Assembled torch but with instructor or peer help	
Plasma Torch Terminology	Explained all parts of the torch, purpose, and thread direction	Explained parts and purposes of the torch parts	Knew most of the torch parts and their purposes	Knew few parts and their purpose	
TOTAL					
				Total	

Name: _____

Date: _____

Period: _____

Presentation Assessment Rubric

Behavior/Skill	**Exemplary 4 Points**	**Accomplished 3 Points**	**Developing 2 Points**	**Beginning 1 Point**	**Score**
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Blackboard E-Portfolio Checklist

The student should initial the box to the right of the task when completed.

Description of Task	Student's Initial
Create and upload a cover letter explaining the topic of the portfolio entry.	
Include proper documentation for the assignment.	
Documentation includes an explanation of the purpose of the E-Portfolio entry.	
Include photographs, video, and/or audio as required by the assignment.	
Photographs, video, and audio DO NOT include other students' faces. (Use of student likenesses requires parental approval.)	
DO NOT include any information about the school, town, or any other geographic information that would create bias in a third-party assessor.	
Upload a student self-assessment of the work.	

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	
				Total Points	

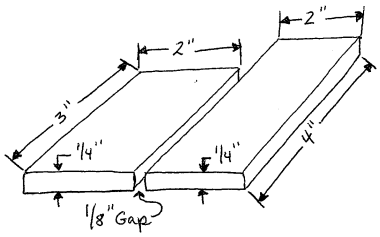
Name: _____

Date: _____

Period: _____

Weld Joint Worksheet

Instructions: Draw, by hand, isometric images of the basic welding joints that the instructor has demonstrated in class. Once completed, scan the document and load into the student Blackboard E-Portfolio for future reference.

Example: BUTT Joint 	BEVELED BUTT Joint:
TEE Joint:	CORNER Joint:
EDGE Joint:	LAP Joint:

Name: _____

Date: _____

Period: _____

Plasma Word List Worksheet (Page 1 of 2)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. Arc cutting

2. Arc plasma

3. Cup

4. Dross

5. Electrode setback

6. Electrode tip

7. Heat-affected zone

8. High-frequency alternating current

9. Ionized gas

10. Joules

Name: _____

Plasma Word List Worksheet (Page 2 of 2)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

11. Kerf

12. Nozzle

13. Nozzle insulator

14. Nozzle tip

15. Pilot arc

16. Plasma

17. Plasma arc

18. Plasma arc gouging

19. Stack cutting

20. Standoff distance

21. Water shroud

22. Water table

Name: _____

Date: _____

Period: _____

Oxy-Fuel Word List Worksheet (Page 1 of 2)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. Carburizing flame

2. Oxidizing flame

3. Neutral flame

4. Purging

5. MAPP

6. Safety check valve

7. Sparklighter

8. Gauge pressure

9. Leak-detection solution

10. Regulator gauge

11. Backfire

Name: _____

Oxy-Fuel Word List Worksheet (Page 2 of 2)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

12. Combustion

13. Crack

14. Primary combustion

15. Cutting torches

16. Inner cone

17. Bourdon tube

18. Regulators

19. Molecules

20. Flashback arrestor

21. Flashback

22. Atoms

23. Creep

24. Acetone

25. Working pressure

Name: _____

Date: _____

Period: _____

Air Carbon Arc Cutting Word List Worksheet

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. Air outlet holes

2. Hand held electrode holde

3. Air valve

4. Air line

5. Power source

6. Base metal

7. Compressed air

8. Work lead

9. Electrode lead

10. Upper arm lever

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

Competency 1: Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade. (CONTREN Module: 29101-09) (DOK 1) [WWS]

Suggested Enduring Understandings

1. Identifying and correctly using personal protective devices is imperative in the welding craft.
2. Welders should be able to identify and correct welding safety issues in the work environment.

Suggested Essential Questions

1. Why do welders wear protective clothing?
2. Why worry about electrical safety in welding?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Recite safety hazards in the shielded metal arc welding shop environment. (DOK 1)	a. Demonstrate the safety hazards involved with SMAW welding equipmennt.[E1, E2, E3, E5, E8, E9, E10] Demonstrate what happens when a ground clamp is placed on one piece of equipment and welding is to take place on an adjacent piece of equipment, such as two conveyors end to end. The only grounded conductor between the equipment is a No. 12 (or smaller) piece of wire. Allow a student to make a high-amperage weld. The wire should get extremely hot and melt the wires' insulation illustrating how improper grounding can damage electrical components and wiring of the machinery being welded.	a. The student should create a poster depicting the proper placement of grounding clamps. Use the **Poster Assessment Rubric** to assess the student's work. Students should familiarize themselves with the common terms used in SMAW welding by defining the terms listed in the **SMAW Term Worksheet** found at the end of this unit.
b. Perform safety inspection of SMAW welding equipment. (DOK 1)	b. Demonstrate how to inspect SMAW equipment including the power supply, ground cabling, electrode holder cabling, ground clamps, electrode holders, and helmet lenses. Lay out a damaged electrode cable, and illustrate how damage occurred and what safety issue is associated with the damage.	b. The teacher should inspect equipment prior to the assignment noting any damage. Have the student inspect the shop's welding machines. The student should label the paper with the machine location and then number a piece of notebook paper. The student should then inspect and write up any damage to the welder equipment. This can be used as a team project; use the **Team-Building and Participation Skills Rubric** for assessment.
c. Properly handle welding materials. (DOK 1)	c. Discuss proper storage of SMAW electrodes by showing the damage moisture can cause to electrodes. Leave a number of SMAW electrodes	c. Students are to inspect welding rods that have been weathered. After inspection,

	outside in the elements (especially rainy weather). Demonstrate welding with wet electrodes.	students should attempt to weld with the wet rods. Number of arc strikes should be recorded and the quality of weld inspected. The student should write a short essay on how rods should be properly stored. Use the **Writing Rubric** to assess the student.

Competency 2: Identify types of shielded metal arc welding machines and their accessories. (CONTREN Module: 29107-09) (DOK 2) [SWS]

Suggested Enduring Understandings

1. Welders should be able to identify types and name brands of welding machines as well as select appropriate accessories for welding applications.

Suggested Essential Questions

1. What should you consider when purchasing a welder?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Explain the differences in electrical current used in welding shielded metal arc welding applications and the type of machines needed to perform the welding project. (DOK 1)	a. Discuss the polarities of the SMAW welding machine. DCEP, DCEN, and AC current should be discussed as the polarities relate to heat and penetration in the weld.	a. Using a multi-polarity welder, have the students perform similar types of weld joints using each polarity setting. Perform a destructive test on each welded joint to determine tensile strength of the welds. The students should reflect on their welds and share their thoughts with the class about using damaged electrodes and what effects they have on welded joints. Use the **Presentation Assessment Rubric** to assess the student.
b. Demonstrate setting up arc welding equipment and how to use tools associated with weld cleaning. (DOK 2)	b. Demonstrate how to set up a SMAW welding application. Using two pieces of 1/2-in. plate steel and a standard electrode for this application. Perform a butt weld on the two pieces. After the piece has cooled, demonstrate how to clean the slag and splatter from the joint using a chipping hammer and wire brush.	b. The student should perform a SMAW weld on basic joints: butt, grooved butt, tee, and corner joints. After welding, the student should photograph the unclean parts. Once the parts are photographed, the student should clean the parts and

		photograph again. Once all photographs are taken, the student should upload the photos to the **Blackboard E-Portfolio**. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment.

Competency 3: Select shielded metal arc electrodes for welding applications. (CONTREN Module: 29108-09) (DOK 2)
SES

Suggested Enduring Understandings

1. Welders should know how to select SMAW welding electrodes for projects as well as how to carry and handle welding electrodes.

Suggested Essential Questions

1. Why are there different types of electrodes for welding?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Explain factors that affect electrode selection, types of filler material, the ASME filler metal classification system, and how to store the filler electrodes. (DOK 1)	a. Explain how to determine what electrode to use based on the material to be welded and the tensile strength of the desired weld. As you discuss tensile strength, elaborate on ASME classification and what the electrode numbering system means. • The following links may provide students with references to investigate filler metals: http://www.thefabricator.com/Consumables/Consumables_Article.cfm?ID=1936 • http://www.angelfire.com/my/welding/electrodes.html	a. Lay out welding electrodes. Number each electrode 1, 2, 3, and so forth (e.g., No. 1: E6011, No. 2: E6012, No. 3: E7018, etc.). The student should number a sheet of notebook paper as the electrodes are numbered. The student should then write down the ASME electrode number. The student will determine the diameter, tensile strength, welding position, type of flux coating, and the welding current that is to be used: AC, DCEP, or DCEN current.
b. Properly select and weld metal using filler electrodes. (DOK 3)	b. Demonstrate how to select welding electrodes according to diameter, tensile, position, and current to be used. The following link may be useful in demonstrating electrode selection: • http://www.ehow.com/video_4420304_selecting-electrode-arc-welding.html • http://www.ehow.com/how_2211945_select-electrode-welding.html	b. Students should demonstrate selecting their own electrodes when performing in-shop welding projects. Give the student projects that consist of different parent metal thicknesses and joint types.

Competency 4: Setup and make beads and fillet welds. (CONTREN Module: 29109-09) (DOK 2) [SBF]

Suggested Enduring Understandings

1. Welders should be able to exhibit a working knowledge of striking and extinguishing an arc using SMAW practices.
2. Welders should be able to distinguish among horizontal, vertical, and overhead welding positions.

Suggested Essential Questions

1. Why is it harder to strike an arc on low power supply current settings?
2. How can you finish the weld without leaving a crater in the end of the bead?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe the process for striking and extinguishing an arc, arc blow, and wander while properly exhibiting the process using a SMAW machine. (DOK 2)	a. Demonstrate how to strike an arc using an E6011 electrode in the flat position. Wearing welding helmets, students should observe the instructor striking the arc. Illustrate arc blow, wandering, and extinguishing the arc while presenting the demonstration.	a. Give the students the same rods used in the instructor demonstration. The students should practice making stinger beads 1 in. in length. The students should self-assess their welds and make adjustments to their technique and then continue welding practice.
b. Demonstrate stinger, weave, and overlapping beads in the horizontal, vertical, and overhead positions. (DOK 2)	b. Demonstrate show to produce a stringer, weave, and overlapping bead in all weld positions. Wearing welding helmets, students should observe the instructor striking the arc and making the welding passes for each demonstration.	b. Give the students the same rods used in the instructor demonstration. The students should practice making all beads 4 in. in length and in all positions. The students should self-assess their welds and make adjustments to their technique and then continue welding practice.

Competency 5: Set up and perform groove welds with backing and without backing. (CONTREN Module: 29111-09 and 29112-09) (DOK 2) [GWB, OGW]

Suggested Enduring Understandings

1. Welders should be able to identify, set up, and demonstrate groove welds with and without backing.

Suggested Essential Questions

1. Where are groove welds used in welding?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Demonstrate groove with backing and open root groove welding procedures using	a. Using two pieces of 1/2 plate steel, prepare the parent metal for a grooved weld. The angle of groove will be determined by the instructor. Lay the pieces of grooved steel on an aluminum	a. The student should practice welding in multiple positions of the closed and open root

SMAW equipment in the flat, horizontal, vertical, and overhead positions. (DOK 3)	welding table or other nonstick surface. Demonstrate how to set up the plates for welding in the “with backing” and “open root” welding procedures. Once the two pieces are properly aligned, set up the welding machine and weld the two pieces together. It may take multiple passes to properly weld the piece together. Repeat procedures for both closed and open root welds in the flat, horizontal, vertical, and overhead welding positions.	welding processes. The student’s final welding project should be photographed in the preparation, alignment, and welded stages depicting knowledge of the grooved welding process. The student should create a photo album of the welding processes for the flat, horizontal, vertical, and overhead positions for both closed and open root welds. The eight sets of photographs should be loaded into the student’s **Blackboard E-Portfolio** for future reference of skill attainment. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment.

Standards

Industry Standards

CONTREN WELDING LEVEL ONE

GWB SMAW – Groove Welds with Backing (Module 29111-09)
OGW SMAW – Open V-Groove Welds (Module 29112-09)
SBF SMAW – Beads and Fillet Welds (Module 29109-09)
SES Shielded Metal Arc Electrodes (Module 29108-09)
SWS SMAW – Equipment and Setup (Module 29107-09)
WWS Welding Symbols (Module 29201-09)

Applied Academic Credit Standards

SEVENTH-GRADE MATH

SGM1 Apply concepts of rational numbers, and perform basic operations emphasizing the concepts of ratio, proportion, and percent with and without the use of calculators.

TRANSITION TO ALGEBRA

TTA3 Understand geometric principles of polygons, angles, and figures.
TTA4 Demonstrate and apply various formulas in problem-solving situations.

21st Century Learning Standards

CS1 Flexibility and Adaptability
CS2 Initiative and Self-Direction
CS3 Social and Cross-Cultural Skills
CS4 Productivity and Accountability
CS5 Leadership and Responsibility

National Educational Technology Standards for Students

T1 Creativity and Innovation
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T6 Technology Operations and Concepts

ACT College Readiness Standards

E1 Topic Development in Terms of Purpose and Focus
E2 Organization, Unity, and Coherence
E3 Word Choice in Terms of Style, Tone, Clarity, and Economy
M3 Numbers: Concepts and Properties
M6 Properties of Plane Figures
M7 Measurement
R2 Supporting Details
R3 Sequential, Comparative, and Cause–Effect Relationships
R4 Meaning of Words
R5 Generalizations and Conclusions
W1 Expressing Judgments

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

Suggested Rubrics and Checklists

Poster Assessment Rubric

Presentation Assessment Rubric

Team-Building and Participation Skills Rubric

Writing Rubric

Blackboard E-Portfolio Checklist

SMAW Term Worksheet

Name: _____

Date: _____

Period: _____

Poster Assessment Rubric

Behavior/Skill	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1	Total Score
CONTENT	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
CLARITY	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
VISUAL AIDS	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
LENGTH	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Presentation Assessment Rubric

Behavior/Skill	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Team-Building and Participation Skills Rubric

The student	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Actively participates in team discussions and activities.					
Encourages other team members to participate in discussions and activities.					
Works with other members to keep the activity on schedule and task.					
Shares ideas and thoughts.					
Offers constructive recommendations.					
Credits others for their contributions and ideas.					
Empathizes with other members.					
Requests input from others to reach an agreement.					
Expresses ideas and thoughts.					
Actively listens to other team members.					
				Total	

Notes:

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	
				Total Points	

Name: _____

Date: _____

Period: _____

Blackboard E-Portfolio Checklist

The student should initial the box to the right of the task when completed.

Description of Task	Student's Initial
Create and upload a cover letter explaining the topic of the portfolio entry.	
Include proper documentation for the assignment.	
Documentation includes an explanation of the purpose of the E-Portfolio entry.	
Include photographs, video, and/or audio as required by the assignment.	
Photographs, video, and audio DO NOT include other student's faces. (Use of student likenesses requires parental approval).	
DO NOT include any information about the school, town, or any other geographic information that would create bias in a third-party assessor.	
Upload a student self-assessment of the work.	

Name: _____

Date: _____

Period: _____

SMAW Term Worksheet (Page 1 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. SMAW –
2. Manual metal arc welding (MMA) –
3. Stick welding –
4. AC –
5. Alternating current –
6. Arc eye –
7. Arc welding –
8. Cornea and retina –
9. Crater –
10. DC –
11. DCEP –
12. DCEN –
13. Direct current –
14. Electric arc –
15. Electric current –

Name: _____

SMAW Term Worksheet (Page 2 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

16. Electrode (for SMAW) –
    a. E6011 –
    b. E7024 –
    c. E6012 –
    d. E6013 –
    e. E7014 –

17. Electrode arc –

18. Electrode cable –

19. Electrode core wire –

20. Electrode holder (SMAW) –

21. Ferrous metal –
    a. Types of ferrous metals –

22. Filler material –

23. Flux –

24. Gaseous shield –

25. Ground cable –

26. Ground clamp –

27. Weld helmet –

28. Molten weld metal –

29. Nonferrous metal –
    a. Types of nonferrous metals –

30. Oxidation –

Name: _____

SMAW Term Worksheet (Page 3 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

31. Parent metal –

32. Penetration –

33. Polarized lense –

34. Shielding gas –

35. Slag –

36. Ultraviolet light –

37. Voltage –

38. Welding power supply –

39. Weld splatter –

40. Workpiece –

Unit 6: Orientation and Safety (Review and Reinforcement)

Competency 1: Describe local program and vocational/career–technical center policies and procedures. (CONTREN Modules: 00107-09 and 00108-09`) (DOK 1) COM, EMP

Suggested Enduring Understandings

1. Safety is an integral part of daily life.
2. Rules and regulations are essential to a safe work environment.

Suggested Essential Questions

1. What would happen if there were no rules and regulations?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe local program and vocational/career–technical center policies and procedures. (DOK 1)	a. Discuss school policy and MS-CPAS2 requirements using the school handbook, and discuss the history of the occupational skill and how it relates to today's technology. Then have a student with higher reading ability partner with a student who has lower reading ability to read the course syllabus and career center rules. Once the students have read the syllabus and rules, have students discuss the ramifications of breaking rules and regulations set forth by the school, department, and/or instructor. To determine if the students understand the school rules, use a hook to get the students involved in the classroom exercise. Start by giving the students scenarios that set up a rule violation, and then call on a student to discuss what may happen as a result of rule breaking. Have students act out punishment scenarios. Assign one student to be a school director or principal, and have another student act as a student offender. The student offender should give a defense of the rule violation about why he or she broke the school regulation. The mock principal should evaluate the offense using the school rules and regulations and then make a decision regarding punishment. After the role-play activity, ask students in the class to give their opinions about the seriousness of the offense and if they think the punishment given by the thespian principal is fair. Make sure to reinforce the school's rules and regulations before moving on to another topic. CS1, CS2, CS3, CS4, CS5, T1, T2, T3, R1, R2, R3, R4, R5, W1, W2, W3	a. The role-play will be evaluated by students answering questions about the topics presented and by using the **Role-Play or Skit Rubric**. Then give an electronic test on local school rules and regulations using the Blackboard class Web site. Have students complete a form verifying that they have received instructions on local school rules and policies. Parents/guardians should also sign to acknowledge rules and policies. This should be kept in a student folder.

Competency 2: Describe employment opportunities and responsibilities of the welder. (CONTREN Modules: 00108-09) (DOK 2) EMP

Suggested Enduring Understandings

1. Employers are looking for specific skills and abilities in employees.

Suggested Essential Questions

1. What would the nation and world be like without welders?

2. Stay aware of job opportunities in your field.	2. How can I make myself more employable for jobs in welding?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe employer expectations in the workplace. (DOK 1)	a. Ask students to discuss what their expectations are from their high school degrees and how they plan to use their high school diplomas. Ask the students if they plan to attend a community or senior college after graduating high school. Let the students interact with one another and discuss what they want to do with their skills. Discuss how the skills learned in your classroom relate to postsecondary courses available in higher education; give a brief history of the county/city school district, when the career–technical center was built, and why it was built. Tell the students who the vocational complex is intended to serve (industry needs). Then have students research area job opportunities that are available within the local industry relating to manufacturing. Allow students to use any media available to them so that they are focused on job availability by using the most desirable method to them. CS2, T1, T2, T3, T4, T5, T6, R1, R2, R3, R4, R5, W1	a. After initially discussing what each student plans to do after graduation, have students perform Internet research on community colleges that offer industrial welding degrees and certificates. Have students relate how the high school welding course relates to postsecondary courses that are available to them at their nearest local community college or university. Overall, encourage the students to pursue manufacturing careers, and guide them in programs that are offered after high school graduation. Then have students research and verbally report on job opportunities found in a newspaper, journal, or other publications and media sources. Have students tape the article to a piece of paper and then write several points the article mentions. Students could submit the article for a daily grade.

Competency 3: Explore leadership skills and personal development opportunities. (CONTREN Modules: 00107-09 and 00108-09) (DOK 2) COM, EMP

Suggested Enduring Understandings

1. Leadership and team-building skills are skills needed to be successful in a career.
2. Student involvement in SkillsUSA develops and enhances the skills employers seek.

Suggested Essential Questions

1. What leadership and team-building skills are necessary for success in any career?
2. What are some strategies you could use to make yourself more employable?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Demonstrate team-building and leadership skills. (DOK 2)	a. Use PowerPoint demonstrations and information retrieved from the SkillsUSA Web site, and/or show videos on past state-level or national-level SkillsUSA competitions. The National Skills USA Web site is http://www.skillsusa.org, and the Mississippi Skills USA Web site is http://www.mde.k12.ms.us/vocational/ SkillsUSA. If your school has historical video with past students attending the state competition, you may show that to the students to try to peak their interest in SkillsUSA. Ask students to elaborate on how they value leadership, what makes a good leader, and why they think they would be good leaders. Ask about the accomplishments of the students in other areas such as athletics, academics, and so forth. CS1, CS2, CS3, CS5, T1, T2, R1, R2	a. Have students write a short essay (1/2-page minimum) about how SkillsUSA is an important organization and how it can benefit the welding program by preparing leadership in the world of work. The essay should include how the organization incorporates leadership skills (soft skills) with tangible career skills taught in the manufacturing program. Use the **Writing Rubric** to evaluate student writings. Monitor the class for participation.
b. Demonstrate through practice appropriate work ethics. (DOK 2)	b. Discuss the advantages of joining SkillsUSA, and elaborate on how the students should value what SkillsUSA means to students, schools, and industry. After explaining what SkillsUSA encompasses, ask the students how membership in SkillsUSA would personally benefit them. Use interclass student competition. Have one class compete against other classes. For example, have the morning class compete against the afternoon class. Assign team tasks to groups within the classroom so that students have the opportunity to grow their leadership abilities. Develop cleanup crews that are responsible for areas of the classroom/shop areas. Award points per team per 9 weeks to encourage team competition among project groups. Use team-building concepts to create student cooperation and teamwork. CS1, CS2, CS3, CS4, CS5, T1, T2, T3, R1, R2, R3	b. As the semester progresses, assign projects to individuals or to teams, and have them compete for first, second, and third place just as SkillsUSA individuals and teams compete. Evaluate each team using an average grade point and the SkillsUSA competition rubrics. Each grade is used for a percentage of the individual's grade assessment. The **Work Ethics and Values Rubric** also can be used for assessment.

Competency 4: Describe general safety rules for working in a shop/lab and industry. (CONTREN Modules: 00101-09, 29101-09) (DOK 1) [SAF, WSS]

Suggested Enduring Understandings

1. Safe use and proper choice of tools is important to safely complete a welding job.
2. Understanding common safety violations and the consequences of committing unsafe acts is important in the workplace.

Suggested Essential Questions

1. Why do we have safety rules and regulations?
2. How do fires happen, and how do you extinguish a fire?
3. What happens when you choose the improper tool for the job or use a tool in an incorrect manner?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Discuss safety issues and prevention associated with the installation and service shop area. (DOK 1)	a. Use PowerPoint presentations from the Contren Learning Series (NCCER). This should prepare the students for school shop safety and NCCER examinations. Show safety videos such as the Farm Bureau Safety Video. Then discuss the school shop/lab safety rules that pertain to the school premise, and explain that the students must pass the class safety test with 100% competency in order to work in the school shop/lab. Instruct the students that they will not be allowed to work in the shop area unless they learn the school and shop safety rules and regulations. [R1, R2]	a. After administering a Contren Learning Series (NCCER) safety test that students must pass with 100% mastery, have the students go to the shop area and demonstrate how to safely operate a hand tool such as a hacksaw. Be very critical of the students to make sure that they follow safe practices. Use the **Safety Review Rubric** to evaluate the students' understanding of shop safety. Explain and demonstrate proper lifting procedures, and explain the importance of safety when lifting tall or long work pieces. Have students explain verbally or in writing the emergency procedures as described on the MSDS of a specific product. Have students use Inspiration to document the emergency procedures and properly interpret a mock MSDS chemical sheet. The students should be able to locate emergency contact phone numbers, the chemical

					name, properties, flash point, reactivity, and other important information. Have students explain emergency procedures in the event of a chemical spill. For example, locate the emergency exits, telephone numbers, eye wash and showers, spill kits, and emergency evacuation routes. Use the **Interpret MSDS Rubric** to evaluate the students' understanding of the MSDS.
b.	Demonstrate fire safety and prevention techniques in the workplace. (DOK 2)	b.	Explain the fire triangle—fuel, oxygen, and heat—and explain what flash point is for various shop materials. Then explain and discuss the various types of fires with students such as wood, grease, electrical, and metal. Explain the classes of fire extinguishers and with what types of fires to use them. Demonstrate the proper use of a fire extinguisher. The following video clip illustrates how a fire extinguisher works and how to use it to put out fires: http://videos.howstuffworks.com/howstuffworks/34-how-a-fire-extinguisher-works-video.htm. CS2, T1, T2, R1, R2, R3	b.	Have students do a simulated OSHA inspection to locate mock (teacher-made) safety violations. Place air hoses across walkways to create trip hazards, pressurize a leaky air hose, open breaker panel doors to expose breakers, lay out an extension cord that has frayed wiring, block fire extinguishers so that it is difficult to access them in the event of fire, block emergency exits with trash bins to inhibit escape, and so forth. Have students walk around the shop and locate safety violations, document the violation, and propose a remedy for the safety issue. Use the **Safety Review Rubric** to evaluate the students' understanding of shop safety.

Standards

Industry Standards

CONTREN CORE

SAF Basic Safety (Module 00101-09)
COM Basic Communication Skills (Module 00107-09)
EMP Basic Employability Skills (Module 00108-09)

CONTREN WELDING LEVEL ONE

WSS Welding Safety (Module 29101-09)

21st Century Learning Standards

CS1 Flexibility and Adaptability
CS2 Initiative and Self-Direction
CS3 Social and Cross-Cultural Skills
CS4 Productivity and Accountability
CS5 Leadership and Responsibility

National Educational Technology Standards for Students

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

ACT College Readiness Standards

R1 Main Ideas and Author's Approach
R2 Supporting Details
R3 Sequential, Comparative, and Cause–Effect Relationships
R4 Meaning of Words
R5 Generalizations and Conclusions
W1 Expressing Judgments
W2 Focusing on the Topic
W3 Developing a Position

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

Suggested Rubrics and Checklists

Interpret MSDS Rubric

Role-Play or Skit Rubric

Safety Review Rubric

Writing Rubric

Work Ethics and Values Rubric

Name: _____

Date: _____

Period: _____

Interpret MSDS Rubric

Your instructor will furnish you with the name of a chemical that is commonly used in agricultural and natural resources occupations. You are to conduct a search of the Internet to locate a material safety data sheet (MSDS) for this material and use it to answer the following questions.

1. What is the Web address of the Internet site on which you found this information?

2. If you accidentally drank some of this material, what first aid procedure would you do first?

3. What special precautions should be taken in storing this material?

4. What is the flash point of this material?

5. If you spilled a small amount of this product, how would you clean it up?

6. What immediate effects would likely happen if you spilled some of this material on your skin?

Name: _____

Date: _____

Period: _____

Role-Play or Skit Rubric

Behavior/Skill	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1	Total Score
ACCURACY	All information was accurate.	Almost all information was accurate.	Most information was accurate.	Very little information was accurate.	
ROLE	Excellent character development; student contributed in a significant manner.	Good character development; student contributed in a cooperative manner.	Fair character development; student might have contributed.	Little or no character development; student did not contribute much at all.	
KNOWLEDGE GAINED	Can clearly explain several ways in which his or her character "saw" things differently than other characters and can explain why	Can clearly explain several ways in which his or her character "saw" things differently than other characters	Can clearly explain one way in which his or her character "saw" things differently than other characters	Cannot explain any way in which his or her character "saw" things differently than other characters	
PROPS	Used several props and showed considerable creativity	Used one or two appropriate props that made the presentation better	Used one or two props that made the presentation better	Used no props to make the presentation better	
REQUIRED ELEMENTS	Included more information than required	Included all required information	Included most required information	Included less information than required	

Comments:

Name: _____

Date: _____

Period: _____

Safety Review Rubric

	Scoring Criteria			
The student	Excellent 4	Good 3	Needs Improvement 2	Unacceptable 1
Selects appropriate PPE.				
Wears protective clothing and eye protection.				
Demonstrates fire extinguisher operation.				
Subtotal for safety equipment				
Maintains clean facility				
Cleans area after tasks are complete.				
Stores materials properly.				
Subtotal for facility cleanliness				
Models appropriate behavior				
Observes safety rules.				
Follows written directions.				
Follows oral directions.				
Observes surroundings.				
Subtotal for appropriate behaviors				

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	
				Total Points	

Name: _____

Date: _____

Period: _____

Work Ethics and Values Rubric

Behavior/Skill	**Exemplary 4 Points**	**Accomplished 3 Points**	**Developing 2 Points**	**Beginning 1 Point**	**Score**
Punctuality (arrives on time)					
Preparation (completes pre-assignments and brings necessary materials)					
Respects other students/workers					
Listens to supervisor and follows directions					
Accepts responsibility for actions					
Demonstrates positive personality traits (kindness, trustworthiness, honesty)					
Demonstrates productivity (patience, thoroughness, hard working)					
Demonstrates a concern for others					
Remains on task and allows others to remain on task					
Takes initiative as appropriate					
				Total Score	

Unit 7: Gas Metal Arc Welding (GMAW) and Flux Core Arc Welding (FCAW).

Competency 1: Demonstrate and discuss safety procedures of, applications of, and advantages and limitations of and identify the machine controls for GMAW and FCAW. (CONTREN Module: 29205-09 and 29206-09) (DOK 2) [GFE, GFP]

Suggested Enduring Understandings

1. Locating safety hazards and adhering to safety guidelines is important when working with GMAW and FCAW welding machines.

Suggested Essential Questions

1. What could go wrong with GMAW or FCAW equipment?
2. How do you repair damaged welding cables?

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Perform safety inspections of types of GMAW and FCAW equipment and accessories available in the school shop while explaining the characteristics of welding current and power sources. (DOK 1)	a. Before class, set up damaged equipment in the lab. Make sure that the power is off on the machines to prevent any damage. Assemble the students in the lab, and discuss the damaged equipment while showing the students what to look for in broken parts. Demonstrate how to repair or replace the damaged equipment with good workable parts.	a. In the following days, set up damaged equipment again and have student pairs go out into the shop and locate the broken equipment. The student pairs should return to class and present their findings to the class and discuss how the equipment should be repaired. The **Team-Building and Participation Skills Rubric** and **Presentation Assessment Rubric** can be used to evaluate the student's work.
b. Identify and explain the use of GMAW and FCAW equipment: • Spray transfer • Globular • Short circuiting • Pulse (DOK 1)	b. Using the textbook and Internet, discuss how the "wire welder" operates to transfer filler material to parent metals that adheres the pieces together. The following Web sites may be useful: • http://www.weldreality.com/spray_transfer_above100.htm • http://www.aws.org/wj/may99/sadler.html • http://www.gowelding.org/MIG_Welding.html • http://www.uswelding.com/gases_gas_metal_arc_welding.htm • http://www.lincolnelectric.com/knowledge/articles/content/pulsedmig.asp	b. In order to fully understand welding terminology, the student should define the terms found on the **SMAW, FCAW, and GTAW Terms Worksheet** found at the end of this unit. The student should write an essay contrasting spray transfer, globular transfer, short circuiting, and pulse welding. The student should be prepared to have a round-table discussion with other classmates about the types of filler metal transfer. The **Writing Rubric**, **Team-Building and Participation Skills Rubric,** and **Presentation Assessment Rubric** can be used to

			evaluate the student's work.
c.	Demonstrate the ability to set up and perform GMAW/FCAW welding operations on plate: • GMAW-S (short-circuit) multiple-pass fillet welds in multiple positions, using solid or composite wire and shielding gas • GMAW-S (short-circuit) multiple-pass V-groove welds in multiple positions (with or without backing), using solid or composite wire • GMAW spray fillet and V-groove welds in multiple positions (with or without backing), using solid or composite wire and shielding gas • FCAW multiple-pass fillet welds in multiple positions, using flux cored wire and, if required, shielding gas • FCAW multiple-pass V-groove welds in multiple positions (with or without backing), using flux cored wire and, if required, shielding gas (DOK 2)	c. Set up a GMAW/FCAW welding machine to weld various weld joints in the flat, horizontal, and vertical positions. Demonstrate how to adjust current, wire feed, and hand speed to make quality welds. Discuss the control that must be used by the operator in order to create quality welds. Make sure students wear welding lenses while watching the demonstration.	c. The students should practice welding using GMAW/FCAW on 1/4-inch. solid carbon steel plate. Plates should be cut 2 inch by 4 inch (See Unit 4, Competency 2, Objective D). Butt, tee, corner, and lapp joint welds should be made. The welded pieces should be labeled and photographed for display in the student's Blackboard E-Portfolio. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment.

Standards

Industry Standards

CONTREN WELDING LEVEL TWO

GFE GMAW and FCAW: Equipment and Filler Materials (Module 29205-09)
GFP GMAW and FCAW: Plate (Module 29206-09)

Applied Academic Credit Standards

PRE-ALGEBRA

PRA1 Apply concepts and perform basic operations using real numbers in real-world contexts.
PRA5 Interpret, organize, and make predictions about a variety of data using concepts of probability.

TRANSITION TO ALGEBRA

TTA1 Understand relationships between numbers and their properties, and perform operations fluently.
TTA2 Understand, represent, and analyze patterns, relations, and functions.
TTA4 Demonstrate and apply various formulas in problem-solving situations.
TTA5 Interpret data.

ALGEBRA I

ALG1-3 Understand how algebra and geometric representations interconnect and build on one another.
ALG1-4 Demonstrate and apply various formulas in problem-solving situations.

National Educational Technology Standards for Students

T6 Technology Operations and Concepts

ACT College Readiness Standards

M1 Basic Operations and Applications
M5 Graphical Representations
M7 Measurement
R1 Main Ideas and Author's Approach
R3 Sequential, Comparative, and Cause–Effect Relationships
S1 Interpretation of Data
W5 Using Language

References

Althouse, A., Turnquist, C., Bowditch, W., Bowditch, K., & Bowditch, M. (2004). *Modern welding: Complete coverage of the welding field in one easy-to-use volume!* Tinley Park, IL: The Goodheart-Willcox Company, Inc.

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

Suggested Rubrics and Checklists

Presentation Assessment Rubric

Team-Building and Participation Skills Rubric

Blackboard E-Portfolio Checklist

GMAW, FCAW, and GTAW Term Worksheet

Writing Rubric

Name: _____

Date: _____

Period: _____

Presentation Assessment Rubric

Behavior/Skill	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Team-Building and Participation Skills Rubric

The student	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Actively participates in team discussions and activities.					
Encourages other team members to participate in discussions and activities.					
Works with other members to keep the activity on schedule and task.					
Shares ideas and thoughts.					
Offers constructive recommendations.					
Credits others for their contributions and ideas.					
Empathizes with other members.					
Requests input from others to reach an agreement.					
Expresses ideas and thoughts.					
Actively listens to other team members.					
				Total	

Notes:

Name: _____

Date: _____

Period: _____

Blackboard E-Portfolio Checklist

The student should initial the box to the right of the task when completed.

Description of Task	Student's Initial
Create and upload a cover letter explaining the topic of the portfolio entry.	
Include proper documentation for the assignment.	
Documentation includes ad explanation of the purpose of the E-Portfolio entry.	
Include photographs, video, and/or audio as required by the assignment.	
Photographs, video, and audio DO NOT include other students' faces. (Use of student likenesses requires parental approval.)	
DO NOT include any information about the school, town, or any other geographic information that would create bias in a third-party assessor.	
Upload a student self-assessment of the work.	

Name: _____

Date: _____

Period: _____

GMAW, FCAW, and GTAW Term Worksheet (Page 1 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

1. GMAW –

2. FCAW –

3. GTAW –

4. Arc eye –

5. Contact tip –

6. Contact tube –

7. Crater –

8. Dross –

9. Electric arc –

10. Electric current –

11. Electrode arc –

12. Electrode cable –

13. Electrode wire –

14. Ferrous metal –
    a. Types of ferrous metals –

15. Filler material –

Name: _____

GMAW, FCAW, GTAW Term Worksheet (Page 2 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

16. Flux –

17. Gaseous shield –

18. Globular metal transfer –

19. GMAW shielding gas diffuser –

20. GMAW torch handle –

21. GMAW torch nozzle –

22. GTAW cup –

23. GTAW filler rod –

24. GTAW gas diffuser –

25. GTAW torch collets –

26. GTAW tungsten electrode –

27. Ground cable –

28. Ground clamp –

29. Inert gas –
    a. Common inert gases used in welding –

30. MIG welding –

31. Molten weld metal –

32. Nonferrous metal –
    a. Types of nonferrous metals –

Name: _____

GMAW, FCAW, and GTAW Term Worksheet (Page 3 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

33. Oxidation –

34. Parent metal –

35. Penetration –

36. Porosity –

37. Shielding gas –

38. Short-circuiting metal transfer –
    a. Modified short-circuiting metal transfer –

39. Slag –

40. Solidified weld metal –

41. Spray metal transfer –
    a. Pulsed spray metal transfer –

42. TIG welding –

43. Ultraviolet light –

44. Voltage –

45. Welding power supply –

46. Weld spatter –

47. Wire feeder –

48. Workpiece –

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	_____
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	_____
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	_____
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	_____
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	_____
				Total Points	

Unit 8: Gas Tungsten Arc Welding (GTAW).

Competency 1: Demonstrate and discuss safety procedures of, applications of, and the advantages and limitations of and identify the machine controls for the GTAW welding process. (CONTREN Module: 29207-09 and 29208-09) (DOK 2). GTE, GTP

Suggested Enduring Understandings

1. Locating safety hazards and adhering to safety guidelines are important when working with

Suggested Essential Questions

1. What could go wrong with GMAW or FCAW equipment?

GMAW welding machines.	2. How do you repair damaged welding cables used on the GTAW?	

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Explain the gas tungsten arc welding safety, equipment, filler metals, and shielding gases. (DOK 1)	a. Before class, set up damaged equipment in the lab. Make sure that the power is off on the machines to prevent any damage. Assemble the students in the lab, and discuss the damaged equipment while showing the students what to look for in broken parts. Demonstrate how to repair or replace the damaged equipment with good workable parts.. T6, M1, M5, M7	a. In the following days, set up damaged equipment again and have student pairs go out into the shop and locate the broken equipment. The student pairs should return to class and present their findings to the class and discuss how the equipment should be repaired. Welding safety and weld quality should be addressed in the presentation followed by a roundtable discussion. The **Team-Building and Participation Skills Rubric** and **Presentation Assessment Rubric** can be used to evaluate the student's work.
b. Set up and weld using gas tungsten arc welding equipment in multiple weld positions using carbon steel filler material in the 1F, 2F, 3F, 4F, 1G, 2G, 3G, and 4G welding positions. (DOK 2)	b. Using a piece of carbon sheet steel, demonstrate how to make a GTAW stringer bead. Explain about the finesse needed to create a quality GTAW bead using the GTAW gun and filler material.	b. The students should practice making stringer beads using the GTAW welding equipment. The student should document her or his welding ability by videoing the GTAW process and uploading to the Blackboard E-Portfolio for future reference and grading. The **Blackboard E-Portfolio Checklist** should be used to ensure that the student has properly completed the assignment.

Standards

Industry Standards

CONTREN WELDING LEVEL TWO

GTE GTAW: Equipment and Filler Metals (Module 29207-09)
GTP GTAW: Plate (Module 29208-09)

Applied Academic Credit Standards

PRE-ALGEBRA

PRA1 Apply concepts and perform basic operations using real numbers in real-world contexts.
PRA5 Interpret, organize, and make predictions about a variety of data using concepts of probability.

TRANSITION TO ALGEBRA

TTA1 Understand relationships between numbers and their properties, and perform operations fluently.
TTA2 Understand, represent, and analyze patterns, relations, and functions.
TTA4 Demonstrate and apply various formulas in problem-solving situations.
TTA5 Interpret data.

ALGEBRA I

ALG1-3 Understand how algebra and geometric representations interconnect and build on one another.
ALG1-4 Demonstrate and apply various formulas in problem-solving situations.

National Educational Technology Standards for Students

T6 Technology Operations and Concepts

ACT College Readiness Standards

M1 Basic Operations and Applications
M5 Graphical Representations
M7 Measurement
R1 Main Ideas and Author's Approach
R3 Sequential, Comparative, and Cause–Effect Relationships
S1 Interpretation of Data
W5 Using Language

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Althouse, A., Turnquist, C., Bowditch, W., Bowditch, K., & Bowditch, M. (2004). *Modern welding: Complete coverage of the welding field in one easy-to-use volume!* Tinley Park, IL: The Goodheart-Willcox Company, Inc.

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Suggested Rubrics and Checklists

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Writing Rubric

Name: _____

Date: _____

Period: _____

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Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, and grammatically correct	Adequate, mostly accurate, and few grammatical errors	Poorly planned, somewhat accurate, and some grammatical errors	Weak, inaccurate, and many grammatical errors	
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Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	
				TOTAL	

Comments:

Name: _____

Date: _____

Period: _____

Team-Building and Participation Skills Rubric

The student	Exemplary 4 Points	Accomplished 3 Points	Developing 2 Points	Beginning 1 Point	Score
Actively participates in team discussions and activities.					
Encourages other team members to participate in discussions and activities.					
Works with other members to keep the activity on schedule and task.					
Shares ideas and thoughts.					
Offers constructive recommendations.					
Credits others for their contributions and ideas.					
Empathizes with other members.					
Requests input from others to reach an agreement.					
Expresses ideas and thoughts.					
Actively listens to other team members.					
				Total	

Notes:

Name: _____

Date: _____

Period: _____

Blackboard E-Portfolio Checklist

The student should initial the box to the right of the task when completed.

Description of Task	Student's Initial
Create and upload a cover letter explaining the topic of the portfolio entry.	
Include proper documentation for the assignment.	
Documentation includes ad explanation of the purpose of the E-Portfolio entry.	
Include photographs, video, and/or audio as required by the assignment.	
Photographs, video, and audio DO NOT include other students' faces. (Use of student likenesses requires parental approval.)	
DO NOT include any information about the school, town, or any other geographic information that would create bias in a third-party assessor.	
Upload a student self-assessment of the work.	

Name: _____

Date: _____

Period: _____

GMAW, FCAW, and GTAW Term Worksheet (Page 1 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

49. GMAW –

50. FCAW –

51. GTAW –

52. Arc eye –

53. Contact tip –

54. Contact tube –

55. Crater –

56. Dross –

57. Electric arc –

58. Electric current –

59. Electrode arc –

60. Electrode cable –

61. Electrode wire –

62. Ferrous metal –
    a. Types of ferrous metals –

63. Filler material –

Name: _____

GMAW, FCAW, GTAW Term Worksheet (Page 2 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

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65. Gaseous shield –

66. Globular metal transfer –

67. GMAW shielding gas diffuser –

68. GMAW torch handle –

69. GMAW torch nozzle –

70. GTAW cup –

71. GTAW filler rod –

72. GTAW gas diffuser –

73. GTAW torch collets –

74. GTAW tungsten electrode –

75. Ground cable –

76. Ground clamp –

77. Inert gas –
    a. Common inert gases used in welding –

78. MIG welding –

79. Molten weld metal –

80. Nonferrous metal –
    a. Types of nonferrous metals –

Name: _____

GMAW, FCAW, and GTAW Term Worksheet (Page 3 of 3)

Instructions: Define the following word list by using textbooks, the Internet, or other craft related materials.

81. Oxidation –

82. Parent metal –

83. Penetration –

84. Porosity –

85. Shielding gas –

86. Short-circuiting metal transfer –
    a. Modified short-circuiting metal transfer –

87. Slag –

88. Solidified weld metal –

89. Spray metal transfer –
    a. Pulsed spray metal transfer –

90. TIG welding –

91. Ultraviolet light –

92. Voltage –

93. Welding power supply –

94. Weld spatter –

95. Wire feeder –

96. Workpiece –

Name: _____

Date: _____

Period: _____

Writing Rubric

Project Title:

Criteria					Points
	1 Point	**2 Points**	**3 Points**	**4 Points**	
Organization	Sequence of information is difficult to follow.	Reader has difficulty following work because student jumps around.	Student presents information in logical sequence that reader can follow.	Information is in logical, interesting, sequence that reader can follow.	_____
Format and Sentences	Student does not follow the required format; plagiarism is depicted.	Student does not follow format; essay includes sentences that are unclear and incorrect.	Student follows format; article is attached; article is written.	Student follows format; article is attached and typed.	_____
Grammar and Spelling	Demonstrates little concept of proper grammar usage and spelling	Presentation has three misspellings and/or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has no misspellings or grammatical errors.	_____
Creativity	Work displays no creativity.	Work displays little creativity.	Work displays some creativity.	Work is very neat and creative.	_____
Due Date	Worked turned in a week late	Worked turned in 3 days late	Work turned in 1 day late	Work turned in on time	_____
				Total Points	

Recommended Tools and Equipment

CAPITALIZED ITEMS

** (Quantities for 20 students multiplied by the number of classes)

1	Bandsaw, portable with accessories	**2**
2	Bench, work or steel topped layout	**2**
3	Bits, drill 1/16 in.—1 in.	**1**
4	Compressed air supply and accessories (min. 80 psi @ 8 cfm/station)	**1**
5	Student computer with operating software with multimedia kit	**1**
6	Instructor computer with operating software with multimedia kit	**1**
7	Crane (A-frame) or cart	**1**
8	Cut off saw, 18 in.	**1**
9	Cutter, plasma arc (PAC)	**1**
10	Gas metal arc (GMAW/FCAW) (spray and short circuit)	**6**
11	Grinder, pedestal	**2**
12	Helmet, welding	**20**
13	Hoist, chain 5-ton	**1**
14	Ironworker with accessories	**1**
15	Jacket, cape, sleeves, or apron (leather)	**20**
16	Ornamental bender with accessories	**1**
17	Oven, electrode	**1**
18	Oxy-fuel set, manual gas cutting	**5**
19	Oxy-fuel set, machine gas cutting	**1**
20	Press, drill magnetic base 3/4 drive	**1**
21	Press, hydraulic	**1**
22	Press, drill 3/4-in. drive	**1**
23	Saw, band	**1**

24	Shear, 1/4-in. capacity	**1**
25	Station, eye wash	**1**
26	Table, Oxy-fuel burning with dross pan and replaceable slats (4 ft by 8 ft by 31 in.)	**2**
27	Table, Oxy-fuel welding, double-sided	**2**
28	Ventilation system	**1**
29	Vise, bench, medium duty	**4**
30	Welder, shielded metal arc (SMAW)	**20**
31	Welder, gas tungsten arc	**6**
32	Welder (GMAW/FCAW)	**6**
33	Portable induction welder	**1**
34	Robotic welding cell	**1**
35	Handheld resistance welder	**1**
36	Pipe welding alignment fixture	**6**

NON-CAPITALIZED ITEMS

** (Quantities for 20 students multiplied by the number of classes)

1	Burning, oxy-fuel tips, various sizes	**10**
2	Brush, carbon steel wire	**20****
3	Brush, stainless steel wire	**20****
4	Safety glasses	**20****
5	Com-a-long 1 1/2 ton	**1**
6	Chisel set, cold	**2**
7	Grinder, 4- to 5-in. right angle	**4**
8	Clamps, C 8-in.	**4**
9	Cleaners, oxy-fuel tip	**12**

10	Drill, 1/2-in. electric hand	**1**
11	Drill, 3/8-in. electric hand	**1**
12	Cutter, air carbon arc (CAC-A)	**1**
13	Dividers (radius maker, minimum 6-in.)	**15**
14	Extinguisher, fire	**3**
15	File, 10-in. mill, half round-bastard cut	**5**
16	Flashlight	**2**
17	Flints, oxy-fuel friction	**12****
18	Gloves, welders (pair)	**20****
19	Goggles, burning or face shield (OFC and PAC)	**20****
20	Grinder, 7- to 9-in. right angle	**4**
21	Cabinet, eye safety, sanitizing	**1**
22	Hammer, chipping	**20****
23	Hammer, 16-oz ball peen	**3**
24	Kit, first aid	**1**
25	Level, magnetic torpedo	**4**
26	Level, 2-ft level	**4**
27	Lighter, oxy-fuel friction spark	**12**
28	Pliers, 10-in. groove or slip joint	**20**
29	Pliers, 6-in. side or diagonal cutting	**5**
30	Pliers, 10-in. vise grip clamp	**5**
31	Pliers, 6-in. needle nosed	**5**
32	Pliers, MIG	**6**
33	Pliers, 10-in. vise grip	**5**
34	Portable welder 250 A with GMAW/FCAW capability and accessories	**1**
35	Pry bars	**2**

36	Punch, center	**5**
37	Rule, 12-in. English/metric steel bench	**20****
38	Screwdriver set, Phillips head	**3**
39	Screwdriver set, flathead	**3**
40	Scribe, metal	**5**
41	Square, combination set	**15**
42	Square (18 by 24 ft), framing	**15**
43	Square (4-ft), framing	
44	Tape, 25-ft steel measure	**10**
45	Tongs, welder	**20**
46	Wrench set, combination (SAE)	**1**
47	Wrench set, Allen or hex to 3/8 in.	**5**
48	Wrench, 12-in. adjustable	**3**
49	Wrench set, combination (metric)	**1**
50	Wrench set, sockets with ratchets and pull handles (SAE 3/8-in., 1/4-in., and 1/2-in. drives)	**2**
51	Wrench set, sockets with ratchets and pull handles (Metric 3/8-in., 1/4-in., and 1/2-in.)	**2**

RECOMMENDED INSTRUCTIONAL AIDS

It is recommended that instructors have access to the following items:

1	Scientific calculator	**1**
2	Cart, AV, for overhead projector	**1**
3	Cart, AV, for TV–VCR	**1**
4	Computer with operating software with multimedia kit	**20**
5	VCR/DVD	**1**
6	Video/audio data projector	**1**
7	Laptop computer	**1**

8	Computer file server with network software	**1**
9	Digital camera	**1**
10	Digital scanner with optical character recognition (OCR)	**1**
11	Interactive display board	**1**

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: Orientation, Leadership, and Safety

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

Unit 2: Math for Welding Applications

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

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

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

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

_____ 1. Explore regulations and codes for welding, base metal cleaning, and joint designs and their purpose. (DOK 2)
_____ 2. Identify and describe the basic equipment, setup, and safety rules for proper use of equipment, and prepare base metal for oxy-fuel welding. (DOK 2)
_____ 3. Identify and describe the basic equipment, setup, use, and safety rules for proper use of equipment, and prepare base metal for plasma arc cutting. (DOK 2)
_____ 4. Explore the selection, setup, and operation of carbon arc cutting equipment. (DOK 2)

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

_____ 1. Explain safety hazards, protective devices used, and how to avoid accidents that commonly occur in the welding trade. (DOK 1)

_____ 2. Identify types of shielded metal arc welding machines and their accessories. (DOK 2)

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

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

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

Unit 6: Orientation and Safety (Review and Reinforcement)

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

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

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

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

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

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

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

Unit 8: Production Welding Processes

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

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

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

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

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

Appendix A: 21st Century Skills Standards

CLS1 Flexibility and Adaptability
CLS2 Initiative and Self-Direction
CLS3 Social and Cross-Cultural Skills
CLS4 Productivity and Accountability
CLS5 Leadership and Responsibility

Today's life and work environments require far more than thinking skills and content knowledge. The ability to navigate the complex life and work environments in the globally competitive information age requires students to pay rigorous attention to developing adequate life and career skills.

CS 1 Flexibility and Adaptability

- Adapting to varied roles and responsibilities
- Working effectively in a climate of ambiguity and changing priorities

CS 2 Initiative and Self-Direction

- Monitoring one's own understanding and learning needs
- Going beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
- Demonstrating initiative to advance skill levels toward a professional level
- Defining, prioritizing, and completing tasks without direct oversight
- Utilizing time efficiently and managing workload
- Demonstrating commitment to learning as a lifelong process

CS 3 Social and Cross-Cultural Skills

- Working appropriately and productively with others
- Leveraging the collective intelligence of groups when appropriate
- Bridging cultural differences and using differing perspectives to increase innovation and the quality of work

CS 4 Productivity and Accountability

- Setting and meeting high standards and goals for delivering quality work on time
- Demonstrating diligence and a positive work ethic (e.g., being punctual and reliable)

CS 5 Leadership and Responsibility

- Using interpersonal and problem-solving skills to influence and guide others toward a goal
- Leveraging strengths of others to accomplish a common goal
- Demonstrating integrity and ethical behavior
- Acting responsibly with the interests of the larger community in mind

Appendix B: Mississippi Academic Standards

SEVENTH-GRADE MATH

SGM1. Apply concepts of rational numbers, and perform basic operations emphasizing the concepts of ratio, proportion, and percent with and without the use of calculators.

- Use the order of operations to simplify and/or evaluate whole numbers (including exponents and grouping symbols). (DOK 1)
- Solve problems involving addition, subtraction, multiplication, and division of rational numbers. Express answers in simplest form. (DOK 2)
- Convert among decimals, fractions, mixed numbers, and percents. (DOK 1)
- Evaluate and estimate powers and square roots of real numbers. (DOK 2)
- Explain the relationship between standard form and scientific notation. (DOK 1)
- Multiply and divide numbers written in scientific notation. (DOK 1)
- Solve real-life problems involving unit price, unit rate, sales price, sales tax, discount, simple interest, commission, and rates of commission. (DOK 1)
- Solve contextual problems requiring the comparison, ordering, and application of integers. (DOK 2)
- Develop a logical argument to demonstrate the 'denseness' of rational numbers. (DOK 3)

SGM2. Develop and apply the basic operations of rational numbers to algebraic and numerical tasks. Create and apply algebraic expressions and equations.

- Recognize, describe, and state the rule of generalized numerical and geometric patterns using tables, graphs, words, and symbols. (DOK 2)
- Solve equations that represent algebraic and real-world problems using multiple methods including the real number properties. (DOK 1)
- Formulate algebraic expressions, equations, and inequalities to reflect a given situation and vice versa. (DOK 2)
- Complete a function table based on a given rule and vice versa. (DOK 1)
- Identify the following properties using variables, and apply them in solving problems. (DOK 1)
    - Zero property of multiplication
    - Inverse properties of addition/subtraction and multiplication/division
    - Commutative and associative properties of addition and multiplication
    - Identity properties of addition and multiplication
    - Distributive properties of multiplication over addition and subtraction
- Predict the shape of a graph from a function table. (DOK 2)

SGM3. Apply geometric relationships of angles, two- and three-dimensional shapes, and transformations.

- Classify and compare three-dimensional shapes using their properties. (DOK 1)
- Construct two-dimensional representations of three-dimensional objects. (DOK 2)
- Justify the congruency or symmetry of two figures. (DOK 2)
- Perform transformations (rigid and non-rigid motions) on two-dimensional figures using the coordinate plane. (DOK 2)
- Create an argument using the Pythagorean theorem principles to show that a triangle is a right triangle. (DOK 2)

- Construct and classify angles. (DOK 2)

SGM4. Apply appropriate techniques, tools, and formulas to determine measurements with a focus on real-world problems. Recognize that formulas in mathematics are generalized statements about rules, equations, principles, or other logical mathematical relationships.

- Convert from one unit to another, perform basic operations, and solve real-world problems using standard (English and metric) measurements within the same system. (DOK 2)
- Use formulas and strategies, such as decomposition, to compute the perimeter and area of triangles, parallelograms, trapezoids, and the circumference and area of circles, and find the area of more complex shapes. (DOK 2)
- Develop and justify geometric formulas for volume and surface area of cylinders, pyramids, and prisms. (DOK 3)
- Solve problems involving scale factors using ratios and proportions. (DOK 2)

SGM5. Organize and interpret data. Analyze data to make predictions.

- Use proportions, estimates, and percentages to construct, interpret, and make predictions about a population based on histograms or circle graph representations of data from a sample. (DOK 2)
- Determine how outliers affect mean, median, mode, or range. (DOK 2)
- Construct and interpret line graphs, frequency tables, circle graphs, box-and-whisker plots, and scatterplots to generalize trends from given data. (DOK 2)
- Determine probabilities through experimentation, simulation, or calculation.
- (Note: Make and test conjectures and predictions by calculating the probability of an event.) (DOK 2)

PRE-ALGEBRA

PRA1. Apply concepts and perform basic operations using real numbers in real-world contexts.

- Define, classify, and order rational and irrational numbers and their subsets. (DOK 1)
- Formulate and solve standard and real-life problems involving addition, subtraction, multiplication, and division of rational numbers. (DOK 2)
- Apply the concepts of greatest common factor (GCF) and least common multiple (LCM) to monomials with variables. (DOK 2)
- Simplify and evaluate expressions using order of operations, and use real number properties to justify solutions. (DOK 2)
- Explain the rules of exponents related to multiplication and division of terms with exponents. (DOK 2)
- Recognize and appropriately use exponential and scientific notation. (DOK 1)
- Explain and use the inverse relationship between square roots and squares. (DOK 2)

PRA2. Apply properties to simplify algebraic expressions, solve linear equations and inequalities, and apply principles of graphing.

- Simplify and evaluate numerical and algebraic expressions. (DOK 1)
- Apply properties of real numbers with an emphasis on the distributive properties of multiplication over addition and subtraction. (DOK 1)
- Solve and check equations and inequalities using one variable. (DOK 2)
- Model inequalities (and their solutions) on a number line. (DOK 1)

- Graph linear equations and nonlinear equations ($y = x^2$) using multiple methods including t-tables and slope-intercept. (DOK 2)
- Given a linear graph, identify its slope as positive, negative, undefined, or zero, and interpret slope as rate of change. (DOK 2)
- Determine slope, x-intercept, and y-intercept from a graph and/or equation in slope-intercept or standard form. (DOK 1)
- Add, subtract, and multiply monomials and binomials. (DOK 1)
- Predict characteristics of a graph given an equation or t-table. (DOK 2)

PRA3. Identify and apply geometric principles to polygons, angles, and two- and three-dimensional figures.

- Locate and identify angles formed by parallel lines cut by a transversal(s) (e.g., adjacent, vertical, complementary, supplementary, corresponding, alternate interior, and alternate exterior). (DOK 1)
- Find missing angle measurements for parallel lines cut by a transversal(s) and for a vertex of a polygon. (DOK 1)
- Explain the Pythagorean theorem, and apply it to solve routine and non-routine problems. (DOK 3)
- Solve real-world and non-routine problems involving congruent and similar figures. (DOK 3)
- Use two-dimensional representations (nets) of three-dimensional objects to describe objects from various perspectives. (DOK 2)

PRA4. Understand measurable attributes of objects, and apply various formulas in problem-solving situations.

- Solve real-world application problems that include length, area, perimeter, and circumference using standard measurements. (DOK 2)
- Develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios. (DOK 3)
- Use formulas and/or appropriate measuring tools to find length and angle measures (to appropriate levels of precision), perimeter, area, volume, and surface area of polygons, circles, spheres, cones, pyramids, and composite or irregular figures. (DOK 1)

PRA5. Interpret, organize, and make predictions about a variety of data using concepts of probability.

- Use a given mean, mode, median, and range to summarize and compare data sets including investigation of the different effects that change in data values have on these measures. (DOK 2)
- Select the appropriate measures of central tendency for a particular purpose. (DOK 2)
- Make and list conjectures by calculating probability for experimental or simulated contexts. (DOK 3)
- Construct and interpret scatterplots to generalize trends from given data sets. (DOK 3)

TRANSITION TO ALGEBRA

TTA1. Understand relationships between numbers and their properties, and perform operations fluently.

- Compare and contrast the subsets of real numbers. (DOK 1)

- Simplify and evaluate expressions using the order of operations, and use real number properties to justify solutions. (DOK 2)
- Express, interpret, and compute numbers using scientific notation in meaningful contexts. (DOK 1)
- Apply the concept of greatest common factor (GCF) and least common multiple (LCM) to monomials with variables. (DOK 2)
- Use the inverse relationship to develop the concept of roots and perfect squares. (DOK 2)

TTA2. Understand, represent, and analyze patterns, relations, and functions.

- Given a literal equation, solve for a specified variable of degree one. (DOK 1)
- Explain and illustrate how changes in one variable may result in a change in another variable. (DOK 2)
- Solve and check multi-step equations and inequalities, including distributive property, variables on both sides, and rational coefficients. (DOK 2)
- Use real-world data to express slope as a rate of change. (DOK 2)
- Graph solutions to linear inequalities. (DOK 2)
- Write linear equations given slope and y-intercept or two points. (DOK 2)
- Identify domain, range, slope, and intercepts of functions. (DOK 1)
- Develop generalizations to characterize the behaviors of graphs (linear, quadratic, and absolute value). (DOK 2)
- Classify and determine the degree of a polynomial, and arrange polynomials in ascending or descending order of a variable. (DOK 1)
- Apply ratios, and use proportional reasoning to solve real-world algebraic problems. (DOK 2)
- Add, subtract, multiply, and divide polynomial expressions. (DOK 1)
- Analyze the relationship between x and y values, and determines whether a relation is a function. (DOK 2)

TTA3. Understand geometric principles of polygons, angles, and figures.

- Apply the Pythagorean Theorem to solve problems. (DOK 2)
- Apply proportional reasoning to determine similar figures and find unknown measures. (DOK 2)

TTA4. Demonstrate and apply various formulas in problem-solving situations.

- Solve real-world problems involving measurements (i.e., circumference, perimeter, area, volume, distance, temperature, etc.). (DOK 2)
- Explain and apply the appropriate formula to determine length, midpoint, and slope of a segment in a coordinate plane (i.e., distance formula and Pythagorean Theorem). (DOK 2)

TTA5. Interpret data.

- Construct graphs, make predictions, and draw conclusions from tables, line graphs, and scatterplots. (DOK 3)
    - Use a given mean, mode, median, and range to summarize and compare data sets including investigation of the different effects that change in data have on these

measures of central tendency, and select the appropriate measures of central tendency for a given purpose. (DOK 2)
- Calculate basic probability of experiments and simulations to make and test conjectures about results. (DOK 3)

ALGEBRA I

ALG1-1. Understand relationships between numbers and their properties, and perform operations fluently.
- Apply properties of real numbers to simplify algebraic expressions, including polynomials. (DOK 1)
- Use matrices to solve mathematical situations and contextual problems. (DOK 2)

ALG1-2. Understand, represent, and analyze patterns, relations, and functions.
- Solve, check, and graph multi-step linear equations and inequalities in one variable, including rational coefficients in mathematical and real-world situations. (DOK 2)
- Solve and graph absolute value equations and inequalities in one variable. (DOK 2)
- Analyze the relationship between x and y values, determine whether a relation is a function, and identify domain and range. (DOK 2)
- Explain and illustrate how a change in one variable may result in a change in another variable and apply to the relationships between independent and dependent variables. (DOK 2)
- Graph and analyze linear functions. (DOK 2)
- Use algebraic and graphical methods to solve systems of linear equations and inequalities in mathematical and real-world situations. (DOK 2)
- Add, subtract, multiply, and divide polynomial expressions. (DOK 1)
- Factor polynomials by using Greatest Common Factor (GCF), and factor quadratics that have only rational roots. (DOK 1)
- Determine the solutions to quadratic equations by using graphing, tables, completing the square, the quadratic formula, and factoring. (DOK 1)
- Justify why some polynomials are prime over the rational number system. (DOK 2)
- Graph and analyze absolute value and quadratic functions. (DOK 2)
- Write, graph, and analyze inequalities in two variables. (DOK 2)

ALG1-3. Understand how algebra and geometric representations interconnect and build on one another.
- Apply the concept of slope to determine if lines in a plane are parallel or perpendicular. (DOK 2)
- Solve problems that involve interpreting slope as a rate of change. (DOK 2)

ALG1-4. Demonstrate and apply various formulas in problem-solving situations.
- Solve real-world problems involving formulas for perimeter, area, distance, and rate. (DOK 2)
- Explain and apply the appropriate formula to determine length, midpoint, and slope of a segment in a coordinate plane. (i.e., distance formula and Pythagorean theorem). (DOK 2)
- Represent polynomial operations with area models. (DOK 2)

ALG1-5. Represent, analyze, and make inferences based on data with and without the use of technology.

- Draw conclusions and make predictions from scatterplots. (DOK 3)
- Use linear regression to find the line of best fit from a given set of data. (DOK 3)

Appendix C: ACT College Readiness Standards

English

E1 Topic Development in Terms of Purpose and Focus

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

E2 Organization, Unity, and Coherence

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

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

- Revise sentences to correct awkward and confusing arrangements of sentence elements.
- Revise vague nouns and pronouns that create obvious logic problems.
- Delete obviously synonymous and wordy material in a sentence.

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

E4 Sentence Structure and Formation

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

E5 Conventions of Usage

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

- Ensure that a verb agrees with its subject when a phrase or clause between the two suggests a different number for the verb.

E6 Conventions of Punctuation

- Delete commas that create basic sense problems (e.g., between verb and direct object).
- Provide appropriate punctuation in straightforward situations (e.g., items in a series).
- Delete commas that disturb the sentence flow (e.g., between modifier and modified element).
- Use commas to set off simple parenthetical phrases.
- Delete unnecessary commas when an incorrect reading of the sentence suggests a pause that should be punctuated (e.g., between verb and direct object clause).
- Use punctuation to set off complex parenthetical phrases.
- Recognize and delete unnecessary commas based on a careful reading of a complicated sentence (e.g., between the elements of a compound subject or compound verb joined by *and*).
- Use apostrophes to indicate simple possessive nouns.
- Recognize inappropriate uses of colons and semicolons.
- Use commas to set off a nonessential/nonrestrictive appositive or clause.
- Deal with multiple punctuation problems (e.g., compound sentences containing unnecessary commas and phrases that may or may not be parenthetical).
- Use an apostrophe to show possession, especially with irregular plural nouns.
- Use a semicolon to indicate a relationship between closely related independent clauses.
- Use a colon to introduce an example or an elaboration.

Math

M1 Basic Operations and Applications

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

M2 Probability, Statistics, and Data Analysis

- Calculate the average of a list of positive whole numbers.
- Perform a single computation using information from a table or chart.
- Calculate the average of a list of numbers.
- Calculate the average, given the number of data values and the sum of the data values.
- Read tables and graphs.
- Perform computations on data from tables and graphs.
- Use the relationship between the probability of an event and the probability of its complement.
- Calculate the missing data value, given the average and all data values but one.
- Translate from one representation of data to another (e.g., a bar graph to a circle graph).
- Determine the probability of a simple event.

- Exhibit knowledge of simple counting techniques.*
- Calculate the average, given the frequency counts of all the data values.
- Manipulate data from tables and graphs.
- Compute straightforward probabilities for common situations.
- Use Venn diagrams in counting.*
- Calculate or use a weighted average.
- Interpret and use information from figures, tables, and graphs.
- Apply counting techniques.
- Compute a probability when the event and/or sample space is not given or obvious.
- Distinguish between mean, median, and mode for a list of numbers.
- Analyze and draw conclusions based on information from figures, tables, and graphs.
- Exhibit knowledge of conditional and joint probability.

M3 Numbers: Concepts and Properties

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

M4 Expressions, Equations, and Inequalities

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

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

M5 Graphical Representations

- Identify the location of a point with a positive coordinate on the number line.
- Locate points on the number line and in the first quadrant.
- Locate points in the coordinate plane.
- Comprehend the concept of length on the number line.*
- Exhibit knowledge of slope.*
- Identify the graph of a linear inequality on the number line.*
- Determine the slope of a line from points or equations.*
- Match linear graphs with their equations.*
- Find the midpoint of a line segment.*
- Interpret and use information from graphs in the coordinate plane.
- Match number line graphs with solution sets of linear inequalities.
- Use the distance formula.
- Use properties of parallel and perpendicular lines to determine an equation of a line or coordinates of a point.
- Recognize special characteristics of parabolas and circles (e.g., the vertex of a parabola and the center or radius of a circle).†
- Match number line graphs with solution sets of simple quadratic inequalities.
- Identify characteristics of graphs based on a set of conditions or on a general equation such as y = ax2 + c.
- Solve problems integrating multiple algebraic and/or geometric concepts.
- Analyze and draw conclusions based on information from graphs in the coordinate plane.

M6 Properties of Plane Figures

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

M7 Measurement

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

M8 Functions

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

Notes

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

Reading

R1 Main Ideas and Author's Approach

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

R2 Supporting Details

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

R3 Sequential, Comparative, and Cause—Effect Relationships

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

R4 Meaning of Words

- Understand the implication of a familiar word or phrase and of simple descriptive language.
- Use context to understand basic figurative language.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in uncomplicated passages.
- Use context to determine the appropriate meaning of virtually any word, phrase, or statement in uncomplicated passages.
- Use context to determine the appropriate meaning of some figurative and nonfigurative words, phrases, and statements in more challenging passages.
- Determine the appropriate meaning of words, phrases, or statements from figurative or somewhat technical contexts.
- Determine, even when the language is richly figurative and the vocabulary is difficult, the appropriate meaning of context-dependent words, phrases, or statements in virtually any passage.

R5 Generalizations and Conclusions

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

Science

S1 Interpretation of Data

- Select a single piece of data (numerical or nonnumerical) from a simple data presentation (e.g., a table or graph with two or three variables, a food web diagram).
- Identify basic features of a table, graph, or diagram (e.g., headings, units of measurement, axis labels).
- Select two or more pieces of data from a simple data presentation.
- Understand basic scientific terminology.
- Find basic information in a brief body of text.
- Determine how the value of one variable changes as the value of another variable changes in a simple data presentation.
- Select data from a complex data presentation (e.g., a table or graph with more than three variables, a phase diagram).
- Compare or combine data from a simple data presentation (e.g., order or sum data from a table).
- Translate information into a table, graph, or diagram.
- Compare or combine data from two or more simple data presentations (e.g., categorize data from a table using a scale from another table).
- Compare or combine data from a complex data presentation.
- Interpolate between data points in a table or graph.
- Determine how the value of one variable changes as the value of another variable changes in a complex data presentation.
- Identify and/or use a simple (e.g., linear) mathematical relationship between data.
- Analyze given information when presented with new, simple information.
- Compare or combine data from a simple data presentation with data from a complex data presentation.
- Identify and/or use a complex (e.g., nonlinear) mathematical relationship between data.
- Extrapolate from data points in a table or graph.
- Compare or combine data from two or more complex data presentations.
- Analyze given information when presented with new, complex information.

S2 Scientific Investigation

- Understand the methods and tools used in a simple experiment.
- Understand the methods and tools used in a moderately complex experiment
- Understand a simple experimental design.
- Identify a control in an experiment.
- Identify similarities and differences between experiments.

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

S3 Evaluation of Models, Inferences, and Experimental Results

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

Writing

W1 Expressing Judgments

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

- Examining different perspectives, and/or
- Evaluating implications or complications of the issue, and/or
- Posing and fully discussing counterarguments to the writer's position

W2 Focusing on the Topic

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

W3 Developing a Position

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

W4 Organizing Ideas

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

W5 Using Language

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

Appendix D: National Industry Standards

Industry Standards

CONTREN CORE

SAF – Basic Safety (MODULE 00101-09)

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

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

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

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

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

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

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

BLU – Introduction to Blueprints (MODULE 00105-09)

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

RIG – Basic Rigging (MODULE 00106-09)

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

COM – Basic Communication Skills (MODULE 00107-09)

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

EMP – Basic Employability Skills (MODULE 00108-09)

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

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

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

CONTREN PIPEFITTING

LEVEL ONE

OTT – ORIENTATION TO THE TRADE

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

PHT – PIPEFITTING HAND TOOLS

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

PPT – PIPEFITTING POWER TOOLS

- State the safety procedures that must be followed when working with power tools.

- Cut pipe using a portable band saw.
- Identify and explain the uses of portable grinders.
- Explain the proper and safe operation of machines used in pipe joint preparation:
    - Pipe threaders
    - Portable power drives
    - Pipe bevelers
- Perform selected pipe joint preparation operations using power tools.

LEVEL TWO

DDS – DRAWINGS AND DETAIL SHEETS

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

BWP – BUTT WELD PIPE FABRICATION

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

CONTREN WELDING

LEVEL ONE

WSS – WELDING SAFETY (MODULE 29101-09)

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

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

- Identify and explain the use of oxyfuel cutting equipment.
- Set up oxyfuel equipment.
- Light and adjust an oxyfuel torch.
- Shut down oxyfuel cutting equipment.
- Disassemble oxyfuel equipment.
- Change cylinders.
- Perform oxyfuel cutting:
    - Straight line and square shapes
    - Piercing and slot cutting
    - Bevels

    - Washing
    - Gouging
- Operate a motorized, portable oxy-fuel gas cutting machine.

PAC – PLASMA ARC CUTTING (MODULE 29103-03)

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

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

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

BMP – BASE METAL PREP (MODULE 29105-09)

- Clean base metal for welding or cutting.
- Identify and explain joint design.
- Explain joint design considerations.
- Mechanically bevel the edge of a mild steel plate.
- Thermally bevel the end of a mild steel plate.
- Select the proper joint design based on a welding procedure specification (WPS) or instructor direction.

WQT – WELD QUALITY (MODULE 29106-09)

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

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

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

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

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

- Identify and select the proper electrode for an identified welding task.

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

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

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

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

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

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

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

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

LEVEL TWO

WWS – WELDING SYMBOLS (MODULE 29201-09)

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

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

- Identify and explain a welding detail drawing.
- Identify and explain lines, material fills, and sections.
- Identify and explain object views.

- Identify and explain dimensioning.
- Identify and explain notes and bill of materials.
- Interpret basic elements of a welding detail drawing.
- Sketch or draw a basic welding drawing.

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

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

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

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

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

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

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

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

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

- Explain gas tungsten arc welding (GTAW) safety.
- Identify and explain the function of GTAW equipment.
- Identify and explain the function of GTAW filler metals.
- Identify and explain the function of GTAW shielding gases.
- Set up GTAW equipment.

GTP – GTAW – PLATE (MODULE 29208-09)

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

LEVEL THREE

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

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

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

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

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

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

- 5G
- 6G

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

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

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

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

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

- Set up GTAW equipment to perform stainless and/or low-alloy steel pipe welding.
- Identify and explain open-root V-groove pipe weld techniques.
- Perform open-root V-groove pipe welds using GTAW in the following positions:
  - G-ROTATED
  - 2G
  - 5G
  - 6G

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

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

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

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

    - 4G (overhead)
- Perform V-groove welds on aluminum pipe in the following positions, using aluminum wire and shielding gas:
    - 1G-ROTATED (flat)
    - 2G (horizontal)
    - 5G (multiple)
    - 6G (inclined multiple)

Appendix E:
National Educational Technology Standards for Students

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

T1 Creativity and Innovation
Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students:
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:
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:
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:
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:
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:

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.