



Statewide Framework Document for:

**Welding Technology I**

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments may be developed at the local level. In order to earn state approval, performance assessments must be submitted within this framework. **This course is eligible for 1.0 credit in integrated math 1.**

The Washington State Science Standards performance expectations for high school blend core ideas (Disciplinary Core Ideas, or DCIs) with scientific and engineering practices (SEPs) and crosscutting concepts (CCCs) to support students in developing usable knowledge that can be applied across the science disciplines. These courses are to be taught in a [three-dimensional manner](http://nextgenscience.org/three-dimensions). The details about each performance expectation can be found at [Next Generation Science Standards](http://nextgenscience.org/next-generation-science-standards).

Washington Mathematics Standards (Common Core State Standards) support foundational mathematical knowledge and reasoning. While it is important to develop a conceptual understanding of mathematical topics and fluency in numeracy and procedural skills, teachers should also focus on the application of mathematics to career fields to support the three (3) key shifts of CCSS. The Standards for Mathematical Practice develop mathematical habits of mind and are to be modeled and integrated throughout the course. The details about each mathematical standard can be found at [Common Core Mathematics Standards](http://www.corestandards.org/Math/).

Washington English Language Arts Standards (Common Core State Standards) establish guidelines for literacy in history/social studies, science, and technical subjects. The College and Career Readiness Anchor Standards form the backbone of the ELA/literacy standards by articulating core knowledge and skills, while grade-specific standards provide additional specificity. The details about English Language Arts Standards can be found at [Common Core English Language Arts Standards.](http://www.corestandards.org/ELA-Literacy/)

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| **School District Name** | | |
| **Course Title:** Welding Technology- I | | **Total Framework Actual Hours:** 180 hours |
| **CIP Code:** 480508 | **Exploratory  Preparatory** | **Date Last Modified:** August 2025 |
| **Career Cluster:** Manufacturing | | **Cluster Pathway:** Production |
| **Course Summary:** A course that prepares individuals to apply technical knowledge and skills to join or cut metal surfaces. Includes instruction in thermal welding, arc welding, Oxy fuel cutting, material selection, basic metallurgy and heat treating, structural design, safety, and applicable codes and standards | | |
| **Eligible for Equivalent Credit in: 1.0 Integrated** Math I | | **Total Number of Units:** 12 |
| **Course Resources:** [**https://openbook.millerwelds.com/**](https://openbook.millerwelds.com/) | | |

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| **Unit 1:** Career Exploration | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: In this unit, students delve into advanced career opportunities in the welding industry across the Maritime, Agriculture and Natural Resources and Construction sectors such as roles in inspection, fabrication, and engineering. They explore pathways for career advancement, including the importance of certifications and continuing education. By researching different certifications and interacting with professionals, students develop a career roadmap, setting short- and long-term goals to guide their future in welding. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Career Research and Analysis**:  Students must research specific careers in the welding industry, identifying job roles, responsibilities, required certifications, and qualifications.  **Transferability of Skills.**  Students will assess how foundational welding skills can be adapted for a career in any one of WA. States key sectors like Agriculture and Natural Resources, Aerospace, Maritime, and Construction.  **Certification Mapping**:  Students will develop a career roadmap that outlines the certification levels (e.g., CWI, CWE) and timelines required for different welding career paths.  **Career Reflection and Planning**:  Students will reflect on personal interests, skills, and values, aligning them with potential welding careers. Students will create a detailed career roadmap with achievable goals.  **Professional Communication**:  Students will develop a professional resume and participate in mock interviews, focusing on articulating skills, experience, and career goals with professionalism. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Collaboration and Communication:** Students will work in groups to research different roles in the welding industry and present findings to the class. Each group will present a different pathway, allowing students to understand various perspectives and practice teamwork.   * **Leadership Skill:** 4B.1: Use information accurately and creatively for problem-solving and career decision-making.   **Career Planning and Goal Setting:** Students will lead discussions on the importance of goal setting in career planning and guide their peers in developing a 5-year career plan that incorporates education, certifications, and career goals.   * **Leadership Skill:** 6B.1: Create, implement, and assess personal goals, seeking feedback for improvement.   **Job Readiness:** Students will take on leadership roles in organizing mock interviews, where they will act as both interviewers and interviewees. This will develop communication skills and highlight the importance of leadership in navigating job opportunities.   * **Leadership Skill:** 3A.1: Demonstrate self-discipline and accountability in completing career preparation tasks and organizing events for peers.   **Mentorship:** Pair students with welding professionals in a mentoring session, either virtually or through school partnerships. Students will ask career-related questions and document key learnings to share with peers.  **Leadership Skill:** 7A.1: Demonstrate initiative in seeking guidance and feedback from industry professionals. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:** North Dakota Career Development Content Standards | | **Website:** <https://www.cte.nd.gov/sites/www/files/documents/Standards/CareerDevelopment.pdf> | |
| **1.1: Investigate Careers and Make Informed Decisions**  1.1.1: Develop skills to locate and interpret career information. 1.1.2: Explore a variety of traditional and nontraditional occupations. 1.1.3: Assess personal abilities, skills, interests, and motivations. 1.1.4: Learn to work cooperatively in teams. 1.1.5: Develop decision-making and goal-setting skills. 1.1.6: Understand the importance of career planning.  **2.1: Achieve Career Goals with Satisfaction** 2.1.1: Apply decision-making skills in career planning and course selection. 2.1.2: Relate personal skills and interests to career choices. 2.1.3: Understand the career-planning process and occupational classifications. 2.1.4: Use research and online resources to gather career information. 2.1.5: Recognize how economic and societal changes impact employment trends and future training.  **2.2: Connect Education and Work** 2.2.1: Understand how educational achievement influences career success. 2.2.2: Recognize how work contributes to personal satisfaction. 2.2.3: Identify personal preferences that influence career success. 2.2.4: Acknowledge the need for lifelong learning and skill development in a changing workplace. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and guide solutions; interpret units consistently in formulas and when making data-driven decisions.  Example: Students will calculate the cost of certifications, comparing different welding career paths and determining the time required to complete certifications based on personal timelines.  **N-Q.2:** Define appropriate quantities for descriptive modeling.  Example: Students will quantify the financial investment and time commitment necessary for each career path, including the costs of certifications, continuing education, and training programs, and compare them across various sectors.  **N-Q.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  Example: Students will calculate the approximate time (in months or years) required to achieve certifications like CWI or CWE, using real-world data from welding industry guidelines, factoring in course durations and work experience requirements.  **Modeling (MD)**  **MD.2:** Apply mathematical reasoning to understand and model real-world data related to career progression.  Example: Students will model timelines and financial plans for different welding career paths, projecting when they could achieve certain professional milestones based on salary data, educational costs, and work experience. | | |

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| **Unit 2:** Working as a Team | | | **Total Learning Hours for Unit:** 5 |
| **Unit Summary**: This unit focuses on enhancing teamwork and communication skills through complex welding projects. Students learn about team dynamics, leadership, and conflict resolution, emphasizing the importance of collaboration in achieving project quality and safety standards. Through group projects and reflective discussions, they practice dividing roles and responsibilities, fostering a deeper understanding of effective team performance in a welding setting. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Teamwork & Collaboration**: Students must effectively work in teams, dividing roles and responsibilities to complete welding projects on time and to industry standards. This includes taking ownership of their specific tasks within the group and being accountable for contributing to the overall success of the project. **Communication & Conflict Resolution**: Students will demonstrate effective communication strategies and conflict resolution techniques within teams to ensure successful project completion. Personal accountability is emphasized in resolving conflicts professionally and maintaining open, honest communication with teammates. **Peer Evaluation & Accountability**: Students will assess each other's contributions, offering constructive feedback on team performance and identifying strengths and areas for improvement. **Personal Responsibility & Initiative**: Students will be responsible for managing their own workload, ensuring that they meet deadlines and contribute meaningfully to the team. **Time Management**: Students will demonstrate effective time management by balancing their individual tasks and team responsibilities to meet project deadlines. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaboration and Communication:** Students will work in teams to complete a welding project, dividing roles based on individual strengths and expertise. The team will collaborate to meet the project’s quality and safety standards.   * **Leadership Skill:** 4B.1: Use information accurately and creatively for problem-solving and decision-making in a team environment.   **Conflict Resolution in Teams:** Students will engage in reflective discussions on how their teams managed conflicts and communication challenges. They will develop strategies to address conflicts in future projects.   * **Leadership Skill:** 2B.1: Demonstrate the ability to manage conflict constructively in a team setting.   **Peer Feedback and Reflection:** Students will conduct peer evaluations and provide constructive feedback on their teammates' contributions, helping to foster a culture of collaboration and accountability.  **Leadership Skill:** 3A.2: Demonstrate the ability to give and receive constructive feedback in a team setting to enhance personal and group performance. | | | |
| **Industry Standards and/or Competencies** | | | |
| **Name of standards:** United States Department of Labor, Employment and Training Administration: Advanced Manufacturing Competency  United States Department of Labor, Employment and Training Administration: Commercial and Industrial Construction Competency Model  United States Department of Labor, Employment and Training Administration: Automation Competency Model  AWS Certified Welder Work Process Schedule | | **Website:**  [*https://www.careeronestop.org/CompetencyModel/Competency-Models/pyramid-home.aspx*](https://www.careeronestop.org/CompetencyModel/Competency-Models/pyramid-home.aspx)  [*https://www.aws.org/*](https://www.aws.org/) | |
| **Interacting and working with others/Respecting diversity**   * + 1. Recognize that everyone has rights and responsibilities     2. Respect alternative points of view     3. Recognize, accept, respect and appreciate individual differences     4. Recognize, accept, respect and appreciate ethnic and cultural diversity     5. Recognize and respect differences in various family configurations     6. Use effective communications skills     7. Know that communication involves speaking, listening and nonverbal behavior     8. Demonstrate safety protocols and procedures in relation to teamwork in the welding environment.     9. Show competence in working collaboratively on welding projects to meet both quality and safety standards.     10. Develop conflict resolution skills within a team context to ensure successful project outcomes.     11. Exhibit leadership and communication skills through the division of roles and responsibilities in a welding team. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and guide solutions; interpret units consistently in formulas.  *Example:* Students may apply this standard when organizing their team’s workload by breaking down project hours and dividing them among team members to ensure the project is completed on time.  **N-Q.2:** Define appropriate quantities for the purpose of descriptive modeling.  *Example:* Students could quantify the time required for each team member's task, ensuring that total team productivity meets the project deadline. They might also estimate how delays in one task could affect the overall project completion timeline.  **N-Q.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example:* In peer evaluations, students may apply this standard to provide objective feedback on team contributions by comparing expected versus actual completion times and contributions for various tasks. | | |

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| **Unit 3: Safety** | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: Safety is paramount in welding, and this unit equips students with advanced safety practices. They learn to identify hazards, mitigate risks, and handle welding equipment safely. Students gain an understanding of OSHA and AWS safety standards and apply this knowledge by performing safety inspections and creating comprehensive safety plans and conduct job hazard analysis for various welding processes. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Job Hazard Analysis (JHA)**: Students will demonstrate the ability to conduct a thorough job hazard analysis for specific welding tasks, including hazard identification, risk assessment, and appropriate mitigation strategies. They will analyze hazards, assess risks, and formulate strategies to minimize risks. **PPE Usage**: Students will demonstrate proper usage of personal protective equipment (PPE), such as safety glasses, ear protection, gloves, and shoes. They will evaluate the welding process and materials to select appropriate PPE, ensuring safety and compliance with regulations. **Proper Lifting Techniques**: Students will identify and demonstrate proper lifting procedures and the use of support equipment (rigging, chains, straps, cables) to prevent injuries during material handling. They will apply proper techniques to reduce the risk of injury. **Safety Data Sheets (SDS) Knowledge**: Students will locate and interpret safety data sheets (SDS), ensuring they understand the hazards associated with different materials and chemicals used in the shop. They will demonstrate the ability to apply this knowledge to ensure safe handling of hazardous materials. **Workplace Organization and Cleanliness**: Students will demonstrate proper housekeeping in the welding shop, ensuring work areas are clean and safe. They will follow both verbal and written instructions to complete safety assignments and maintain a hazard-free work environment. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Leading Safety Demonstrations:** Students will rotate as safety leaders, conducting safety demonstrations for their peers, covering topics such as proper equipment use, PPE selection, and fire prevention.   * **Leadership Skill:**1.B.1: Develop, implement, and communicate new ideas to others effectively. 3.A.1: Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills.   **Collaborative Safety Planning:** Students will work in teams to design a comprehensive safety plan for the welding lab, including strategies to mitigate risks and ensure compliance with OSHA and AWS standards.   * **Leadership Skill:** 3.B.1: Demonstrate ability to work effectively and respectfully with diverse teams. 2.B.1: Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems.   **Peer-to-Peer Training:** Students will take turns acting as peer trainers, instructing their classmates on safety protocols, proper equipment use, and emergency response procedures.  **Leadership Skill:** 11.A.1: Use interpersonal and problem-solving skills to influence and guide others toward a goal. 3.B.3: Assume shared responsibility for collaborative work and value individual contributions made by each team member. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  United States Department of Labor, Employment and Training Administration: Advanced Manufacturing Competency  United States Department of Labor, Employment and Training Administration: Commercial and Industrial Construction Competency Model  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA) | | **Website:** <https://www.careeronestop.org/CompetencyModel/Competency-Models/pyramid-home.aspx>  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration> | |
| **1.2.1: Maintaining a Healthy and Safe Environment** **1.2.1.1** Take actions to ensure the safety of self and others, following established safety practices. **1.2.1.2** Anticipate and prevent work-related injuries and illnesses. **1.2.1.3** Comply with federal, state, local regulations, and company health and safety policies. **1.2.1.4** Identify common hazards and unsafe conditions at work, their risks, and appropriate controls. **1.2.1.5** Follow organizational procedures for workplace emergencies, including safe evacuation and emergency response. **1.2.1.6** Maintain a sanitary and clutter-free work environment. **1.2.1.7** Administer first aid or CPR (if trained) and summon assistance as needed. **1.2.1.8** Handle and dispose of hazardous materials properly.  **1.2.2: Safeguarding One’s Person** **1.2.2.1** Engage in safety training. **1.2.2.2** Follow safety procedures as trained. **1.2.2.3** Use equipment and tools safely as designed/documented. **1.2.2.4** Use appropriate personal protective equipment. **1.2.2.5** Describe how workplace risks can affect one’s life and family. **1.2.2.6** Understand the legal rights of workers regarding workplace safety and protections from hazards. **1.2.2.7** Report injuries, incidents, and workplace hazards to a supervisor as soon as safely possible. **1.2.2.8** Contribute to discussions of safety concerns in the workplace, making suggestions as appropriate.  **1.2.3: Preventive Health, Safety, or Environmental Inspections** **1.2.3.1** Identify the elements and procedures related to inspections. **1.2.3.2** Audit of records and documentation. **1.2.3.3** Document inspection findings. **1.2.3.4** Inspect emergency response protocols. **1.2.3.5** Inspect fire protection and control systems | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **CCSS.Math.Content.HSN.Q.A.1**:  Use units and solve equations to understand and calculate power consumption, voltage, and current requirements in welding equipment to ensure safety.  **CCSS.Math.Content.HSA.CED.A.1**:  Create equations to model relationships between electrical variables, such as P=IVP = IVP=IV (power = current × voltage) for equipment safety.  **CCSS.Math.Content.HSN.Q.A.3**:  Define and calculate the appropriate ventilation airflow rates for welding environments based on cubic feet per minute (CFM) calculations and air changes per hour. | | |

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| **Unit 4: Hand and Power Tools** | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: Mastery of hand and power tools is crucial for most welding tasks. In this unit, students practice using a variety of tools, focusing on proficiency, safety, and maintenance. They learn to select appropriate tools for specific tasks, ensuring efficiency and quality in their work. Through hands-on practice and troubleshooting exercises, students become adept at using and maintaining tools like grinders, drills, and cutting equipment. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Develop Proficiency in Tool Selection**: Students will analyze task requirements and select the appropriate hand and power tools for various welding tasks based on the tool's capabilities. They will evaluate tool effectiveness in relation to the tasks and justify their choices based on specific criteria. **Demonstrate Proper Tool Maintenance and Safety**: Students will apply maintenance procedures such as cleaning, basic preventative maintenance, and storage. They will inspect tools to ensure proper functionality and demonstrate accountability by maintaining tools for themselves and others.  **Enhance Troubleshooting and Repair Skills**: Students will identify and diagnose common issues with hand and power tools. They will apply repair strategies to correct malfunctions, ensuring safe functionality after repairs.  **Apply Mathematical Calculations for Tool Performance**: Students will calculate force, torque, RPM, angles, and material volume to optimize tool performance. They will analyze the outcomes of their calculations to predict tool efficiency and evaluate whether adjustments improve quality and efficiency in welding tasks.  **Achieve 100% Tool Safety Proficiency**: Students will demonstrate their understanding of tool safety through a comprehensive test. They will apply proper tool usage, identify potential hazards, and analyze lab/shop environments for safety compliance. They will be personally responsible for maintaining safety standards and evaluating their own and others' adherence to safety protocols. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaborative Tool Maintenance Project:** Students will work in teams to maintain a set of tools for a group project, dividing responsibilities such as inspection, cleaning, and storage.   * **Leadership Skill:** 3.B.3: Assume shared responsibility for collaborative work and value the individual contributions made by each team member.   **Tool Troubleshooting and Peer Training:** Students will guide their peers in troubleshooting common issues with power tools, using critical thinking to identify problems and work collaboratively to repair tools.   * **Leadership Skill:**7.A.1: Adapt to varied roles, jobs, responsibilities, and schedules to solve problems efficiently in the lab setting.   **Efficiency in Tool Use and Time Management:** Students will demonstrate leadership in efficiently managing tool use and completing tasks, ensuring that their team remains on schedule while maintaining high standards for safety and quality.  **Leadership Skill:**10.A.2: Prioritize, plan, and manage work to achieve the intended result (effective use of tools to complete welding tasks on time). | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA) | | **Website:**  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration> | |
| **Identify and Utilize Hand Tools**  1.1.1 Identify hand tools and their appropriate usage.  1.1.2 Identify standard and metric designation.  1.1.3 Demonstrate safe handling and use of appropriate tools.  1.1.4 Demonstrate proper cleaning, storage, and maintenance of tools.  **Identify and Utilize Power Tools and Equipment**  1.2.1 Identify power tools and equipment, and their appropriate usage.  1.2.2 Demonstrate safe handling and use of appropriate power tools and equipment.  1.2.3 Demonstrate proper cleaning, storage, and maintenance of power tools and equipment. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and guide solutions; choose and interpret units consistently in formulas, graphs, and data displays.  *Example:* Students will calculate torque and RPM for different power tools, ensuring consistency in unit interpretation (e.g., foot-pounds, RPM).  **N-Q.2:** Define appropriate quantities for the purpose of descriptive modeling.  *Example:* Students will define quantities such as force, material volume, and cutting speed to model tool performance and efficiency.  **N-Q.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example:* Students will measure tool settings and forces with appropriate precision using tools like calipers and torque wrenches, ensuring accuracy based on tool specifications.  **Algebra (A)**  **A-CED.1:** Create equations and inequalities in one variable and use them to solve problems.  *Example:* Students will create equations to determine the optimal torque for a power tool based on material properties, ensuring the tool operates efficiently without causing damage.  **A-CED.4:** Rearrange formulas to highlight a quantity of interest, using the same reasoning as solving equations.  *Example:* Students will rearrange formulas to solve for torque, force, or speed in tool performance, ensuring that settings are optimized for the task at hand.  **Geometry (G)**  **G-MG.1:** Apply geometric concepts in modeling situations.  *Example:* Students will use geometric concepts to calculate angles and dimensions when setting tools like angle grinders and bevel cutters, ensuring precise material cuts.  **G-SRT.5:** Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  *Example:* Students will use congruence and similarity principles to align tools and materials during tasks such as cutting and welding, ensuring proper fit and alignment.  **Measurement and Data (MD)**  **MD.2:** Apply appropriate tools to determine force, torque, and RPM in tool operation.  *Example:* Students will measure the force required for specific tasks using torque wrenches, ensuring that the appropriate level of force is applied based on tool capability. | | |

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| **Unit 5: Print Reading** | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: This unit builds on students' blueprint reading skills, introducing them to intermediate-level blueprints that includes welding symbols and multi-view drawings. Students practice interpreting and creating welding blueprints with accurate dimensions and specifications. By executing projects based on these blueprints, they develop the ability to plan and carry out welding tasks with precision. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Blueprint Interpretation Project**: Students will interpret a multi-view welding blueprint, including reading welding symbols, dimensions, and tolerances. They will produce a written report detailing the materials, tools, and steps required to complete the welding task outlined in the blueprint.  **Materials List and Bill of Materials (BOM) Creation**: Based on the provided blueprint, students will create a detailed materials list and BOM, ensuring all required parts, fasteners, and weld materials are accounted for. This will include estimating quantities of material based on size, area, and volume calculations.  **Sketching and Dimensioning Exercise**: Students will create their own welding blueprint, ensuring proper dimensioning, tolerances, and the use of industry-standard welding symbols. They will include multiple views (orthographic and isometric) and scale their drawing appropriately.  **Measuring and Scaling Activity**: Students will take measurements from an existing blueprint and use these to create a scaled drawing. They will convert measurements between customary (SAE) and metric systems, applying these values to the scaled version of the drawing.  **Mathematical Calculations for Blueprints**: Students will calculate the size, area, and volume of parts detailed in a blueprint. They will determine tolerances based on specifications and apply the equivalence between fractions and decimals for dimensioning purposes. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaborative Blueprint Project:** Students will work in teams to interpret a complex welding blueprint, assigning roles for material identification, dimensioning, and drawing interpretation. They will collaborate on creating a comprehensive plan to execute the welding project based on the blueprint.   * **Leadership Skill:**3.B.3: Assume shared responsibility for collaborative work and value the individual contributions made by each team member.   **Leading Blueprint Discussions:** Students will take turns leading discussions on interpreting blueprint symbols, reading dimensions, and understanding tolerances. They will explain how to apply these concepts during a welding task.   * **Leadership Skill:**1.B.1: Develop, implement, and communicate new ideas to others effectively.   **Blueprint Presentation and Feedback:** Students will present their blueprint interpretation and materials list to the class, explaining their rationale for tool and material choices. They will receive peer feedback and provide constructive feedback to others.   * **Leadership Skill:**4.A.1: Communicate clearly and persuasively, both orally and in writing, with peers and instructors.   **Time Management in Project Execution:** Students will plan and manage their time during the execution of the blueprint project, ensuring all tasks are completed accurately and within deadlines.  **Leadership Skill:**8.A.3: Utilize time and manage workload efficiently. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  AWS CERTIFIED WELDER WORK PROCESS SCHEDULE  Portland Community College Math on Metal | | **Website:**  <https://www.aws.org/>  <https://spot.pcc.edu/welding/PDFs/final_math_packet4_20.pdf> | |
| **1.1 DEMONSTRATE PRINT READING AND SKETCHING PRACTICES**  1.1.1 Interpret basic elements of a technical drawing  1.1.2 Identify and explain industry standard welding symbols (i.e. fillet weld, plug/slot weld, groove weld)  1.1.3 Prepare a materials list from a technical drawing (i.e., bill of material)  1.1.4 Describe various types of drawings (i.e., part, assembly, pictorial, orthographic, isometric, schematic)  1.1.5 Understand dimensioning, sectional drawings, fasteners, tables, charts, assembly drawings, and revisions  1.1.6 Sketch or draw a basic welding drawing PERFORMANCE STANDARD  **2.1: DEMONSTRATE MEASURING AND SCALING TECHNIQUES**  2.1.1 Identify industry standard units of measure  2.1.2 Convert between customary (i.e., SAE, Imperial) and metric systems  2.1.3 Determine appropriate engineering and metric scales  2.1.4 Measure and calculate size, area, and volume  2.1.5 Determine and apply the equivalence between fractions and decimals  2.1.6 Demonstrate proper use of appropriate measuring tools  **3.1: FRACTIONS**  3.1.1: Understand fractions.  3.1.2: Determine the relative size of fractions  3.1.3: Reduce fractions to their lowest terms.  3.1.4: Change improper fractions to mixed numbers and vice versa.  3.1.5: Add and subtract fractions.  3.1.6: Multiply fractions.  3.1.7: Divide fractions.  3.1.8: Convert fractions to decimals.  **4.1: DECIMALS**  4.1.1: Compare decimals to fractions.  4.1.3: Determine decimal size and measure common objects in decimal inches.  4.1.4: Compare decimal sizes  4.1.5: Round decimals.  4.1.6: Convert decimals to fractions.  4.1.7: Add decimals.  4.1.8: Subtract decimals.  **5.1: TOLERANCES**  5.1.1: Calculate bilateral and unilateral tolerances.  5.1.2: Apply fractional tolerances.  5.1.3: Calculate decimal tolerances.  5.1.4: Apply angle tolerances.  5.1.5: Measure and calculate joint preparation tolerances.  **6.1: MEASURING TOOLS**  6.1.1: Measure with fractions—skills needed in using a ruler; reducing fractions, expressing fractions in higher terms.  6.1.2: Read a ruler with accuracy.  6.1.3: Use a metric ruler.  6.1.4: Convert decimals to the nearest 1/16th of an inch for reading rulers.  6.1.5: Use a protractor. 6.1.6: Use a bevel (angle) finder.  6.1.7: Use a micrometer.  **12.1: SOLVING A FORMULA**  12.1.1: Solve formulas (e.g., using Ohm’s Law and temperature conversions as examples).  12.1.2: Apply order of operations.  12.1.3: Square numbers.  12.1.4: Apply dimensional analysis.  **15.1: GEOMETRY**  15.1.1: Understand circles and Pi.  15.1.2: Calculate the area of rectangles, triangles, and circles.  15.1.3: Square numbers and square roots.  15.1.4: Apply geometric construction techniques in fabrication.  15.1.5: Calculate the area of complex shapes (e.g., squaring corners, finding the center of rectangles).  **17.1: TRIGONOMETRY FOR WELDING AND FABRICATION**  17.1.1: Use trigonometry to calculate angles, dimensions, and weld-related fabrication details. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and guide solutions; choose and interpret units consistently in formulas, graphs, and data displays.  *Example:* Students will convert between customary (SAE) and metric systems when interpreting dimensions and creating scaled drawings from blueprints.  **N-Q.2:** Define appropriate quantities for the purpose of descriptive modeling.  *Example:* Students will define quantities like material volume and weld bead sizes to ensure the blueprint specifications are met during the fabrication process.  **N-Q.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example:* Students will calculate joint gaps, tolerances, and dimensions using precise measurement tools (e.g., micrometers, calipers) and ensure accurate interpretation of blueprint dimensions.  **Geometry (G)**  **G-MG.1:** Apply geometric concepts in modeling situations.  *Example:* Students will use geometric concepts to calculate angles, areas, and volumes in multi-view drawings and weldment layouts, ensuring accurate fit and dimensions.  **G-SRT.5:** Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  *Example:* Students will use congruence and similarity criteria when laying out triangular joints or shapes to ensure proper fit-up and alignment in welding projects.  **G-GMD.1:** Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.  *Example:* Students will apply these formulas to calculate material quantities and the surface area of cylindrical and circular components in their welding blueprints.  **G-MG.3:** Apply geometric methods to solve design problems.  *Example:* Students will apply geometric principles to scale multi-view drawings and create accurate blueprints, ensuring that weldments are fabricated to precise specifications.  **Measurement and Data (MD)**  **MD.2:** Apply appropriate tools to measure distances, angles, and dimensions for welding blueprints.  *Example:* Students will measure and verify blueprint dimensions, using tools like protractors and rulers to ensure that their calculations and drawings are accurate. **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and guide solutions; choose and interpret units consistently in formulas, graphs, and data displays.  *Example:* Students will convert between customary (SAE) and metric systems when interpreting dimensions and creating scaled drawings from blueprints.  **N-Q.2:** Define appropriate quantities for the purpose of descriptive modeling.  *Example:* Students will define quantities like material volume and weld bead sizes to ensure the blueprint specifications are met during the fabrication process.  **N-Q.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example:* Students will calculate joint gaps, tolerances, and dimensions using precise measurement tools (e.g., micrometers, calipers) and ensure accurate interpretation of blueprint dimensions.  **Geometry (G)**  **G-MG.1:** Apply geometric concepts in modeling situations.  *Example:* Students will use geometric concepts to calculate angles, areas, and volumes in multi-view drawings and weldment layouts, ensuring accurate fit and dimensions.  **G-SRT.5:** Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  *Example:* Students will use congruence and similarity criteria when laying out triangular joints or shapes to ensure proper fit-up and alignment in welding projects.  **G-GMD.1:** Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.  *Example:* Students will apply these formulas to calculate material quantities and the surface area of cylindrical and circular components in their welding blueprints.  **G-MG.3:** Apply geometric methods to solve design problems.  *Example:* Students will apply geometric principles to scale multi-view drawings and create accurate blueprints, ensuring that weldments are fabricated to precise specifications.  **Measurement and Data (MD)**  **MD.2:** Apply appropriate tools to measure distances, angles, and dimensions for welding blueprints.  *Example:* Students will measure and verify blueprint dimensions, using tools like protractors and rulers to ensure that their calculations and drawings are accurate. | | |

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| **Unit 6:** Math for Welders | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: This unit focuses on essential mathematical concepts and skills that welders need to ensure precision and accuracy in their work. Students will engage in practical applications of math, including calculations for material dimensions, weld sizes, angles, areas, volumes, and tolerances. By understanding and applying these mathematical principles, students will enhance their ability to perform precise welding tasks and meet industry standards. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Material Dimension Calculations:** Students will calculate the dimensions of materials needed for various welding tasks. They will measure and convert between different units of measurement (e.g., inches to millimeters) and use formulas to determine length, width, and thickness based on project specifications.  **Weld Size and Tolerance Calculations:** Students will calculate the appropriate weld size based on material thickness and welding specifications. They will also determine acceptable tolerances for welded joints to ensure that the welds meet quality standards.  **Angle and Bevel Calculations:** Students will calculate angles for bevel cuts and fit-up techniques in welding. They will use trigonometry to determine the correct torch angles for creating bevels and ensuring proper fit-up of welded joints.  **Area and Volume Calculations:** Students will calculate the surface area and volume of materials being welded. These calculations will help determine the amount of material required for welding and the proper amount of filler metal needed to complete the weld.  **Geometry for Layout and Fit-Up:** Students will use geometry to create accurate layouts and fit-ups for welding tasks. They will calculate the dimensions of complex shapes (e.g., circles, triangles) and apply these calculations to the layout and fitting of parts before welding. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaborative Calculations:** Students work in teams to solve welding-related math problems, assigning roles and ensuring accuracy in material dimensions, weld sizes, and angles.   * **Leadership Skill:** 3.B.3: Assume shared responsibility for collaborative work and value individual contributions​   **Leading Math Discussions:** Students lead discussions on converting measurements, calculating areas and volumes, and applying trigonometry to welding tasks.   * **Leadership Skill:** 1.B.1: Develop and communicate ideas effectively​   **Math Presentations and Peer Feedback:** Students present their calculations, explain methods, and provide/receive feedback from peers to improve accuracy and clarity.   * **Leadership Skill:** 4.A.1: Communicate clearly and persuasively​   **Time Management:** Students manage their time to complete math calculations accurately and on time, prioritizing tasks for efficiency.   * **Leadership Skill:** 8.A.3: Utilize time and manage workload efficiently​   **Problem-Solving and Accountability:** Students take responsibility for their math work, leading problem-solving efforts when errors arise.  **Leadership Skill:** 2.A.1: Use various types of reasoning to solve problems​ | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  AWS CERTIFIED WELDER WORK PROCESS SCHEDULE  Portland Community College Math on Metal | | **Website:** [**https://www.aws.org/**](https://www.aws.org/)  <https://spot.pcc.edu/welding/PDFs/final_math_packet4_20.pdf> | |
| **3.1: FRACTIONS**  3.1.1: Understand fractions.  3.1.2: Determine the relative size of fractions  3.1.3: Reduce fractions to their lowest terms.  3.1.4: Change improper fractions to mixed numbers and vice versa.  3.1.5: Add and subtract fractions.  3.1.6: Multiply fractions.  3.1.7: Divide fractions.  3.1.8: Convert fractions to decimals.  **4.1: DECIMALS**  4.1.1: Compare decimals to fractions.  4.1.3: Determine decimal size and measure common objects in decimal inches.  4.1.4: Compare decimal sizes  4.1.5: Round decimals.  4.1.6: Convert decimals to fractions.  4.1.7: Add decimals.  4.1.8: Subtract decimals.  **5.1: TOLERANCES**  5.1.1: Calculate bilateral and unilateral tolerances.  5.1.2: Apply fractional tolerances.  5.1.3: Calculate decimal tolerances.  5.1.4: Apply angle tolerances.  5.1.5: Measure and calculate joint preparation tolerances.  **6.1: MEASURING TOOLS**  6.1.1: Measure with fractions—skills needed in using a ruler; reducing fractions, expressing fractions in higher terms.  6.1.2: Read a ruler with accuracy.  6.1.3: Use a metric ruler.  6.1.4: Convert decimals to the nearest 1/16th of an inch for reading rulers.  6.1.5: Use a protractor. 6.1.6: Use a bevel (angle) finder.  6.1.7: Use a micrometer.  **12.1: SOLVING A FORMULA**  12.1.1: Solve formulas (e.g., using Ohm’s Law and temperature conversions as examples).  12.1.2: Apply order of operations.  12.1.3: Square numbers.  12.1.4: Apply dimensional analysis.  **13.1: TEMPERATURE CONVERSIONS**  13.1.1: Use formulas to convert between Celsius and Fahrenheit.  **14.1: ELECTRIC POWER PROBLEMS**  14.1.1: Solve electric power problems using appropriate formulas.  **15.1: GEOMETRY**  15.1.1: Understand circles and Pi.  15.1.2: Calculate the area of rectangles, triangles, and circles.  15.1.3: Square numbers and square roots.  15.1.4: Apply geometric construction techniques in fabrication.  15.1.5: Calculate the area of complex shapes (e.g., squaring corners, finding the center of rectangles).  **17.1: TRIGONOMETRY FOR WELDING AND FABRICATION**  17.1.1: Use trigonometry to calculate angles, dimensions, and weld-related fabrication details.  **18.1: CALCULATING THE COSTS OF A WELDING JOB**  18.1.1: Calculate arc time vs. prep time using percentages.  18.1.2: Calculate direct labor costs and overhead.  18.1.3: Calculate the cost of steel and welding consumables.  18.1.4: Calculate heat input using current, voltage, and speed. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q):**  **N-Q.1: Use units as a way to understand problems and guide the solution of multi-step problems. Choose and interpret units consistently in formulas.** *Example:* Students will use consistent units of measurement (inches, millimeters, etc.) when calculating material dimensions, weld sizes, and tolerances, ensuring their calculations align with welding specifications.  **N-Q.2: Define appropriate quantities for the purpose of descriptive modeling.** *Example:* Students will define quantities like filler metal volume, surface area of welds, and material thickness, ensuring accurate calculations for material usage and welding preparation.  **N-Q.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.** *Example:* Students will use appropriate precision (significant figures) when reporting material dimensions and weld sizes, ensuring their measurements meet industry standards and tolerances.  **Algebra (A):**  **A-CED.1: Create equations and inequalities in one variable and use them to solve problems.** *Example:* Students will create equations to calculate the required weld size and filler material volume based on the thickness of the base metal and the welding position.  **A-CED.2: Create equations in two or more variables to represent relationships between quantities.** *Example:* Students will develop equations that represent relationships between welding parameters, such as voltage, current, and material thickness, to optimize weld settings.  **A-REI.3: Solve equations and inequalities involving linear, quadratic, rational, and exponential expressions.** *Example:* Students will solve equations related to calculating weld angles, filler metal requirements, and material tolerances.  **Geometry (G):**  **G-CO.1: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment.** *Example:* Students will apply these geometric concepts when calculating the correct torch angle for bevel cuts and ensuring precise layout and fit-up for welding tasks.  **G-SRT.5: Use congruence and similarity criteria for triangles to solve problems and prove relationships in geometric figures.** *Example:* Students will use congruence and similarity concepts when measuring and laying out triangular or angled weld joints, ensuring accurate fit-up before welding.  **G-GMD.1: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.** *Example:* Students will calculate the volume of cylindrical materials and filler metal needed for welding pipes, ensuring that proper amounts are used to meet project specifications.  **G-MG.1: Apply geometric concepts in modeling situations.** *Example:* Students will use geometric modeling to calculate weld bead size, layout complex joint configurations, and determine the surface area for material preparation before welding.  **Trigonometry (HSG-SRT):**  **HSG-SRT.C.6: Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.** *Example:* Students will apply trigonometric ratios to calculate the correct bevel angles for creating weld joints, ensuring the right angle is maintained during fit-up.  **HSG-SRT.C.8: Use trigonometric ratios and the Pythagorean theorem to solve right triangles in applied problems.** *Example:* Students will calculate angles and dimensions for welding joints using trigonometry, ensuring that proper angles are maintained for the fit-up and layout process. | | |

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| **Unit 7:** **Measurement and Lay Out/Fit-Up Techniques** | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: Precision is key in welding, and this unit teaches students advanced measurement and layout techniques. They use tools like micrometers and laser levels to measure and layout complex shapes and joints. The unit also covers fit-up techniques for various joint configurations, helping students achieve high-quality welds. Through practice and assessment, students learn to ensure accuracy and precision in their welding projects. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Layout and Measurement Lab:** Students will practice laying out parts for welding using tools such as micrometers, calipers, and laser levels. They will take precise measurements and mark parts according to project specifications, ensuring accuracy in alignment and placement. Students will also convert between fractional and decimal measurements to ensure precision.  **Fit-Up Techniques Demonstration:** Students will demonstrate their ability to perform fit-up for various joint configurations, using fit-up gauges and measuring devices to ensure proper alignment and tolerance. They will check for misalignment before and after welding, correcting any issues. Additionally, students will use basic math to calculate gap sizes and ensure proper tolerances are met.  **Welding Blueprint Interpretation and Layout Assignment:** Students will interpret technical drawings, select specified materials and lay out parts based on welding specifications. This task will require students to accurately measure and mark parts, plan the fit-up process, and ensure all dimensions and tolerances are applied correctly. They will perform basic math operations such as addition, subtraction, and division to determine dimensions, calculate material quantities, and ensure all tolerances are met.  **Measuring Distortion and Corrective Techniques:** Students will measure distortion in welded joints and practice using corrective techniques to minimize or eliminate distortion caused by thermal expansion. They will calculate the amount of distortion using basic geometry and algebra to ensure accurate corrections.  **Joint Fit-Up Test:** Students will perform a final fit-up test, ensuring alignment and gap tolerances for plate and pipe joints. They will prepare joints for welding, applying mathematical calculations to verify measurements. This will include basic math for calculating angles, areas, and volumes to ensure joints meet required tolerances. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaboration on Joint Fit-Up:** Students will work in teams to fit up fabrication projects using precise measurements and layout techniques. They will collaborate to ensure all parts are properly aligned and prepared for welding.   * **Leadership Skill:** 3.B.3: Assume shared responsibility for collaborative work and value the individual contributions made by each team member.   **Leading Measurement Workshops:** Students will take turns leading measurement and layout workshops, demonstrating how to use tools like calipers, micrometers, and laser levels to ensure accuracy in fit-up.   * **Leadership Skill:** 4.B.1: Use information accurately and creatively for problem-solving and decision-making in layout and measurement tasks.   **Problem-Solving in Fit-Up and Layout:** Students will guide peers through troubleshooting common fit-up problems, such as misalignment and distortion, and demonstrate corrective techniques.   * **Leadership Skill:** 7.A.1: Adapt to varied roles, jobs, responsibilities, schedules, and contexts, demonstrating flexibility in solving complex layout and fit-up problems.   **Managing Time and Accuracy in Fit-Up Tasks:** Students will manage their time efficiently while performing fit-up tasks, ensuring that measurements and layouts are precise while adhering to deadlines.  **Leadership Skill:** 8.A.3: Utilize time and manage workload efficiently to complete fit-up tasks with accuracy. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  AWS CERTIFIED WELDER WORK PROCESS SCHEDULE  Portland Community College Math on Metal | | **Website:**  <https://www.aws.org/>  <https://spot.pcc.edu/welding/PDFs/final_math_packet4_20.pdf> | |
| **3.3: UTILIZE LAYOUT PRINCIPLES AND PRACTICES**  3.3.1 Interpret drawing, sketch, or specification information  3.3.2 Select appropriate materials to complete work assignment  3.3.3 Use layout and marking tools as required  3.3.4 Layout parts using measurement practices  **3.4: DEMONSTRATE PREPARATION AND FIT-UP PRACTICES**  3.4.1 Identify and explain job specifications.  3.4.2 Use fit-up gauges and measuring devices to check joint fit-up.  3.4.3 Identify and explain distortion and how it is controlled.  3.4.4 Fit-up joints using plate and pipe fit-up tools.  3.4.5 Check for joint misalignment and poor fit-up before and after welding.  **15.1: GEOMETRY**  15.1.1: Understand circles and Pi.  15.1.2: Calculate the area of rectangles, triangles, and circles.  15.1.3: Square numbers and square roots.  15.1.4: Apply geometric construction techniques in fabrication.  15.1.5: Calculate the area of complex shapes (e.g., squaring corners, finding the center of rectangles). | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  *Example:* Students will measure materials using units such as inches for dimensions and degrees for angles. They will apply these units in their fit-up techniques and layout tasks to ensure precise alignment.  **N-Q.2:** Define appropriate quantities for the purpose of descriptive modeling.  *Example:* Students will define quantities such as joint gap size, material thickness, and tolerances during layout and fit-up tasks to ensure proper joint configuration.  **N-Q.3:** Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example:* Students will use calipers and micrometers to measure joint gaps and pipe diameters, ensuring they report measurements with the correct level of precision to meet tolerance requirements.  **Geometry (G)**  **G-CO.1:** Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.  *Example:* Students will use these definitions when laying out and cutting metal pieces, adjusting torch angles, and measuring for precise fit-up of welds.  **G-CO.6:** Understand congruence in terms of rigid motions.  *Example:* When laying out materials for a welding project, students will ensure parts are congruent and aligned correctly for fit-up and welding.  **G-SRT.5:** Use congruence and similarity criteria for triangles to solve problems and prove relationships in geometric figures.  *Example:* Students will apply these concepts when working with triangular layout designs for cuts and ensuring proportional alignment in joints.  **G-GMD.1:** Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone.  *Example:* Students will calculate the amount of material needed for welding pipe joints, using formulas for area and volume to ensure proper preparation.  **G-GMD.4:** Identify the shapes of two-dimensional cross-sections of three-dimensional objects and identify three-dimensional objects generated by rotations of two-dimensional objects.  *Example:* Students will identify and work with cross-sections when cutting pipes and other cylindrical objects during fit-up tasks.  **G-MG.1:** Apply geometric concepts in modeling situations.  *Example:* Students will use geometric models and layouts to measure, mark, and cut materials accurately, ensuring proper fit-up for welding.  **G-MG.3:** Apply geometric methods to solve design problems.  *Example:* Students will design cuts and layouts for weld joints, ensuring correct angles and measurements for proper fit-up and alignment.  **Algebra (A)**  **A-CED.1:** Create equations and inequalities in one variable and use them to solve problems.  *Example:* Students will create equations to calculate the material needed for welding joints, including equations for gas flow rates and joint gaps.  **A-CED.2:** Create equations in two or more variables to represent relationships between quantities.  *Example:* Students will calculate cutting speeds and fit-up dimensions based on material thickness and torch settings.  **A-CED.4:** Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.  *Example:* Students will rearrange formulas for gap tolerances, material volume, and pipe dimensions to ensure correct welding fit-up. | | |

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| **Unit 8:** Fabrication | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: This unit equips students with foundational skills in metal fabrication, covering the entire process from print interpretation to project completion. Students will engage in precision measurement, time management, project layout, technical writing, and working form prints. They will continue to develop skills in using both machines and hand tools. The focus will be on assembly methods and construction of a variety of metal projects accurately and efficiently. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Measurement Precision:** Students will use precision measurement tools (e.g., calipers, micrometers) to ensure that all components are fabricated to exact specifications.  **Time Management:** Students will manage their time effectively during project construction, ensuring that tasks are completed on schedule and within project timelines.  **Project Layout:** Students will create a detailed layout for their fabrication projects, ensuring that materials are cut and prepared according to design specifications before assembly begins.  **Technical Writing / CAD Drawing:** Students will practice technical writing by documenting their project steps and decisions. They will also create or interpret CAD drawings to assist in the fabrication process.  **Technical Reading / Blueprint Interpretation:** Students will interpret blueprints and technical drawings, applying them to the cutting, shaping, and assembly of metal components.  **Machine and Hand Tool Skills:** Students will demonstrate proficiency in the use of both machine and hand tools to cut, shape, and prepare metal materials.  **Fasteners and Assembly Methods:** Students will select and apply appropriate fasteners and assembly methods to complete their metal fabrication projects, ensuring structural integrity and alignment.  **Project Construction:** Students will construct their projects according to the blueprint, applying their skills in cutting, shaping, assembly, and finishing. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaborative Fabrication Projects:** Students will work in teams to execute fabrication tasks, collaborating on material preparation, layout, and construction to ensure project quality.   * **Leadership Skill:**3.B.3: Assume shared responsibility for collaborative work and value individual contributions​   **Leading Project Layout Discussions:** Students will lead discussions on project layout and blueprint interpretation, ensuring their team members understand the technical aspects before beginning fabrication.   * **Leadership Skill:**1.B.1: Develop and communicate ideas effectively​   **Project Presentation and Peer Feedback:** Students will present their fabrication projects, explaining their process and decisions, and provide/receive constructive feedback to improve future work.   * **Leadership Skill:**4.A.1: Communicate clearly and persuasively​   **Time Management in Fabrication:** Students will manage their time to complete fabrication tasks efficiently, ensuring all components are prepared and assembled on time.  **Leadership Skill:**8.A.3: Utilize time and manage workload efficiently​ | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  AWS CERTIFIED WELDER WORK PROCESS SCHEDULE  Portland Community College Math on Metal | | **Website:** <https://www.aws.org/>  <https://spot.pcc.edu/welding/PDFs/final_math_packet4_20.pdf> | |
| **1.1: Utilize Base Metal Preparation Fundamentals**  1.1.1 Clean base metal for welding or cutting.  1.1.2 Identify and explain joint design.  1.1.3 Select the proper joint design based on a welding procedure specification (WPS) or instructor’s direction.  1.1.4 Mechanically bevel the edge of a mild steel plate (i.e., hand beveller, grinder).  1.1.5 Thermally bevel the end of a mild steel plate.  **1.2: Demonstrate Fabrication Techniques**  1.2.1 Demonstrate proper setup of fabrication area, equipment, and materials.  1.2.2 Construct projects in the proper sequence.  1.2.3 Properly layout projects from welding prints.  1.2.4 Check work for accuracy.  **3.1: FRACTIONS**  3.1.1: Understand fractions.  3.1.2: Determine the relative size of fractions  3.1.3: Reduce fractions to their lowest terms.  3.1.4: Change improper fractions to mixed numbers and vice versa.  3.1.5: Add and subtract fractions.  3.1.6: Multiply fractions.  3.1.7: Divide fractions.  3.1.8: Convert fractions to decimals.  **4.1: DECIMALS**  4.1.1: Compare decimals to fractions.  4.1.3: Determine decimal size and measure common objects in decimal inches.  4.1.4: Compare decimal sizes  4.1.5: Round decimals.  4.1.6: Convert decimals to fractions.  4.1.7: Add decimals.  4.1.8: Subtract decimals.  **5.1: TOLERANCES**  5.1.1: Calculate bilateral and unilateral tolerances.  5.1.2: Apply fractional tolerances.  5.1.3: Calculate decimal tolerances.  5.1.4: Apply angle tolerances.  5.1.5: Measure and calculate joint preparation tolerances.  **6.1: MEASURING TOOLS**  6.1.1: Measure with fractions—skills needed in using a ruler; reducing fractions, expressing fractions in higher terms.  6.1.2: Read a ruler with accuracy.  6.1.3: Use a metric ruler.  6.1.4: Convert decimals to the nearest 1/16th of an inch for reading rulers.  6.1.5: Use a protractor. 6.1.6: Use a bevel (angle) finder.  6.1.7: Use a micrometer.  **12.1: SOLVING A FORMULA**  12.1.1: Solve formulas (e.g., using Ohm’s Law and temperature conversions as examples).  12.1.2: Apply order of operations.  12.1.3: Square numbers.  12.1.4: Apply dimensional analysis.  **13.1: TEMPERATURE CONVERSIONS**  13.1.1: Use formulas to convert between Celsius and Fahrenheit.  **14.1: ELECTRIC POWER PROBLEMS**  14.1.1: Solve electric power problems using appropriate formulas.  **15.1: GEOMETRY**  15.1.1: Understand circles and Pi.  15.1.2: Calculate the area of rectangles, triangles, and circles.  15.1.3: Square numbers and square roots.  15.1.4: Apply geometric construction techniques in fabrication.  15.1.5: Calculate the area of complex shapes (e.g., squaring corners, finding the center of rectangles).  **17.1: TRIGONOMETRY FOR WELDING AND FABRICATION**  17.1.1: Use trigonometry to calculate angles, dimensions, and weld-related fabrication details.  **18.1: CALCULATING THE COSTS OF A WELDING JOB**  18.1.1: Calculate arc time vs. prep time using percentages.  18.1.2: Calculate direct labor costs and overhead.  18.1.3: Calculate the cost of steel and welding consumables.  18.1.4: Calculate heat input using current, voltage, and speed. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1**: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  *Example*: Students will calculate gas flow rates, pressure settings, and material thickness using appropriate units (e.g., PSI for pressure, CFM for flow rate, inches for thickness).  **N-Q.2**: Define appropriate quantities for the purpose of descriptive modeling.  *Example*: Students will define quantities such as gas usage, cutting speeds, and material volumes for efficiency and safety in cutting operations.  **N-Q.3**: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example*: Students will measure bevel angles, material thickness, and cutting lengths using precision tools like calipers and rulers, and will determine appropriate levels of accuracy.  **Geometry (G)**  **G-CO.1**: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.  *Example*: Students will use these definitions when cutting complex shapes, adjusting torch angles for bevel cuts, and measuring angles for material layout.  **G-CO.6**: Understand congruence in terms of rigid motions.  *Example*: When creating consistent cuts or shapes, students will ensure congruency between parts for precise fit-up during fabrication.  **G-SRT.5**: Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  *Example*: Students will apply this concept when laying out triangular shapes for cuts or joints to ensure proper alignment and proportions.  **G-GMD.1**: Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone.  *Example*: Students will calculate material quantities, such as the amount of steel to be cut from circular and cylindrical shapes, and use these calculations to plan their cutting operations.  **G-GMD.4**: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.  *Example*: Students will identify cross-sections when cutting cylindrical materials (e.g., pipes) or preparing materials with complex geometries.  **G-MG.1**: Apply geometric concepts in modeling situations.  *Example*: Students will use geometric models to measure and cut materials accurately and to calculate angles for bevel cuts.  **G-MG.3**: Apply geometric methods to solve design problems.  *Example*: Students will design and cut shapes with specific geometric constraints for weld joint preparation, using measurements and angles to ensure proper fit.  **Algebra (A)**  **A-CED.1**: Create equations and inequalities in one variable and use them to solve problems.  *Example*: Students will create equations to determine the amount of gas required for a cutting job based on the time and flow rate.  **A-CED.2**: Create equations in two or more variables to represent relationships between quantities.  *Example*: Students will calculate cutting speeds and material removal rates based on variables such as material thickness and torch settings.  **A-CED.4**: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.  *Example*: Students will rearrange formulas for gas pressure, volume, and flow rate to solve for the desired values in a cutting operation. | | |

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| **Unit 9:** **Oxy Fuel Cutting-OFC** | | | **Total Learning Hours for Unit: 20** |
| **Unit Summary**: In this unit, students build upon their ability to operate oxy-fuel cutting and welding equipment safely and effectively. They perform precise cutting on various metals, understanding the principles of flame control and equipment maintenance. Hands-on practice helps them refine their skills in setting up and adjusting oxy-fuel equipment for different tasks, focusing on maintaining clean cuts and solid welds. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Safety Inspection and Equipment Setup:** Students will inspect and set up oxy-fuel cutting equipment, adjusting gas pressures and ensuring all components are in proper working condition before cutting. **Minor Repairs and Maintenance:** Students will perform minor repairs and maintenance on oxy-fuel equipment, troubleshooting issues like leaks and ensuring replacement parts meet specifications.  **Straight Edge Cutting on Carbon Steel:** Students will perform straight cuts on carbon steel, maintaining proper torch angle and speed to achieve clean cuts. **Shape Cutting on Carbon Steel:** Students will perform shape cuts (e.g., circles, curves) using templates or freehand, maintaining consistent speed and accuracy.  **Bevel Edge Cutting:** Students will perform bevel cuts at specified angles, adjusting torch angle and gas settings to create consistent bevels.  **Scarfing Operations:** Students will perform scarfing to remove material from carbon steel, focusing on efficient removal while maintaining control. **Understanding Fuel Gases and Flame Characteristics:** Students will explain and adjust fuel gases and flame characteristics for various cutting tasks. **Backfire and Flashback Prevention:** Students will set up safety devices and prevent backfires and flashbacks, responding safely to simulated scenarios. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  Safety Leadership in OFC Operations: Students will take turns leading safety inspections and startup procedures for the class, ensuring that all OFC equipment is properly set up and functioning.   * Leadership Skill: 11.A.1: Use interpersonal and problem-solving skills to influence and guide others toward safe practices in OFC operations.   Collaboration on Cutting Projects: Students will work in teams to complete complex cutting projects, ensuring that all team members contribute to planning and execution.   * Leadership Skill: 3.B.3: Assume shared responsibility for collaborative work and value the individual contributions made by each team member.   Peer Training in Oxy-Fuel Cutting: Students will take turns leading small group presentations where they teach their peers about flame control, equipment setup, and precision cutting techniques.   * Leadership Skill: 4.B.1: Use information accurately and creatively for problem-solving and decision-making during OFC operations.   Time Management and Task Prioritization: Students will manage their time efficiently during OFC operations, ensuring that all cutting tasks are completed accurately and within the designated time frame.  Leadership Skill: 8.A.3: Utilize time and manage workload efficiently to complete tasks during OFC operations. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA)  Washington Association of Building Officials (WABO) | | **Website:**  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration>  <https://www.wabo.org/welder-program> | |
| **1.1 Demonstrate Oxy-Fuel Gas Cutting (OFC)**  1.1.1 Perform safety inspections of OFC equipment and accessories.  1.1.2 Demonstrate safe startup, shutdown, disassembly, and cylinder exchange procedures of OFC equipment.  1.1.3 Operate OFC equipment per manufacturers specifications  1.1.4 Perform straight, square edge cutting operations in the flat position.  1.1.5 Perform shape, square edge cutting operations in the flat position.  1.1.6 Perform straight, bevel edge cutting operations in the flat position.  1.1.7 Perform scarfing and gouging operations to remove base and weld metal, in flat and horizontal positions. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units to guide the solution of multi-step problems; choose and interpret units consistently in formulas.  *Example:* Students will calculate gas flow rates and pressure settings in appropriate units (e.g., PSI for pressure, CFM for flow rate) for oxy-fuel cutting tasks.  **N-Q.3:** Choose a level of accuracy appropriate to the limitations on measurement when reporting quantities.  *Example:* Students will measure bevel angles, material thickness, and cutting lengths using precision tools and determine appropriate levels of accuracy for proper cutting operations.  **Geometry (G)**  **G-CO.1:** Know precise definitions of angles and lines, such as perpendicular and parallel, based on geometric principles.  *Example:* Students will apply these definitions to adjust torch angles during bevel cuts and maintain proper alignment for straight and shape cutting tasks.  **G-SRT.5:** Use criteria for triangle congruence and similarity to solve problems.  *Example:* Students will apply this when laying out triangular shapes for cuts or aligning pieces for joint preparation, ensuring proper fit and proportion in fabrication.  **G-MG.1:** Use geometric shapes and their properties to describe objects, such as using cylinders to represent pipes.  *Example:* Students will model pipes as cylinders to calculate angles for bevel cuts and determine the length of cuts required for the project.  **G-GMD.4:** Identify two-dimensional cross-sections of three-dimensional objects.  *Example:* Students will identify cross-sections when cutting cylindrical materials or preparing complex geometries for welding projects.  **G-GPE.7:** Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, using the distance formula.  *Example:* Students will use coordinate geometry to calculate the perimeter of materials they are cutting, as well as the area of shapes such as triangles and rectangles when laying out templates for shape cutting.  **G-GMD.3:** Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.  *Example:* Students will calculate the volume of cylindrical materials such as pipes and use this information to plan cuts and calculate material usage.  **G-CO.12:** Make formal geometric constructions with a variety of tools and methods (compass, straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).  *Example:* Students will construct angles and perpendicular lines during the layout of materials for precise cutting operations, ensuring proper alignment and preparation.  **G-MG.2:** Apply concepts of density based on area and volume in modeling situations.  *Example:* Students will apply density calculations when determining the amount of metal removed during scarfing operations or when calculating the amount of material needed for specific welding tasks.  **Algebra (A)**  **A-CED.1:** Create equations to solve problems.  *Example:* Students will create equations to determine gas consumption based on flow rates and time during cutting operations.  **A-CED.4:** Rearrange formulas to highlight a quantity of interest.  *Example:* Students will rearrange formulas for gas flow rate and pressure to solve for the desired values during oxy-fuel setup. | | |

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| **Unit 10:** Shielded Metal Arc Welding (SMAW) | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: This unit dives deeper into SMAW, teaching students to perform welds on various materials, joints, and positions. They learn to select appropriate electrodes and settings for different welding tasks and troubleshoot common defects. Through practice in different welding positions and quality control exercises, students develop the skills to produce high-quality welds and implement corrective actions when necessary. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **AC/DC Welding Current Comparison:** Students will explain the differences between direct current (DC) and alternating current (AC), including their applications and effects in welding tasks. They will analyze the pros and cons of each current type for various materials and welding positions. **AWS Welding Polarity Abbreviation Interpretation:** Students will interpret American Welding Society (AWS) abbreviations related to welding current polarity (e.g., DCEP, DCEN, AC). They will demonstrate their understanding by setting up the appropriate polarity for a given welding task. **SMAW Equipment Identification and Setup:** Students will identify the equipment and accessories used in SMAW, including welding machines, leads, electrode holders, and safety gear. They will assemble the components of an arc welding outfit and explain how each part functions in the welding process.  **Arc Welding Machine Selection:** Students will identify factors to consider when selecting an arc welding machine (e.g., amperage range, duty cycle, portability). They will evaluate different welding machines and justify their selection based on the task requirements. **SMAW Equipment Inspection:** Students will perform a detailed inspection of a SMAW outfit, checking for damage or wear on components such as leads, electrode holders, and cables. They will document any necessary repairs or replacements to ensure the equipment is safe for use. **Amperage and Polarity Prediction:** Students will predict the proper amperage and polarity settings for a given welding task based on material type, thickness, and electrode selection. They will explain how these settings impact the heat input and weld penetration, ensuring optimal weld quality. Students will adjust the machine accordingly and justify their predictions using industry standards and welding codes. **Electrode Covering Function Explanation:** Students will explain the six purposes of an electrode covering and demonstrate how to select the proper electrode for specific welding tasks. They will ensure proper electrode storage, demonstrating an understanding of the need for keeping electrodes in shipping containers to prevent moisture absorption and contamination. **Flat Position Welding Practice:** Students will perform welds in the flat position, maintaining the correct electrode angle (90° with a slight drag angle of 5° to 15°). They will focus on creating high-quality welds with proper penetration and bead formation. **Horizontal and Vertical Position Welding Practice:** Students will perform welds in both horizontal and vertical positions using SMAW equipment. They will demonstrate the correct weld angles for each position and ensure proper technique for both uphill and downhill welding in vertical positions. **Vertical Weld Angle Demonstration:**  Students will demonstrate proper electrode angles (5° to 15° upward angle) for vertical welding positions (3F and 3G). They will adjust the electrode angle to ensure proper penetration, bead control, and weld quality, focusing on the appropriate angles used for each position. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Safety Leadership:** Students will take turns leading safety inspections, ensuring that all SMAW equipment is correctly set up and that proper safety protocols are followed in the shop environment.   * **Leadership Skill:**11.A.1: Use interpersonal and problem-solving skills to influence and guide others toward a safe working environment.   **Peer Training in Welding Positions:** Students will demonstrate and teach their peers how to perform welds in specific positions, guiding them through the correct setup and welding techniques for 1F, 2F, 3F positions.  **Leadership Skill:** 4.B.1: Use information accurately and creatively to solve problems and guide others in welding operations.  **Collaboration in Troubleshooting:** Students will work in pairs to inspect welds for defects, sharing their observations and collaborating to determine appropriate corrective actions. They will discuss potential solutions and ensure that their troubleshooting process is thorough.   * **Leadership Skill:** 3.B.3: Collaborate effectively, sharing responsibility for identifying issues and implementing corrective actions.   **Time Management in Welding Projects:** Students will be responsible for managing their own time during welding projects, ensuring that all welds are completed according to project specifications and deadlines.   * **Leadership Skill:** 8.A.3: Utilize time efficiently and manage the workload to complete projects on time with precision. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA)  Washington Association of Building Officials (WABO) | | **Website:**  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration>  <https://www.wabo.org/welder-program> | |
| Apply Shielded Metal Arc Welding (SMAW) technique  1.1.1 Identify and explain different types of welding current and polarity.  1.1.2 Perform safety inspections of SMAW equipment and accessories.  1.1.3 Maintain SMAW equipment and accessories.  Produce Welds using SMAW on Carbon Steel  1.2.1 Set up for SMAW operations.  1.2.2 Operate SMAW equipment.  1.2.3 Perform welds in the 1F position.  1.2.4 Perform welds in the 2F position.  1.2.5 Perform welds in the 3F position.  1.2.7 Perform welds in the 1G position.  1.2.8 Perform welds in the 2G position.  1.2.9 Perform welds in the 3G position.  1.2.10 Describe 4G, 5G and 6G welding positions. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Algebra (A)**  **A-CED.1**: Create equations and inequalities in one variable and use them to solve problems.  Example: Students will create equations to calculate the optimal voltage and current settings based on material thickness and electrode specifications.  **A-CED.2**: Create equations in two or more variables to represent relationships between quantities.  Example: Students will develop equations to represent relationships between current settings, electrode diameter, and material thickness for different welding positions.  **A-REI.3**: Solve equations and inequalities involving linear, quadratic, and rational expressions.  Example: Students will solve equations for current and voltage based on the type of weld and material, ensuring correct machine settings.  **Geometry (G)**  **G-CO.1**: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment.  Example: Students will calculate electrode angles during welding for specific positions, ensuring precise geometry for different weld types.  **G-SRT.5**: Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  Example: Students will use congruence criteria when assessing electrode angles and their impact on bead formation, ensuring welds are consistent across different positions.  **G-GMD.1**: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.  Example: Students will calculate the amount of material welded based on cylindrical geometries and use the results to estimate material consumption.  **G-MG.1**: Apply geometric concepts in modeling situations.  Example: Students will use geometric modeling to measure weld bead profiles, calculate volume, and ensure material efficiency during welding operations.  **Trigonometry (HSG-SRT)**  **HSG-SRT.C.6**: Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.  Example: Students will apply trigonometric ratios to calculate the angles needed for electrode positioning during out-of-position welds, ensuring accuracy.  **HSG-SRT.C.8**: Use trigonometric ratios and the Pythagorean theorem to solve right triangles in applied problems.  Example: Students will calculate the correct angles and dimensions for welding joints and electrode positioning using trigonometric principles to maintain consistent weld quality. | | |

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| **Unit 11:** Gas Metal Arc Welding (GMAW) | | | **Total Learning Hours for Unit:** 20 |
| **Unit Summary**: GMAW is a versatile welding process, and this unit focuses on performing GMAW on different materials and joint types. Students learn to set up and adjust GMAW equipment, optimizing parameters like voltage, wire feed speed, and shielding gas flow. They engage in hands-on practice to produce welds with proper bead appearance and penetration, followed by quality inspection and troubleshooting to ensure weld integrity. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **GMAW Equipment Setup and Parameter Adjustment:** Students will set up and adjust GMAW equipment, optimizing voltage, wire feed speed, and gas flow to match material thickness and joint type. They will ensure proper equipment operation for high-quality welds. **Welding in Multiple Positions:** Students will perform GMAW welds in flat, horizontal and vertical positions. They will focus on correct weld angles and proper technique to produce consistent weld beads in each position.  **Weld Quality Inspection and Troubleshooting:** Students will inspect welds for defects such as porosity, undercut, and spatter. They will troubleshoot defects and adjust welding parameters to improve weld quality. **Electrode(wire) and Shielding Gas Selection:** Students will select the correct electrode (wire) and shielding gas based on the material and joint type. They will explain how electrode material and gas flow affect weld quality. **GMAW Safety Inspection:** Students will conduct a safety inspection of GMAW equipment and workspaces. They will identify hazards, ensure compliance with safety standards, and propose corrective actions. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Leadership Alignment:**  **Safety Leadership in GMAW Operations:** Lead lab safety inspections, ensuring compliance with OSHA and AWS standards, and guide peers in hazard recognition and safety protocol adherence.   * **Leadership Skills:**11.A.1: Use interpersonal and problem-solving skills to promote safe GMAW practices.   **Collaborative Problem-Solving in Welding Defects:** Work in pairs or small groups to identify, discuss, and correct common GMAW welding defects.   * **Leadership Skills:**2.D.1, 2.D.2: Apply collaborative problem-solving to diagnose and address defects.   **Peer Training in GMAW Equipment Setup:** Lead workshops on GMAW setup, demonstrating parameter adjustments (voltage, wire feed speed, gas flow, polarity) for optimal weld quality.   * **Leadership Skills:**4.B.1: Use information accurately for decision-making and problem-solving in equipment setup.   **Time Management and Task Efficiency in Welding Projects:** Effectively manage time and tasks during GMAW projects to meet specifications and deadlines while maintaining quality.   * **Leadership Skills:**8.A.3: Manage time and workload efficiently to ensure timely and precise task completion. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:** (*Name of industry standards).*  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA)  Washington Association of Building Officials (WABO) | | **Website:**  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration>  <https://www.wabo.org/welder-program> | |
| 1.1: Apply Gas Metal Arc Welding (GMAW) technique  1.1.1 Identify and explain the use of GMAW equipment (i.e., spray transfer, globular, short circuit, pulse).  1.1.2 Perform safety inspections of GMAW equipment and accessories.  1.1.3 Maintain GMAW equipment and accessories.  1.1.4 Demonstrate safe startup, shutdown, disassembly, and cylinder exchange procedures of GMAW equipment.  1.2: Produce Welds using GMAW on Carbon Steel  1.2.1 Set up for GMAW operations.  1.2.2 Operate GMAW equipment.  1.2.3 Perform welds in the 1F position.  1.2.4 Perform welds in the 2F position.  1.2.5 Perform welds in the 3F position.  1.2.6 Perform welds in the 1G position.  1.2.7 Perform welds in the 2G position.  1.2.8 Perform welds in the 3G position. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q):**  **N-Q.1**: Use units as a way to understand problems and guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  *Example*: Students will calculate gas flow rates, wire feed speeds, and material thickness using appropriate units (e.g., CFM, inches, amps).  **N-Q.2**: Define appropriate quantities for the purpose of descriptive modeling.  *Example*: Students will define quantities such as gas flow rates, voltage, and wire feed speeds based on material and joint type during GMAW equipment setup.  **N-Q.3**: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example*: Students will measure weld bead dimensions and apply appropriate levels of accuracy based on project specifications and industry standards.  **Geometry (G):**  **G-CO.1**: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.  *Example*: Students will apply these geometric principles when calculating welding angles and positions for different joint types.  **G-SRT.5**: Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  *Example*: Students will use geometric principles when determining optimal welding angles for overhead, vertical, and horizontal welding positions.  **G-GMD.1**: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.  *Example*: Students will calculate the area of weld beads or the volume of filler material used in GMAW welds to ensure proper material application. | | |

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| **Unit 12:** Gas Tungsten Arc Welding (GTAW) | | | **Total Learning Hours for Unit: 20** |
| **Unit Summary**: This unit introduces students to Gas Tungsten Arc Welding (GTAW), focusing on the precision and versatility of this welding process. Students will learn to weld in different joint configurations. They will develop skills in setting up and adjusting GTAW equipment, including selecting appropriate tungsten electrodes and shielding gases. The unit emphasizes maintaining quality welds with minimal defects, troubleshooting common issues, and applying advanced math calculations to ensure welding efficiency. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **GTAW Equipment Setup and Parameter Adjustment:** Students will safely set up and adjust GTAW equipment, selecting the appropriate polarity (AC or DC) and adjusting voltage, current, and gas flow to match specific material thickness and joint types. They will ensure proper equipment operation and select the correct polarity based on material type (e.g., aluminum requiring AC and stainless-steel using DC).  **Welding Practice in Multiple Positions:** Students will perform GTAW welds in flat, horizontal, vertical, and overhead positions. They will ensure proper bead appearance, penetration, and consistency across different welding positions, adjusting polarity based on the material being welded..  **Weld Quality Inspection and Troubleshooting:** Students will inspect completed GTAW welds for common defects such as porosity, cracking, and incomplete fusion. They will troubleshoot and adjust GTAW parameters, including current settings and polarity, to correct defects and improve weld quality. **Filler Rod and Shielding Gas Selection:** Students will select appropriate filler rods and shielding gases for specific welding tasks, considering material type and joint configuration. They will explain how their choices, along with the correct polarity (AC or DC), impact weld integrity and quality. **GTAW Safety Practices:** Students will conduct a thorough safety inspection of GTAW equipment and the work area. They will ensure that equipment is set up correctly, including verifying proper polarity settings (AC/DC), and identify hazards to prevent accidents. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Collaborative Work in GTAW Operations**: Students will work in small groups, with partners, and individually to complete assignments and projects related to GTAW. They will collaborate on optimizing equipment settings, troubleshooting welding defects, and ensuring project deadlines are met.   * **Leadership Skills**:2.C.1, 2.C.3: Make judgments and decisions, adapting solutions based on system thinking in the context of GTAW projects. 3.B.1, 3.B.3: Collaborate effectively, sharing responsibilities for equipment setup and troubleshooting in GTAW operations.   **Peer Evaluation and Constructive Feedback**: **Task**: Students will work together as peer evaluators, offering constructive feedback on each other's GTAW projects, such as weld bead quality, equipment settings, and adherence to safety protocols. Peer reviews will help students improve accuracy and consistency in their work.   * **Leadership Skills**: 3.A.4, 3.A.5: Communicate clearly and effectively when giving feedback, ensuring that suggestions are constructive and focused on improvement. 9.B.1, 9.B.2: Work effectively in diverse teams, contributing to team success through collaboration and feedback.   **Maintaining a Safe Working Environment**: **Task**: Students will demonstrate respect for themselves and others by maintaining a safe working environment in the shop/lab setting at all times. This includes conducting safety inspections, ensuring proper equipment setup, and following OSHA, AWS, and ANSI guidelines.  **Leadership Skills**: 7.A.1, 7.B.1: Adapt to changes and be flexible while adhering to safety protocols and best practices in the GTAW environment. 11.A.1: Lead others by setting an example for maintaining safety standards during welding operations and helping peers recognize and mitigate safety risks. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA)  Washington Association of Building Officials (WABO) | | **Website:**  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration>  <https://www.wabo.org/welder-program> | |
| Apply Gas Tungsten Arc Welding (GTAW) technique  1.1.1 Perform safety inspections of GTAW equipment and accessories.  1.1.2 Maintain GTAW equipment and accessories.  1.1.3 Demonstrate safe startup, shutdown, disassembly, and cylinder exchange procedures of GTAW equipment.  1.2: Produce Welds using GTAW on Carbon Steel  1.2.1 Set up for GTAW operations  1.2.2 Operate GTAW equipment.  1.2.3 Perform welds in the 1F position.  1.2.4 Perform welds in the 2F position  1.2.5 Perform welds in the 3F position  1.2.6 Perform welds in the 1G position  1.2.7 Perform welds in the 2G position.  1.2.8 Perform welds in the 3G position. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q):**  **N-Q.1**: Use units as a way to understand problems and guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  *Example*: Students will calculate gas flow rates, current settings, and material thickness using appropriate units (e.g., CFM, inches, amps) when setting up GTAW equipment.  **N-Q.2**: Define appropriate quantities for the purpose of descriptive modeling.  *Example*: Students will define quantities such as gas flow rates, amperage, and tungsten electrode based on material type and joint configuration during GTAW setup.  **N-Q.3**: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  *Example*: Students will measure weld bead dimensions and penetration depth with appropriate levels of accuracy, ensuring consistency in welding outcomes and quality  **Algebra (A-CED):**  **A-CED.1**: Create equations and inequalities in one variable and use them to solve problems.  *Example*: Students will create equations to calculate the optimal current settings and gas flow rates for specific material thicknesses in GTAW.  **A-CED.2**: Create equations in two or more variables to represent relationships between quantities.  *Example*: Students will calculate relationships between current, tungsten electrode diameter, and shielding gas flow to optimize weld quality and ensure stable arcs.  **A-CED.4**: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.  *Example*: Students will rearrange formulas for gas flow rate, current, and voltage to solve for specific parameters during GTAW equipment setup.  **Geometry (G):**  **G-CO.1**: Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.  *Example*: Students will apply geometric principles when adjusting tungsten electrode angles and calculating optimal welding angles for different joint configurations in GTAW.  **G-SRT.5**: Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.  *Example*: Students will use geometric principles when determining weld bead angles and arc lengths for precise welding in GTAW.  **G-GMD.1**: Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.  *Example*: Students will calculate the area of weld beads or the volume of filler material used in GTAW welds to ensure proper material deposition and weld penetration. | | |

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| **Unit 13: Welding Quality Control** | | | **Total Learning Hours for Unit: 10** |
| **Unit Summary**: Quality control is essential in welding, and this unit introduces students to the principles of welding inspection and quality assessment. Students will learn to perform visual and destructive tests to evaluate weld quality. By developing and following a quality control checklist and applying AWS D1.1 standards, students will gain the skills necessary to ensure their welds meet industry standards. The unit covers the measurement and examination of defects like undercut, porosity, and weld reinforcement, as well as the assessment of fillet size and root passes. Students will learn to determine the acceptability of welded samples based on established acceptance criteria and how to inspect various stages of the weld process. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  *Example assessments for this unit include:*  **Weld Defect Identification and Correction:** Students will identify common weld defects (such as undercut, porosity, and incomplete fusion) in completed welds. They will propose corrective actions to address these defects and improve weld quality. For each identified defect, students will describe the likely cause and the adjustments needed to prevent similar issues in future welds. **Joint Fit-Up Inspection and Weld Preparation:** Students will inspect and assess the fit-up of various welded joints before welding, ensuring proper alignment, gap tolerance, and joint cleanliness according to AWS D1.1 standards. They will prepare the joints by checking for misalignment, proper root openings, and ensuring that all components are secured and ready for welding. Students will document any discrepancies and correct them before starting the welding process. **Weld Root Pass and Intermediate Layer Inspection:** Students will inspect root passes and intermediate weld layers, looking for defects like incomplete fusion and slag inclusions. They will determine whether the welds meet AWS D1.1 standards and propose corrective actions if necessary. **Fabrication Project Weld Quality Assessment:** Students will complete welds as part of a larger fabrication project, following the project specifications for material type, joint configuration, and position. They will assess their welds at various stages of the fabrication process, using AWS D1.1 standards to verify that each weld meets quality criteria before moving on to the next step in the project. **Time Management in Quality Control for Fabrication Projects:** Students will be responsible for managing the quality control process in a fabrication project, ensuring that all inspection, cleaning, and finishing tasks are completed within project deadlines. They will prioritize tasks based on critical checkpoints in the fabrication timeline and ensure that all steps meet code requirements before moving on. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*  **Self-Directed Quality Control Inspections:** Students will take responsibility for their own quality control inspections, ensuring that their welds meet AWS D1.1 standards. They will perform self-assessments throughout the welding process, from joint fit-up to final inspection, documenting any corrections they make.   * **Leadership Skills:** 11.A.3: Demonstrate personal responsibility by self-assessing and improving the quality of welds, holding oneself accountable for meeting professional standards.   **Peer Training in Visual Inspection Techniques**: Students will lead demonstrations on how to conduct visual inspections for welding defects, explaining how to use the quality control checklist and apply AWS standards.   * **Leadership Skills**: 4.B.1: Use information accurately for decision-making in quality control processes.   **Time Management in Testing and Inspection Projects**: Students will manage their time efficiently while performing visual inspections, destructive tests, and NDT simulations to complete all testing on schedule.   * **Leadership Skills**: 8.A.3: Utilize time efficiently and manage workload to complete quality control assessments on time and with precision.   **Collaborative Work in Quality Control Assignments**: Students will work in small groups or pairs to assess welded samples, sharing the workload for measuring, inspecting, and comparing results to standards.   * **Leadership Skills:** 3.B.1, 3.B.3: Collaborate effectively, ensuring that all aspects of quality control are completed accurately and shared among team members.   **Community Engagement in Welding Quality Control**: Students will engage with local businesses or welding professionals to learn about real-world quality control practices, comparing their school-based inspections to industry standards.  **Leadership Skills**: 4.A.1, 4.A.2: Assess and evaluate real-world information to enhance understanding of quality control processes. | | | |
| **Industry Standards and/or Competencies**: | | | |
| **Name of standards:**  American Welding Society (AWS)  American National Standards Institute (ANSI)  Occupational Safety and Health Administration (OSHA)  Washington Association of Building Officials (WABO) | | **Website:**  <https://www.aws.org/>  <https://blog.ansi.org/ansi-z49-1-2021-safety-in-welding>  <https://www.usa.gov/agencies/occupational-safety-and-health-administration>  <https://www.wabo.org/welder-program> | |
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| **Aligned Washington State Academic Standards** | | | |
| **Mathematics: Common Core** | **Number and Quantity (N-Q)**  **N-Q.1:** Use units as a way to understand problems and guide the solution of multi-step problems; choose and interpret units consistently in formulas.  *Example:* Students will calculate tensile strength, cross-sectional area, and force during destructive tests, ensuring consistent use of units.  **N-Q.2:** Define appropriate quantities for descriptive modeling.  *Example:* Students will define quantities like defect percentages and weld dimensions for quality assessments.  **N-Q.3:** Choose a level of accuracy appropriate to the limitations on measurement when reporting quantities.  *Example:* Students will ensure the accuracy of weld measurements, such as undercut and porosity dimensions, to meet industry tolerances.  **Algebra (A)**  **A-CED.1:** Create equations and inequalities in one variable and use them to solve problems.  *Example:* Students will create equations to model the relationships between tensile strength, force, and cross-sectional area, ensuring the weld meets strength standards.  **A-CED.2:** Create equations in two or more variables to represent relationships between quantities.  *Example:* Students will develop equations representing the relationship between defect percentages, weld dimensions, and material thickness during quality assessments.  **Geometry (G)**  **G-CO.1:** Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment.  *Example:* Students will apply geometric concepts when assessing weld bead profiles and checking weld angles for fit-up quality.  **G-GMD.1:** Give an informal argument for the formulas for the circumference of a circle, area of a circle, and volume of a cylinder.  *Example:* Students will calculate weld bead volumes and surface areas during inspection, using geometric formulas for quality control.  **G-MG.1:** Apply geometric concepts in modeling situations.  *Example:* Students will model weld dimensions and angles using geometric principles to ensure compliance with specified tolerances.  **Modeling (M)**  **M-SRT.1:** Use trigonometric ratios and the Pythagorean theorem to solve right triangles in applied problems. *Example:* Students will calculate the correct electrode angles for vertical, horizontal, and overhead welding positions using trigonometric principles to maintain consistent weld quality and bead profiles.  **M-GMD.1:** Apply geometric methods to solve real-world problems. *Example:* Students will apply geometric methods to calculate the area and volume of weld joints and beads, ensuring they meet the required specifications and tolerances during inspections.  **Statistics and Probability (S)**  **S-IC.3:** Recognize the purposes and differences among sample surveys, experiments, and observational studies. *Example:* Students will design and conduct quality control experiments, comparing the results from different welding samples to assess the impact of various welding techniques on weld strength and defect formation. | | |