



Statewide Framework Document for:

**Welding Technology II**

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 Lab science.**

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-II | | **Total Framework Actual Hours:** 180 |
| **CIP Code:** 480508 | **Exploratory  Preparatory** | **Date Last Modified:** August 2025 |
| **Career Cluster:** Manufacturing | | **Cluster Pathway:** Production |
| **Course Summary:** Welding Technology-II is a preparatory course focused on advancing welding skills in the production and manufacturing industries. This course builds on foundational skills from Welding Technology-I and introduces students to specialized techniques and materials such as aluminum and other alloys Key welding processes covered include Shielded Metal Arc Welding (SMAW), Gas Metal Arc Welding (GMAW), and Gas Tungsten Arc Welding (GTAW). Students will enhance their knowledge in print reading, metallurgy, and fabrication techniques while learning to execute welds that meet industry standards. Quality control, inspection, and alignment with AWS (American Welding Society) standards remain integral components, supporting the students’ readiness for high-demand industry roles. Additionally, students will explore welding career pathways unique to the Pacific Northwest such as aluminum boat building, specialty fabrication and develop professional competencies, positioning them for success in advanced welding roles or further technical training. Welding Technology II integrates multiple NGSS standards through lab-style investigations, modeling, and applied mathematics. Students conduct scientific inquiries into energy transfer, chemical reactions, and material properties while developing engineering solutions in welding contexts. This three-dimensional approach supports awarding **1.0 Lab Science credit**. | | |
| **Eligible for Equivalent Credit in:** 1.0 Lab Science | | **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**: This unit focuses on exploring advanced welding career paths, such as welding inspectors, specialty fabricators, and seismic welding Students will research various welding careers, mapping pathways for professional growth, including certifications, education, and hands-on experience. They will also participate in professional skill-building activities, such as mock interviews, resume creation, and networking opportunities, preparing them for future success in the welding industry. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)   * **Career Pathway Exploration Project:** Students will research different career paths within the welding industry, focusing on roles such as welding engineers, inspectors, and robotic operators. They will create a career roadmap with detailed steps, including certifications, skills development, and educational requirements. * **Mock Interviews and Resume Development:** Students will participate in mock interviews tailored for welding positions. They will also create a resume highlighting their welding skills, certifications, and future goals. * **Welding Certification Mapping Exercise:** Students will map out the certification requirements for various welding careers, including AWS and WABO certifications, and outline the educational and training paths needed to achieve them. * **Transferability of Skills.** * Students will assess how welding standards and quality control practices vary across industry sectors, such as automotive, construction, aerospace, and manufacturing, and discuss 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. * **Career Networking Research:** Students will identify professional organizations and networking opportunities within the welding industry (e.g., AWS, local trade groups). They will create a networking plan, including strategies for making industry connections. * **Reflection Essay on Career Goals:** Students will write a reflection essay outlining their short-term and long-term welding career goals. They will evaluate the steps necessary to achieve their goals and reflect on their current skills, identifying areas for improvement. * **Regional Job Market Analysis and Employer Research** * Students will research local job boards, apprenticeship programs, and employer websites to identify hiring trends in the welding industry within Washington State. They will document companies with high demand for skilled welders and list entry-level requirements, such as certifications or skills. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Career Research Leadership:** Students will lead a group research session on welding career paths, helping their peers find resources and understand the steps to certification and career advancement.   * **Leadership Skill:** 4.B.1: Use information creatively and accurately to guide others in career decision-making and research.   **Interview Preparation Workshops:** Students will organize and lead mock interview workshops, coaching peers on how to present their skills and answer technical questions related to welding careers.   * **Leadership Skill:** 3.B.3: Collaborate effectively, ensuring that all participants are prepared for interviews by offering feedback and support.   **Resume Feedback Sessions:** Students will lead a peer feedback session on resume creation, offering constructive criticism and suggestions to help classmates improve their professional resumes.   * **Leadership Skill:** 2.D.1: Provide peer feedback on resumes to enhance professional presentation and career preparedness.   **Career Goal-Setting Presentations:** Students will present their career goals and steps to achieve them, guiding their peers on how to create actionable plans for their future careers in welding.   * **Leadership Skill:** 8.A.3: Utilize goal-setting techniques to help others structure their career aspirations.   **Networking and Industry Engagement Leadership:** Students will lead a discussion on the importance of networking within the welding industry, presenting strategies for connecting with professionals and getting involved with industry organizations.  **Leadership Skill:** 4.A.1: Communicate the importance of professional networking and industry involvement to peers. | | | | | |
| **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**](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** | | | | | |
| **English Language Arts: Common Core** | **CCSS.ELA-LITERACY.CCRA.L.1:**  Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.  *Example:* Students will use proper grammar and language conventions when documenting tasks, explaining procedures, or presenting project outcomes in written and verbal form.  **CCSS.ELA-LITERACY.CCRA.L.2:**  Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.  *Example:* Students will ensure accuracy in capitalization, punctuation, and spelling when writing reports, completing assignments, or presenting information in both technical and general contexts. | | | | |
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| **Unit 2:** Working as a Team | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: This unit focuses on developing teamwork and collaboration skills through complex welding projects. Students will explore the dynamics of working in teams, dividing roles and responsibilities, and communicating effectively to complete assigned tasks. The unit emphasizes conflict resolution strategies and leadership within a team context, ensuring that all team members contribute to achieving project goals. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Team Welding Project:** Students will work in small groups to complete a multi-step welding project. Each team member will take on specific roles, such as lead welder, quality inspector, and safety officer, to ensure the project is completed efficiently and to industry standards.  **Collaborative Blueprint Reading Exercise:** Students will collaborate to interpret a welding blueprint for the team project. They will divide tasks, assign responsibilities, and ensure that each team member understands their role in the project.  **Conflict Resolution Reflection:** After the team project, students will reflect on any challenges or conflicts that arose during the project. They will analyze how conflicts were resolved and propose strategies for improving teamwork in future projects.  **Peer Feedback and Self-Evaluation:** Students will provide constructive feedback to their team members, focusing on communication, collaboration, and performance. They will also complete a self-evaluation, reflecting on their contribution to the team and identifying areas for improvement.  **Leadership Rotation Exercise:** During the team project, students will rotate leadership roles, with each student taking on the responsibility of guiding the team at different stages of the project. Leadership roles include managing the workflow, ensuring safety, and making critical decisions. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Team Leadership in Welding Projects:** Students will take turns leading the welding project, ensuring the team follows the project plan, maintains safety, and adheres to quality standards.   * **Leadership Skill:** 11.A.1: Use interpersonal and problem-solving skills to influence and guide others toward project success.   **Conflict Resolution Leadership:** Students will demonstrate leadership by managing and resolving conflicts that arise during the team project, ensuring the team remains focused on their goals.   * **Leadership Skill:** 2.D.2: Address and resolve conflicts within the team using collaborative problem-solving techniques.   **Delegation and Role Assignment:** Students will demonstrate leadership by delegating tasks to team members based on their strengths, ensuring each member contributes effectively to the team’s success.   * **Leadership Skill:** 3.B.1: Collaborate effectively by assigning roles and responsibilities to team members, ensuring the workload is shared.   **Time Management Leadership:** Students will lead their teams in managing time efficiently throughout the project, ensuring that each stage is completed on schedule without compromising quality or safety.  **Leadership Skill:** 8.A.3: Utilize time efficiently and manage workload to meet deadlines while ensuring the project is completed to industry standards. | | | |
| **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.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.   1.1.11 Exhibit leadership and communication skills through the division of roles and responsibilities in a welding team. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **English Language Arts: Common Core** | **CCSS.ELA-LITERACY.CCRA.L.1:**  Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.  *Example:* Students will use proper grammar and language conventions when documenting tasks, explaining procedures, or presenting project outcomes in written and verbal form.  **CCSS.ELA-LITERACY.CCRA.L.2:**  Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.  *Example:* Students will ensure accuracy in capitalization, punctuation, and spelling when writing reports, completing assignments, or presenting information in both technical and general contexts. | | |

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| **Unit 3:** Personal Success as a Welding Professional | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: This unit focuses on the personal and professional development of students as future welding professionals. It emphasizes the soft skills needed to succeed in the welding industry, including responsibility, professionalism, problem-solving, and the importance of work ethic. Students will explore their career goals, develop communication and teamwork skills, and learn how to navigate the demands of a professional welding environment. | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Career Planning and Reflection Assignment:** Students will create a detailed career plan that outlines their short- and long-term goals in the welding industry. The plan will include potential career paths, necessary certifications, and continuing education opportunities.  **Professionalism in Welding Lab Practice:** Students will demonstrate professionalism during welding lab activities by adhering to safety protocols, being punctual, and maintaining a clean workspace. They will be assessed on their attitude, attention to detail, and work ethic throughout the unit.  **Problem-Solving Scenarios in the Workplace:** Students will be presented with common workplace challenges, such as equipment malfunctions or material shortages. They will work individually or in groups to propose solutions to these problems, demonstrating critical thinking and resourcefulness.  **Communication Skills Reflection:** After participating in group activities, students will reflect on their communication styles and how effectively they worked with others. They will analyze how their communication influenced team dynamics and identify areas for improvement. | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Leadership in Career Planning:** Students will lead discussions about career opportunities in welding, guiding their peers through the process of mapping out professional goals and identifying steps to achieve them.   * **Leadership Skill:** 4.B.1: Use information creatively and accurately to guide peers in developing and pursuing career plans.   **Self-Assessment and Accountability:** Students will take ownership of their professional development by conducting self-assessments, identifying areas for improvement, and setting personal goals for growth.   * **Leadership Skill:** 8.A.3: Demonstrate accountability by setting clear professional goals and taking action to achieve them.   **Problem-Solving Leadership in the Workplace:** Students will lead teams through problem-solving exercises, helping peers navigate challenges encountered in a welding environment, such as equipment issues or team conflicts.   * **Leadership Skill:** 2.D.1: Lead collaborative efforts to solve workplace challenges using critical thinking and team input.   **Time Management Leadership:** Students will manage their time effectively while working on personal development and professional goal-setting tasks, ensuring they balance their time between practical welding tasks and self-improvement activities.   * **Leadership Skill:** 8.A.3: Utilize time efficiently and manage workloads to balance professional tasks with personal development.   **Peer Mentorship in Professionalism:** Students will act as mentors for their peers, providing feedback on professionalism and workplace behavior during welding lab activities.   * **Leadership Skill:** 11.A.1: Use interpersonal skills to mentor peers in professional behavior and work ethic. | | | |
| **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.aws.org/> | |
| 1.3: Demonstrating Professional Behavior  1.3.1: Self-Control 1.3.1.1 Maintain composure and manage emotions effectively. 1.3.1.2 Handle stressful or difficult situations with poise. 1.3.1.3 Accept constructive feedback and learn from mistakes.  1.3.2: Professional Appearance 1.3.2.1 Exhibit a professional demeanor at work. 1.3.2.2 Dress appropriately according to workplace standards. 1.3.2.3 Maintain proper personal hygiene. 1.3.2.4 Project a positive and professional image of oneself and the organization.  1.3.3: Social Responsibility 1.3.3.1 Avoid lifestyle choices that negatively affect the workplace or individual performance. 1.3.3.2 Refrain from substance abuse.  1.3.4: Maintaining a Positive Attitude 1.3.4.1 Demonstrate a positive outlook towards work. 1.3.4.2 Show pride in personal and organizational achievements. | | | |
| **Aligned Washington State Academic Standards** | | | |
| **English Language Arts: Common Core** | **CCSS.ELA-LITERACY.CCRA.L.1:**  Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.  *Example:* Students will use proper grammar and language conventions when documenting tasks, explaining procedures, or presenting project outcomes in written and verbal form.  **CCSS.ELA-LITERACY.CCRA.L.2:**  Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.  *Example:* Students will ensure accuracy in capitalization, punctuation, and spelling when writing reports, completing assignments, or presenting information in both technical and general contexts. | | |

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| **Unit 4:** Safety | | | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: Safety is paramount, especially with advanced welding techniques. This unit provides an in-depth understanding of safety practices, hazard identification, and risk mitigation. Students learn how to handle advanced welding equipment and materials safely, implement OSHA, AWS and ANSI safety standards, and perform safety audits. By the end of this unit, students are equipped to create and follow comprehensive safety plans tailored to specific welding processes, ensuring a secure working environment. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Basic Shop Safety Assessment:** Students will complete a written safety test, achieving 100% to pass, and demonstrate their knowledge of shop safety rules. They will identify proper behaviors and safety protocols needed to maintain a hazard-free environment in the welding lab.  **Tool and Equipment Safety Assessment:** Students will pass written and verbal assessments on the standard operating procedures (SOPs) for tools and equipment in the shop, scoring 95% or better. They will demonstrate their knowledge of the safe use of welding machines, grinders, and other shop equipment.  **Hazard Identification and Job Hazard Analysis (JHA):** Students will complete a Job Hazard Analysis (JHA) worksheet, recognizing potential hazards in the welding shop. They will identify and mitigate safety concerns by proposing corrective actions for each identified hazard, with particular focus on understanding the health risks associated with welding fumes, arc radiation, and exposure to hazardous materials.  **PPE Usage and Health Risk Prevention:** Students will demonstrate the correct usage of PPE, including welding helmets, gloves, face shields, and jackets, with a focus on preventing long-term health risks. They will explain the potential negative effects of welding fumes, UV radiation from the welding arc, and other hazards on respiratory and skin health, reinforcing why PPE is essential for protection.  **Emergency Response and Fire Safety Assessment:** Students will develop and present an emergency response plan that includes fire safety procedures, correct use of fire extinguishers, and evacuation routes. They will also participate in a fire safety drill, demonstrating knowledge of the location and use of emergency equipment.  **Investigation of Electrical Forces and Thermal Energy** Students will design and conduct an investigation to determine the strength of electrical forces between particles (e.g., through demonstrations of Coulombic attraction or simulations) and explore thermal energy transfer in welding-related contexts. They will collect and analyze data, create graphs or visual representations, and produce a lab report that connects their findings to welding safety practices, such as arc stability and prevention of electrical hazards.  **Respiratory System Protection Modeling** Students will develop multi-level models of the human respiratory system to show how welding fumes and particulates affect respiratory health. They will then expand their models to illustrate how personal protective equipment (PPE), such as respirators or ventilation systems, protects these systems. Students will communicate their models through a scientific product (poster, infographic, or presentation), explaining mechanisms of harm and demonstrating how PPE reduces health risks.  **Mathematical Comparison of UV and Infrared Energy** Students will use mathematical equations (e.g., E=hν or E=hc/λ) to calculate and compare the energy of ultraviolet (UV) and infrared (IR) radiation. They will apply their results to explain why UV radiation poses a greater risk for eye and skin damage in welding compared to IR. Students will present their findings in a written analysis or oral explanation, explicitly connecting the math to PPE requirements such as welding helmets, shields, and protective clothing. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Leadership in Safety Inspections:** Students will take turns leading safety inspections in the welding lab, guiding their peers in identifying hazards and implementing safety measures. They will ensure that all team members adhere to safety protocols and understand the long-term health risks associated with exposure to welding fumes and arc radiation.   * **Leadership Skill:** 11.A.1: Use interpersonal and problem-solving skills to guide peers in maintaining safety in the workplace.   **Peer Training in PPE Usage and Health Protection:** Students will lead training sessions on the proper use of PPE, explaining the importance of each piece of equipment in preventing exposure to hazardous fumes and arc radiation. They will demonstrate correct procedures for donning and doffing gear and emphasize how PPE protects physical health.   * **Leadership Skill:** 4.B.1: Use information creatively and accurately to guide others in the proper use of PPE and protect against health risks.   **Collaborative Hazard Identification and JHA Completion:** Students will collaborate in small groups to complete the Job Hazard Analysis (JHA), identifying potential hazards, including the dangers of fume inhalation and exposure to UV radiation. They will share responsibility for ensuring the safety of their group’s work area.   * **Leadership Skill:** 3.B.3: Collaborate effectively to identify and mitigate safety hazards, ensuring a safe working environment.   **Self-Assessment and Accountability in Safety and Health Practices:** Students will will take responsibility for maintaining their own safety as well as the safety of others.  **Leadership Skill:** 8.A.3: Demonstrate accountability by ensuring consistent adherence to safety protocols during welding activities. | | | | | |
| **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** | | | | | |
| **Science** | **HS-PS1: Matter and Its Interactions**  ***HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.***  *Example:* This standard relates to understanding how welding fumes are generated at the particle level and how these particles can impact physical health, reinforcing the need for appropriate PPE.  **HS-PS3: Energy**  **HS-PS3-4:** Plan and conduct an investigation to provide evidence that the transfer of thermal energy (via conduction, convection, and radiation) influences matter.  *Example:* This standard can apply to the heat generated during welding, understanding the thermal energy's effect on both materials and the environment (welding arc), and the importance of PPE to protect against burns and exposure to harmful energy levels.  **HS-PS4: Waves and Their Applications in Technologies for Information Transfer**  ***HS-PS4-1: Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.***  *Example:* This can relate to understanding how the intense light (welding arc) involves electromagnetic radiation, reinforcing the necessity of protective gear to shield the eyes and skin from UV and infrared exposure. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Planning and Carrying Out Investigations  Using Mathematics and Computational Thinking | | PS3.B: Conservation of Energy and Energy Transfer PS3.D: Energy in Chemical Processes  PS4.A: Wave Properties | | PatternsSystems and System Models Cause and Effect | |

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| **Unit 5:** Print Reading | | | | | **Total Learning Hours for Unit: 15** |
| **Unit Summary**: This unit builds on prior blueprint reading knowledge by introducing students to advanced welding blueprints, focusing on complex welding symbols, tolerances, and multi-view drawings. Students practice interpreting, sketching, and revising welding blueprints with accurate dimensions and specifications. Through hands-on projects, students develop the ability to plan and execute welding tasks with precision while considering advanced tolerances and quality control standards. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Advanced Blueprint Interpretation Project:** Students will interpret an advanced multi-view welding blueprint, including reading welding symbols, dimensions, tolerances, and detailed welding specifications. They will generate a comprehensive written report, detailing materials, tools, and procedural steps for executing the welding task as per the blueprint.  **Complex Materials List and Bill of Materials (BOM) Creation:** Students will create a detailed BOM from an advanced blueprint. This will include estimating quantities of materials using area, volume, and complex shape calculations.  **Advanced Sketching and Dimensioning:** Students will create and revise their own advanced welding blueprint, including multiple views (orthographic, isometric) and ensure proper dimensioning, tolerances, and the use of complex welding symbols.  **Precision Measuring and Scaling Activity:** Students will take detailed measurements from an advanced blueprint and create a precise scaled drawing. They will convert complex measurements between customary and metric systems and apply those values to ensure accuracy.  **Tolerance and Quality Control Calculations:** Students will calculate tolerances and ensure adherence to quality control standards based on specifications in an advanced welding blueprint. They will make adjustments to meet strict quality benchmarks. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Team-Based Blueprint Interpretation:** Students will work in groups to interpret and discuss an advanced welding blueprint, each taking responsibility for different components such as materials, symbols, and tolerances.   * **Leadership Skill:** 3.B.3: Assume shared responsibility for collaborative work and value each team member's contributions.   **Peer Review of Blueprint Drafts:** Students will lead peer review sessions, providing constructive feedback on the accuracy of sketches and dimensions in blueprints and revising their own work based on feedback.   * **Leadership Skill:** 4.A.1: Communicate clearly and persuasively with peers, providing and receiving feedback effectively.   **Blueprint Project Leadership:** Students will take turns leading a team project to create an advanced welding blueprint, assigning roles for sketching, dimensioning, and material identification while managing project timelines.   * **Leadership Skill:** 8.A.3: Utilize time efficiently and manage workload to complete blueprint projects on time.   **Presentation of Advanced Blueprint Interpretations:** Students will present their interpretation of advanced welding blueprints, explaining their rationale for tool and material selections. They will engage the class in discussions and answer questions.   * **Leadership Skill:** 1.B.1: Develop, implement, and communicate ideas to others effectively.   **Problem-Solving in Blueprint Revision:** Students will collaborate to solve problems arising during the blueprint revision process, ensuring that changes comply with industry standards and tolerances.  **Leadership Skill:** 7.A.1: Adapt to varied roles and responsibilities to solve problems 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> | | |
| **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. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | **HS-PS2-6**: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.  *Example:* Students will analyze material specifications and tolerances in blueprints to understand how the properties of materials impact their use in welding applications.  **HS-ETS1-3**: Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints.  *Example:* Students will evaluate different blueprint designs and welding plans, considering constraints like material availability, tolerance limits, and weld quality.  **HS-ETS1-2**: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering practices.  *Example:* Students will interpret multi-view blueprints and break down complex welding tasks into steps, ensuring precision in each stage of the process. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Obtaining, Evaluating, and Communicating Information | | PS1.A: Structure and Properties of Matter PS2.B: Types of Interactions | | Structure and Function | |

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| **Unit 6:** Basic Metallurgy for Welders | | | | | **Total Learning Hours for Unit:** 15 |
| **Unit Summary**: This unit introduces students to the fundamental principles of metallurgy, focusing on how different metals behave during the welding process. Students will learn about the properties of ferrous and non-ferrous metals, the effects of heat on metal structures, and how different welding techniques impact metal strength and durability. Through practical applications and analysis, students will develop a deeper understanding of metal selection and its importance in ensuring high-quality welds. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Metal Identification and Classification:** Students will identify various ferrous and non-ferrous metals based on their physical characteristics and classify them according to their composition and usage in welding. They will apply this knowledge to select appropriate materials for specific welding tasks. **Heat-Affected Zone (HAZ) Analysis:** Students will analyze the heat-affected zone in different metals, identifying changes in the metal's structure and properties after welding. They will assess how these changes affect the strength and durability of welded joints. **Metal Selection Assignment:** Students will select appropriate metals for a fabrication project based on strength, ductility, and other material properties. They will justify their selections based on welding conditions and the project’s structural requirements. **Weld Defect Analysis and Metallurgical Causes:** Students will inspect welds for common defects (e.g., cracking, porosity) and identify whether these defects were caused by improper metallurgical practices. They will propose corrective actions to prevent similar issues in future welds.  **Designing and Building Energy Conversion Devices** Students will design and construct a simple device that converts one form of energy into another (e.g., electrical → thermal, thermal → mechanical, or light → thermal). They will document the design process, identify energy inputs and outputs, and test the device under welding-related constraints. Students will then develop a model that illustrates all of the energy transfers occurring in the welding process, showing how electrical energy is converted to heat, light, and sound, and how that energy affects metals at the molecular level.  **Investigation of Aluminum’s Thermal Conductivity** Students will plan and conduct an investigation into the thermal conductivity of aluminum compared to another metal (e.g., steel or copper). Using controlled heating and temperature probes, they will measure and analyze how quickly heat moves through each sample. Students will present their findings in a lab report that explains why aluminum’s high thermal conductivity poses challenges in welding, and propose strategies welders use to manage heat transfer. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Communication in Technical Metallurgical Concepts:**  Students will work in teams to analyze and propose solutions for common metallurgical issues in welding, such as material selection, heat treatment, and metal fatigue.   * **Leadership Skills:** 3.A.1: Articulate thoughts and ideas effectively using oral communication to explain metallurgical concepts.3.A.5: Communicate effectively in diverse environments to address different learning styles and technical comprehension levels.   **Collaboration in Metallurgical Testing:**  Students will collaborate to conduct and analyze results from metallurgical tests such as hardness, tensile strength, and impact testing, ensuring each group member contributes to the process.   * **Leadership Skills:** 3.B.3: Assume shared responsibility for conducting metallurgical tests, valuing each member's contributions. 7.B.3: Balance diverse viewpoints during group discussions on test results and their implications for welding applications.   **Ethical Responsibility in Metallurgical Practices:**  Students will analyze ethical issues related to welding metallurgy, such as the use of substandard materials or improper metal treatments and propose ethical guidelines for professional practice.  **Leadership Skills:** 11.A.4: Demonstrate integrity and ethical behavior in discussions about material quality and metallurgical practices. 11.B.1: Act responsibly, with the interest of the larger community in mind, when making decisions related to material choices. | | | | | |
| **Industry Standards and/or Competencies**: | | | | | |
| **Name of Standards:**  ASM International  WHB-1.9 WELDING HANDBOOK VOLUME 1 - WELDING SCIENCE & TECHNOLOGY  The James F. Lincoln Arc Welding Foundation | | | **Website:**  <https://www.asminternational.org/>  <https://www.aws.org/>  <https://www.jflf.org/> | | |
| **1.1: Understand and Apply Metal Properties and Their Effects on Welding** 1.1.1: Describe physical and mechanical properties of metals, including hardness, ductility, and toughness, as related to welding.  1.1.2: Explain the impact of alloying elements (e.g., carbon, chromium) on weldability, strength, and corrosion resistance.  1.1.3: Identify key differences in metallurgical properties among various metals and alloys used in welding.  **1.2: Analyze Heat Effects on Metal Structure and Weld Integrity**  1.2.1: Explain the effects of heating and cooling on metal structure, including grain growth and phase transformation.  1.2.2: Identify and control the heat-affected zone (HAZ) to minimize warping and cracking in welds.  1.2.3: Apply preheating, interpass temperature, and post-weld heat treatment practices for optimal weld integrity.  **1.3: Select and Use Filler Metals for Metallurgical Compatibility**  1.3.1: Choose filler metals that align with base metals based on metallurgical properties and AWS codes.  1.3.2: Explain the role of carbon equivalency in filler metal selection and weld preparation.  1.3.3: Demonstrate proper storage and handling of filler metals to prevent contamination.  **1.4: Interpret and Apply Metallurgical Standards and Specifications**  1.4.1: Use AWS and ASTM standards to evaluate material specifications and welding procedures.  1.4.2: Interpret specifications and codes to determine appropriate weld parameters for various alloys.  1.4.3: Ensure compliance with industry standards for material selection and weld quality.  **1.5: Troubleshoot and Correct Metallurgical Weld Defects**  1.5.1: Identify common metallurgical defects (e.g., porosity, cracking) and their causes in welding.  1.5.2: Develop strategies to prevent metallurgical issues, such as preheating, controlled cooling, and proper fit-up.  1.5.3: Conduct and interpret weld tests to assess defect causes, applying corrective actions as needed. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | **HS-PS2-6**: Communicate scientific and technical information about why molecular-level structure is important in the functioning of designed materials.  *Example*: Students will describe how the molecular structure of metals influences weld quality, with particular focus on how alloy composition and grain structure impact weld strength.  **HS-PS3-3**: Design, build, and refine a device that works within given constraints to convert one form of energy into another.  *Example*: Students explore how electrical energy is converted into thermal energy in the welding process and how this impacts weld quality based on different energy inputs.  **HS-PS3-4**: Plan and conduct an investigation to provide evidence that the transfer of thermal energy between system components requires energy conservation and energy transfer principles.  *Example*: Students will explore how aluminum’s high thermal conductivity affects heat distribution, emphasizing the importance of energy management in preventing weld defects.  **HS-ETS1-4**: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with multiple criteria and constraints on system interactions.  *Example*: Students will use simulation software to model the heat-affected zone (HAZ) and predict metallurgical changes in welded joints.  **HS-PS3-1.** Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.  **HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects). | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Obtaining, Evaluating, and Communicating Information Constructing Explanations and Designing Solutions | | PS1.A: Structure and Properties of Matter PS2.B: Types of Interactions  PS3.A: Definitions of Energy  S3.D: Energy in Chemical Processes  ETS1.A: Defining and Delimiting Engineering Problems | | Structure and Function Energy and Matter  Influence of Science, Engineering, and Technology on Society and the Natural World | |

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| **Unit 7:** Measurement and Layout/Fit-Up Techniques | | | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: Precision is key in advanced welding projects. This unit teaches students to use sophisticated measuring tools like micrometers and laser alignment devices for accurate layout and fit-up of components. Students learn fit-up techniques for complex joint configurations, including aluminum and other alloys, ensuring the highest quality welds. They engage in practical exercises to assess and improve their measurement and fit-up skills in complex assemblies. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Advanced Tolerance Measurement and Application Lab** Students will plan and conduct an investigation to measure tolerances in welded joints, analyzing how thermal expansion and contraction during welding affect alignment (HS-PS3-4).  **Material Waste Minimization Assignment** Students will design a layout plan that minimizes material waste while ensuring accuracy, using mathematical representations to evaluate efficiency and justify design choices (HS-ETS1-2).  **Fit-Up and Layout for Non-Standard Shapes** Students will develop and use models to explain how molecular structure and heat transfer impact fit-up in irregular joint shapes, presenting their findings to peers (HS-PS2-6).  **Tolerance Inspection and Correction Lab** Students will inspect welded joints, construct explanations for distortion caused by energy transfer, and revise fit-up techniques to improve accuracy (HS-PS1-3, HS-PS3-4).  **Final Fit-Up and Waste Reduction Test** Students will evaluate and refine their fit-up process for a complex welding task, integrating measurement data, thermal energy considerations, and waste-reduction strategies (HS-ETS1-2). | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Time Management in High-Tolerance Projects:** Students will manage time efficiently while working on high-tolerance projects, ensuring that all layout and fit-up tasks are completed within deadlines and to the required precision. **Leadership Skill:** 8.A.3: Utilize time and manage workload efficiently to complete high-tolerance tasks.  **Troubleshooting Fit-Up Issues in Non-Standard Configurations:** Students will lead their peers in identifying and solving fit-up issues related to non-standard shapes and tight tolerances, demonstrating flexibility and adaptability in resolving complex problems. **Leadership Skill:** 7.A.1: Adapt to varied roles and responsibilities to troubleshoot fit-up issues in complex configurations.  **Team Lead for Material Waste Reduction Strategies:** Students will lead teams in developing strategies to reduce material waste during layout and fit-up tasks, emphasizing efficient use of materials and sustainable practices. **Leadership Skill:** 11.A.1: Use problem-solving skills to guide peers in reducing material waste while maintaining precision in welding projects. | | | | | |
| **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 Advanced Layout Principles and Practices**  1.1.1: Interpret complex drawings and specifications.  1.1.2: Select appropriate materials for advanced welding projects.  1.1.3: Use advanced layout and marking tools with precision.  1.1.4: Perform layout for complex parts and assemblies.  **1.2: Demonstrate Fit-Up Practices for Advanced Joint Configurations**  1.2.1: Identify and explain job specifications for complex joints.  1.2.2: Use fit-up gauges and devices for advanced joint configurations.  1.2.3: Explain and control distortion in complex assemblies.  1.2.4: Perform fit-up for plate and pipe joints in advanced projects.  1.2.5: Check for misalignment in advanced joints and correct issues. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | **HS-PS2-6:** Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. • *Example*: Students will explain how the molecular structure of metals affects their behavior during the welding process. They will discuss how thermal expansion and contraction influence fit-up and distortion, making it critical to account for these factors when planning layouts and joint configurations.  ***HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.*** • *Example*: Students will investigate how different metals and alloys react to heat during welding and how their structure affects weldability, fit-up techniques, and the resulting joint tolerances.  **HS-PS3-4:** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined results in a more uniform energy distribution. • *Example*: Students will analyze the effects of thermal expansion in metals during welding, focusing on how heat affects alignment and fit-up, and how temperature changes influence material tolerances.  **HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into smaller, manageable problems that can be solved through engineering. • *Example*: Students will break down complex layout and fit-up challenges, such as working with non-standard shapes or tight tolerances, into smaller tasks, adjusting fit-up techniques and minimizing material waste to meet the specifications. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Obtaining, Evaluating, and Communicating Information | | PS1.A: Structure and Properties of Matter PS2.B: Types of Interactions  PS3.D: Energy in Chemical Processes | | Structure and FunctionPatterns Systems and System Models | |

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| **Unit 8:** Shielded Metal Arc Welding (SMAW) | | | | | **Total Learning Hours for Unit:** 25 |
| **Unit Summary**: Students perform SMAW on various materials, joints, and positions, including challenging configurations. They learn to select the appropriate electrodes, adjust settings for different materials, and troubleshoot welding defects. Through practice in diverse welding positions and quality control exercises, students refine their skills to produce professional-grade welds. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Electrode Selection and Setup**  Students will demonstrate how to select the appropriate electrodes for different materials and welding conditions, explaining how the choice affects arc stability, penetration, and overall weld quality. Students will also adjust current and polarity settings on the machine to match the material and electrode type.  **SMAW in Multiple Positions**  Perform SMAW welds in various positions, such as flat, horizontal, vertical, and overhead. Students will demonstrate control over bead appearance and penetration in each position while maintaining the appropriate travel angle and speed.  **Certification Skills Demonstration**: Students perform multi-pass welds in challenging positions (vertical, overhead), replicating certification-level tasks. Their performance is assessed on bead uniformity, fusion, and lack of defects (porosity, slag inclusion).  **Weld Defect Troubleshooting and Correction**  After completing a weld, students will inspect their work for defects such as porosity, undercutting, or slag inclusions. They will then troubleshoot and make adjustments to eliminate the defects in future welds.  **Quality Control Inspection**  Students will inspect completed welds according to AWS standards, using fillet weld gauges and visual inspection techniques. They will document any defects or inconsistencies and determine whether the welds meet industry quality standards.  **Safety and Maintenance Demonstration**  Students will perform a safety inspection of SMAW equipment, checking for faulty connections, damaged cables, and electrode holder wear. They will demonstrate how to safely replace parts and maintain the equipment to ensure a safe working environment. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Team-Based Quality Inspection**  Students will lead small groups in performing quality control inspections, ensuring that each member contributes to the analysis and documentation of weld defects. The leader will also guide the team in making recommendations for corrective actions.   * **Leadership Skill:** 3.B.3: Collaborate effectively, sharing responsibility for maintaining quality standards.   **Demonstrating Safety Practices**  Students will rotate roles in leading safety briefings before starting each welding session, ensuring that all equipment is properly inspected and that team members follow safety protocols.   * **Leadership Skill:** 11.A.1: Use interpersonal and problem-solving skills to influence and guide peers toward safe welding practices.   **Peer Coaching in Multiple Positions**  Students will coach peers in mastering SMAW in challenging positions (e.g., vertical and overhead), offering tips for controlling bead appearance and adjusting angles. They will provide feedback on welds to ensure continuous improvement.   * **Leadership Skill:** 7.A.1: Adapt to roles as a coach, demonstrating flexibility in helping peers troubleshoot and improve.   **Collaborative Problem-Solving in Welding Defects**  Students will collaborate in pairs or small groups to troubleshoot common SMAW welding defects. They will identify root causes and propose corrective actions.  **Leadership Skill:** 2.D.1: Solve problems by diagnosing welding defects using collaborative problem-solving techniques. | | | | | |
| **Industry Standards and/or Competencies**: | | | | | |
| **Name of Standards:**  AWS D1.1 Structural Welding Code  AWS A5.1: Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding | | | **Website:**  <https://www.aws.org> | | |
| **1.1: SMAW Techniques and Safety Practices**  **1.1.1**: Select electrodes based on material composition, thickness, and joint configuration, considering factors such as penetration requirements and the operating conditions.  **1.1.2**: Perform SMAW welds across multiple positions, including flat, horizontal, vertical, and overhead, with emphasis on controlling heat input and minimizing weld defects.  **1.1.3**: Diagnose and troubleshoot advanced weld defects, such as crater cracks and underbead cracking, and apply specific techniques to adjust parameters and correct issues.  **1.1.4**: Conduct thorough inspections of welds according to AWS standards, identifying subtle defects, and taking appropriate corrective actions for enhanced weld integrity.  **1.1.5**: Conduct comprehensive safety inspections of SMAW equipment and environment, adhering to OSHA and AWS standards, and identify potential hazards before, during, and after welding operations.  **1.2: SMAW Equipment Setup and Maintenance**  **1.2.1**: Set up and configure SMAW equipment, including the selection of appropriate polarity and amperage based on welding position and electrode type.  **1.2.2**: Inspect and maintain SMAW equipment components such as cables, electrode holders, and ground clamps, ensuring optimal performance and safety compliance.  **1.2.3**: Perform routine maintenance on welding machines, following manufacturer guidelines to prevent equipment failure and ensure consistent weld quality.  **1.2.4**: Demonstrate proficiency in replacing and safely storing electrodes to prevent contamination and moisture absorption, which can impact weld integrity.  **1.2.5**: Identify and mitigate risks associated with high-voltage equipment, ensuring all safety protocols are followed when operating SMAW machines.  **1.3 Perform SMAW Welds in Advanced and Varied Positions**  **1.3.1**: Execute precise welds in complex positions, including vertical-up (3G) ensuring control over bead consistency, penetration, and weld quality.  **1.3.2**: Apply techniques for overhead (4G) welding, demonstrating mastery in handling heat and gravity’s impact on weld puddle control, minimizing defects like spatter and undercut. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | ***HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of chemical properties.***  *Example*: Students examine oxidation in welding, explaining how electron configurations in metals lead to oxidation or slag formation on the weld surface.  **HS-PS1-6**: Refine the design of a chemical system by specifying a change in conditions to produce increased amounts of products at equilibrium.  *Example*: Students explore how flux and shielding gas adjustments optimize weld penetration and prevent oxidation in SMAW, examining equilibrium in the weld pool. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Constructing Explanations and Designing Solutions | | PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions | | Stability and Change | |

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| **Unit 9:** Gas Metal Arc Welding (GMAW)- Aluminum | | | | | **Total Learning Hours for Unit:** 25 |
| **Unit Summary**: This unit advances students’ capability in GMAW, focusing on refining skills in specialized applications and more complex materials and joint types. Students will demonstrate an understanding of equipment setup, precise parameter adjustments, and weld quality troubleshooting while working on challenging configurations and materials. Emphasis is placed on consistent quality across various positions and rigorous quality control to meet industry standards. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **GMAW Equipment Setup and Parameter Optimization** Students will set up and adjust GMAW equipment with a focus on optimizing parameters for different metals and complex joints. They will troubleshoot and refine settings to achieve precise bead characteristics, demonstrating advanced control over variables like wire feed speed and gas flow.  **Welding Techniques for Non-Standard Materials and Complex Joints** Students will apply advanced GMAW techniques on materials aluminum. They will execute welds on complex joint configurations, maintaining consistent bead appearance and penetration across multiple positions.  **Weld Defect Analysis and Quality Improvement** After completing welds, students will conduct a thorough inspection for common defects and apply troubleshooting techniques to identify root causes. They will refine their approaches to minimize defects and enhance weld quality.  **Project-Based Application: Industry-Standard Joint Preparation and Execution** In a project setting, students will prepare joints to specific tolerances and complete welding tasks based on real-world specifications, incorporating pre-weld planning, fit-up, and final inspection.  **GMAW Quality Control and Documentation** Students will perform quality control checks on completed welds, documenting the findings according to industry standards and evaluating the work’s compliance with specified tolerances. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Precision in Collaborative Tool Setup** Students will collaborate in small groups to set up and adjust GMAW equipment precisely, including adjustments for voltage, wire feed speed, and gas flow. They will guide peers through troubleshooting and refine adjustments to ensure optimal weld quality.   * **Leadership Skill:** 2.D.1 - Solve various types of non-familiar problems through effective collaboration and problem-solving techniques​   **Efficiency and Time Management in Group Tasks** Students will be assigned specific roles within a team, prioritizing task management and planning for efficient GMAW project execution. They will practice balancing speed with precision to meet project timelines without compromising quality.   * **Leadership Skill:** 8.A.3 - Manage workload efficiently, demonstrating accountability and effective time management in high-stakes, practical settings​   **Peer Mentorship in Advanced Weld Techniques** Students will take turns coaching peers on advanced GMAW welding techniques, such as welding aluminum in challenging positions. They will provide feedback, encouraging skill development and continuous improvement.   * **Leadership Skill:** 7.A.1 - Adapt to varied roles and responsibilities as a mentor, demonstrating flexibility in supporting others’ learning and troubleshooting complex issues​   **Innovation in Material Efficiency** In teams, students will lead discussions on minimizing material waste in GMAW projects, proposing innovative methods to increase efficiency. They will work on balancing project goals with sustainable material usage.  **Leadership Skill:** 1.A.1 - Use creative thinking techniques to propose and implement material-saving strategies that align with industry standards​ | | | | | |
| **Industry Standards and/or Competencies**: | | | | | |
| **Name of Standards:**  AWS D1.1 Structural Welding Code—Steel  AWS D1.2 Structural Welding Code—Aluminum | | | **Website:**  <https://www.aws.org> | | |
| **1.1: GMAW Techniques and Safety Practices**  **1.1.1:** Choose appropriate wire electrodes and shielding gases based on material composition, thickness, and joint configuration, with consideration for penetration, spatter, and welding speed under various conditions.  **1.1.2:** Execute GMAW welds across multiple positions, including flat, horizontal, vertical, and overhead, while controlling heat input and minimizing defects for consistent weld quality.  **1.1.3:** Diagnose and troubleshoot weld defects, such as cold lap and lack of penetration, adjusting parameters to improve quality and structural integrity.  **1.1.4:** Perform weld inspections following AWS standards, identifying defects and implementing corrective actions to ensure weld reliability.  **1.1.5:** Conduct comprehensive safety and equipment checks, adhering to OSHA and AWS standards, and proactively addressing potential hazards.  **1.2: GMAW Equipment Setup and Maintenance**  **1.2.1:** Set up and configure GMAW equipment, selecting appropriate polarity, voltage, and wire feed speed for the specific material and welding position.  **1.2.2:** Inspect and maintain GMAW components, including gas hoses, wire feeders, and gun parts, ensuring equipment readiness and compliance with safety standards.  **1.2.3:** Follow routine maintenance protocols on welding machines per manufacturer recommendations to maintain optimal performance and prevent downtime.  **1.2.4:** Store wire electrodes and shielding gases properly to prevent contamination, oxidation, and moisture absorption, maintaining high weld quality.  **1.2.5:** Identify and mitigate risks with high-voltage equipment, applying safety protocols to protect the operator and the welding environment.  **1.3: Fabrication Welding using GMAW**  **1.3.1:** Set up and execute GMAW welds for fabrication tasks, ensuring precise alignment and fit-up to meet fabrication standards for joint strength and appearance.  **1.3.2:** Apply weld passes for complex assembly welding, managing heat input and sequence to minimize distortion and ensure consistent bead formation across various joints.  **1.3.3:** Perform multi-pass welds for thick materials in structural fabrication, adjusting travel speed and electrode angle to ensure deep fusion and eliminate gaps in multi-layered joints.  **1.3.4:** Integrate effective clamping and bracing techniques to maintain dimensional accuracy and joint alignment during fabrication, ensuring all components meet specified tolerances.  **1.3.5:** Assess and optimize welding techniques based on joint type, material thickness, and assembly requirements, achieving high-quality welds that support structural integrity and visual consistency. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | **HS-PS3-3**: Design, build, and refine a device that converts one form of energy into another within constraints.  *Example*: Students investigate how electrical energy is converted into thermal energy in GMAW. By adjusting parameters like voltage and wire feed speed, they analyze the energy transfer's impact on weld quality, bead penetration, and metal fusion.  **HS-PS3-4**: Plan and conduct an investigation to provide evidence that energy is conserved as it transfers and changes form.  *Example*: During GMAW, students observe how energy transfers from the arc to the base metal, affecting heat distribution and thermal conductivity. They measure and document how energy conservation affects the quality and consistency of the weld.  **HS-PS2-6**: Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.  *Example*: Students explore the effects of molecular structure in aluminum and other metals, examining how alloy composition influences the weld’s properties, stability, and strength. This informs decisions on current, shielding gas, and filler material selection for different metals.  ***HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.***  *Example*: Students test weld strength across different metals, analyzing how electron configurations and bonding influence conductivity and weld stability, particularly with aluminum alloys in the GMAW process.  ***HS-PS1-2: Construct and revise explanations for the outcomes of simple chemical reactions based on the periodic table and knowledge of chemical properties.***  *Example*: Students examine oxidation and chemical reactions in GMAW, explaining how reactivity impacts electrode choice and affects weld quality, slag formation, and contamination prevention in aluminum welding. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Analyzing and Interpreting Data;  Constructing Explanations | | PS1.A: Structure and Properties of Matter  PS2.B: Types of Interaction  PS3.B: Conservation of Energy | | Energy and Matter; Cause and Effect | |

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| **Unit 10:** Gas Tungsten Arc Welding (GTAW)-Aluminum | | | | | **Total Learning Hours for Unit:** |
| **Unit Summary**: This unit builds on foundational GTAW knowledge. Emphasis is placed on welding precision, control of heat input, and welding of low carbon steel as well as aluminum. Students will explore critical parameters, including polarity selection, shielding gas optimization, and tungsten electrode selection, to ensure high-quality, defect-free welds. Quality inspection, troubleshooting, and understanding of material behavior under high heat are integrated to align with industry standards. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Advanced GTAW Equipment Setup and Adjustment** Students will set up and adjust GTAW equipment for aluminum welding, selecting tungsten types and shielding gases suitable for each material. They will demonstrate proper current, voltage, and polarity settings to ensure quality welds in various positions.  **Welding Precision Practice** Students will perform GTAW on low carbon steel, aluminum focusing on bead consistency, penetration control, and weld appearance. They will practice in multiple positions (flat, horizontal, vertical), demonstrating precision and attention to the heat input for each material.  **Defect Analysis and Troubleshooting** Students will inspect GTAW welds for common defects such as porosity, cracking, and discoloration. They will identify causes and adjust parameters, such as amperage and shielding gas flow, to correct defects, enhancing weld integrity.  **Tungsten Electrode Selection and Use** Students will select and prepare tungsten electrodes for specific tasks, ensuring optimal arc stability and reducing contamination. They will explain their choices based on the weld requirements for each material, considering factors like electrode shape and composition.  **Weld Quality and Standards Adherence**: Students practice preparing, executing, and inspecting welds to meet specific AWS standards. Performance assessment includes documenting weld parameters (e.g., amperage, electrode type, shielding gas flow rate) and ensuring weld beads meet certification visual criteria (e.g., bead uniformity, penetration depth).  **Certification Mock Exam Practice**: Provide simulated AWS certification tests to evaluate students’ precision in GTAW. Assessment criteria could include scoring based on AWS certification standards and adjusting welding parameters to optimize performance.  **Chemical Reaction Explanation in GTAW:** Students will construct and revise an explanation for oxidation and slag formation during GTAW, using evidence from electron states, periodic trends, and chemical properties of metals. *(HS-PS1-2)*  **Investigation of Electrical Forces in Metals:** Students will plan and conduct an investigation comparing aluminum and another metal to infer how molecular structure and electrical forces between particles affect weld strength and stability. *(HS-PS1-3)*  **Modeling Structure–Property Relationships:** Students will develop and present models showing how molecular-level structure influences weld properties such as strength, ductility, and corrosion resistance in GTAW applications. *(HS-PS2-6)*  **Designing an Energy Conversion Model in GTAW:** Students will design and refine a model that illustrates energy conversion in GTAW (electrical → thermal → light). They will analyze how adjustments in welding parameters impact energy transfer and weld quality. *(HS-PS3-3)* | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Team-Based Parameter Optimization** Students will lead small teams in setting up GTAW parameters for complex materials, guiding peers in decisions on amperage, gas flow, and electrode type.   * **Leadership Skill:** 1.1.1: Guide team members to achieve welding goals through effective communication and problem-solving.   **Peer Instruction on Defect Identification** Students will assist others in identifying and mitigating GTAW defects, teaching peers inspection techniques and corrective methods.   * **Leadership Skill:** 2.3.2: Demonstrate confidence and clarity when instructing peers on technical skills.   **Safety and Maintenance Leadership** Students will rotate as safety leaders, conducting daily checks on GTAW equipment and guiding peers in safe setup, shutdown, and gas handling practices.   * **Leadership Skill:** 1.2.3: Promote and model safe practices to peers, ensuring adherence to established safety protocols.   **Time Management in Welding Sequences** Students will manage time for team projects, ensuring all welds meet quality and safety standards within given time frames.   * **Leadership Skill:** 3.2.1: Effectively organize tasks and manage group resources for efficient project completion.   **Reflective Practice and Feedback** After completing welds, students will lead peer reviews, providing constructive feedback and discussing areas for improvement.  **Leadership Skill:** 2.2.4: Engage in reflective practice, using feedback to support skill development | | | | | |
| **Industry Standards and/or Competencies**: | | | | | |
| **Name of Standards:**  AWS C5.5 Recommended Practices for Gas Tungsten Arc Welding  AWS D1.1 Structural Welding Code—Steel  AWS D1.2 Structural Welding Code—Aluminum | | | **Website:**  <https://www.aws.org> | | |
| **1.1: Demonstrate GTAW Safety Practices**  1.1.1: Identify and assess hazards specific to the GTAW environment, and explain mitigation strategies according to AWS and OSHA guidelines.  1.1.2: Use personal protective equipment (PPE) effectively to protect against arc radiation, fumes, and high temperatures, ensuring compliance with OSHA standards.  1.1.3: Perform pre-weld safety inspections of GTAW equipment, identifying issues in torches, cables, and shielding gas supplies that could compromise safety.  1.1.4: Demonstrate proper handling and storage of shielding gases to prevent contamination and ensure safety compliance.  1.1.5: Implement emergency response procedures specific to GTAW, including handling high-voltage equipment and managing confined-space hazards safely.  **1.2: Setup and Operation of GTAW Equipment**  1.2.1: Select appropriate tungsten electrodes and shielding gases for specific metals and thicknesses, optimizing arc stability and weld quality.  1.2.2: Set up GTAW equipment, adjusting settings for current type (AC/DC), amperage, and shielding gas flow to match project specifications and material properties.  1.2.3: Calibrate and maintain GTAW equipment, checking for issues with torch tips, cables, and connections, and documenting maintenance for compliance.  1.2.4: Demonstrate proper electrode sharpening techniques to improve arc stability and control over bead appearance.  1.2.5: Perform routine torch maintenance, including cleaning and replacing consumable parts, to maintain equipment longevity and ensure optimal weld quality.  **1.3: Perform Fabrication Welding with GTAW**  1.3.1: Execute GTAW welds for complex fabrication projects, ensuring precision in assembly, fit-up, and joint configurations specific to aluminum and other alloy applications.  1.3.2: Use GTAW to create welds on thin-gauge and delicate materials, adjusting parameters to prevent warping or burn-through, especially in intricate fabrications.  1.3.3: Perform multi-pass and root-pass welds on fabrication components, utilizing controlled heat input to maintain material properties and structural integrity in various joint types.  1.3.4: Apply GTAW techniques for edge preparation, including tack welding and precise gap filling, ensuring smooth, uniform weld beads in multi-part assemblies.  1.3.5: Integrate advanced techniques to manage distortion, ensuring consistent fit-up throughout fabrication projects, adjusting shielding gas and travel speed as needed for project specifications. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | **Chemistry (HS-PS1: Matter and Its Interactions)**  ***HS-PS1-2: Construct and revise an explanation for the outcome of a simple chemical reaction based on electron states, trends in the periodic table, and chemical properties.***  *Example:* Students will analyze reactions such as oxidation and slag formation, explaining how factors like heat input and shielding gas affect chemical changes in different alloys during GTAW.  ***HS-PS1-3: Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.***  *Example:* Students will compare metals like aluminum and stainless steel to understand how their molecular structures impact GTAW practices, joint strength, and application-specific weld properties.  **Physical Science (Physics) (HS-PS2: Motion and Stability: Forces and Interactions)**  **HS-PS2-6:** Communicate scientific and technical information about why molecular structure is essential in designed materials.  *Example:* Students will research how grain structure affects GTAW weld quality, explaining how alloy composition impacts factors like strength, ductility, and corrosion resistance in welded joints.  **HS-PS3-3:** Design, build, and refine a device that converts one form of energy to another.  *Example:* Students explore energy transformation from electrical to thermal energy in GTAW, adjusting parameters to control heat input and produce effective welds on different materials.  **Engineering and Technology (HS-ETS1: Engineering Design)**  **HS-ETS1-2:** Design a solution to a complex real-world problem by breaking it down into manageable tasks solvable through engineering.  *Example:* Students break down the GTAW process into stages such as material selection, gas setup, and heat control to optimize weld integrity for specific applications.  **HS-ETS1-4:** Use computer simulation to model impacts of solutions to complex problems within and between systems.  *Example:* Students use simulation software to model the heat-affected zone (HAZ) and predict material responses during GTAW, adjusting weld parameters to reduce distortion. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Developing and Using Models; Planning and Carrying Out Investigations | | PS1.A: Structure and Properties of Matter; PS2.B: Types of Interactions; PS3.B: Conservation of Energy | | Structure and Function; Energy and Matter | |

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| **Unit 11:** Aluminum Fabrication | | | | | **Total Learning Hours for Unit:** 25 |
| **Unit Summary**: This unit focuses on aluminum fabrication techniques widely used in the Washington State welding industry. Students will explore aluminum's unique properties, including its high thermal conductivity and oxidation tendencies, and develop specialized welding and fabrication skills for this lightweight but durable material. They will engage in hands-on projects that require precision, heat control, and advanced layout techniques specific to aluminum. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **Precision Layout and Measurement for Aluminum Projects** Students will conduct precise measurements and layouts for aluminum fabrication projects, using calipers, laser levels, and other tools to ensure accuracy. They will apply industry standards for layout tolerances, measuring and marking complex shapes.  **Thermal Control in Aluminum Welding** Students will weld aluminum components, focusing on managing thermal input to prevent warping and cracking. They will analyze and adjust their welding parameters, considering aluminum’s high conductivity and low melting point.  **Joint Configurations and Fit-Up Techniques** Students will perform fit-ups for aluminum joints, including complex T-joints and butt joints, ensuring precise alignment and gap tolerances. They will troubleshoot issues related to alignment and make adjustments to maintain joint integrity.  **Surface Preparation and Oxidation Prevention** Students will prepare aluminum surfaces for welding by removing oxides and contaminants. They will demonstrate proper cleaning techniques and explain how oxidation impacts weld quality. This includes using wire brushes and other methods to ensure a clean surface.  **Final Aluminum Fabrication Project** In a capstone project, students will design and fabricate a complex aluminum structure, selecting appropriate joint types and welding techniques. They will incorporate all learned techniques to produce a project that meets industry standards, including layout accuracy, thermal management, and joint quality. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Collaborative Project Planning** Students will collaborate on planning an aluminum fabrication project, discussing roles, timelines, and resource allocation. They will ensure team members understand the specifics of working with aluminum and agree on quality and safety expectations.   * **Leadership Skill:** 6.B.1: Manage time and resources effectively while collaborating with peers on project planning and execution.   **Technical Presentation on Aluminum Properties** Each student will present findings on aluminum's unique properties, including thermal conductivity, oxidation, and strength-to-weight ratio. Presentations will address why these properties make aluminum ideal for specific applications in welding and fabrication.   * **Leadership Skill:** 2.C.1: Communicate complex technical information clearly and accurately to peers and instructors.   **Safety Audit and Inspection Rotation** Students will take turns leading safety inspections, focusing on aluminum-specific hazards like fume management and proper PPE. Each student will provide feedback to peers on safety practices.   * **Leadership Skill:** 11.A.2: Exercise judgment in safety audits, guiding others in risk assessment and best practices for aluminum fabrication.   **Problem-Solving Session on Distortion Management** Students will lead discussions on techniques for controlling distortion in aluminum welding, including clamping methods and pre-heating. Each student will propose and discuss strategies for mitigating distortion during fabrication.   * **Leadership Skill:** 3.B.3: Lead collaborative problem-solving, sharing strategies for overcoming technical challenges.   **Quality Control and Peer Feedback** Students will evaluate each other's projects, providing constructive feedback on weld quality, precision, and adherence to project specifications. They will assess and discuss areas for improvement as a team.  **Leadership Skill:** 7.A.1: Demonstrate teamwork and accountability by engaging in peer assessment to uphold project quality standards. | | | | | |
| **Industry Standards and/or Competencies**: | | | | | |
| **Name of Standards:** AWS D1.2 Structural Welding Code—Aluminum | | | **Website:** [**AWS D1.2 Aluminum Welding Standards**](https://www.aws.org/) | | |
| **1.1: Aluminum Welding Procedures and Safety Standards**  1.1.1: Identify and explain specific safety protocols for aluminum welding, including fume management and PPE requirements.  1.1.2: Interpret technical drawings and specifications for aluminum welding projects.  1.1.3: Select appropriate filler metals and shielding gases based on aluminum alloy composition and thickness.  1.1.4: Perform pre-weld surface cleaning to remove oxides and contaminants for optimal weld quality.  **1.2: Precision Layout and Fabrication Techniques for Aluminum**  1.2.1: Conduct precise layouts for aluminum components, ensuring adherence to tight tolerances.  1.2.2: Select appropriate tools for layout and marking on aluminum, including specialized clamps and measuring devices.  1.2.3: Apply advanced fit-up techniques for complex aluminum joints, maintaining alignment and gap control. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | ***HS-PS1-3: Plan and conduct an investigation to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.***  *Example:* Students will examine the molecular structure of aluminum alloys, analyzing how their bonding and lattice structures affect mechanical strength, weldability, and corrosion resistance in fabrication applications.  **HS-PS1-6:** Refine the design of a chemical system by specifying changes in conditions that would produce increased amounts of products at equilibrium.  *Example:* Students will explore how adjusting shielding gas and filler material compositions can optimize aluminum weld quality by stabilizing the weld pool and reducing oxidation, ensuring the weld maintains structural integrity.  ***HS-PS1-2: Construct and revise an explanation for the outcome of chemical reactions based on electron states, periodic trends, and chemical properties.***  *Example:* Students will investigate oxidation reactions in aluminum, explaining how electron configurations and reactivity with oxygen influence the formation of oxide layers and the need for special welding techniques like GTAW to prevent oxidation during fabrication.  **HS-PS3-4:** Plan and conduct an investigation to provide evidence that the transfer of thermal energy between system components requires conservation principles.  *Example:* Students explore how aluminum’s high thermal conductivity requires unique heat management techniques in fabrication, adjusting parameters to maintain consistent weld quality without overheating surrounding areas.  **HS-ETS1-1:** Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions.  *Example:* Students research the global demand for lightweight, corrosion-resistant aluminum in fabrication and analyze engineering challenges, such as material strength and recyclability, when producing sustainable welding solutions.  **HS-ETS1-3:** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, and reliability.  *Example:* Students evaluate different welding techniques for aluminum, assessing cost-effectiveness, safety, and durability to determine the optimal approach for aluminum structures in high-stress applications like aerospace or maritime. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
| Obtaining, Evaluating, and Communicating Information; Analyzing and Interpreting Data | | PS1.A: Structure and Properties of Matter; PS3.B: Conservation of Energy; ETS1.A: Defining Problems | | Energy and Matter; Stability and Change; Structure and Function | |

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| **Unit 12:** Welding Quality Control | | | | | **Total Learning Hours for Unit:** 10 |
| **Unit Summary**: This unit emphasizes the welder’s role as the first line of quality control. Students learn to assess weld quality against industry standards, focusing on reading and adhering to Welding Procedure Specifications (WPS). They develop skills in identifying common defects and taking corrective actions, interpreting quality control guidelines, documenting weld quality, and understanding the importance of maintaining high standards in welding work. | | | | | |
| **Performance Assessments**:(Districts to complete for each unit)  **WPS Adherence Exercise** Students follow a specific Welding Procedure Specification (WPS) to perform welds, documenting each step to ensure compliance with parameters such as heat input, travel speed, and material specifications.  **Visual Inspection of Weld Quality** Students inspect welds according to AWS standards, identifying defects such as porosity or inconsistent bead appearance. They document findings and determine whether welds meet quality standards.  **Non-Destructive Testing (NDT) Simulation** Students conduct mock non-destructive testing (e.g., dye penetrant test) to evaluate weld integrity. They analyze results, identify potential issues, and propose corrective measures to ensure structural soundness.  **Mock Certification Inspection**  Conduct a peer-led inspection where students evaluate each other’s welds based on AWS quality standards. Each student plays the role of an inspector, applying fillet gauges, calipers, and visual inspection techniques to assess bead uniformity, penetration, and surface quality.  **Defect Detection and Analysis Lab**  Students perform welds on aluminum and carbon steel in various positions. Afterward, they conduct a self-inspection, identifying potential defects like porosity, cracking, or undercutting. They analyze root causes for any detected defects and document corrective actions to improve weld quality.  **Corrective Action Plan for Defects** Students develop a corrective action plan based on inspection results, adjusting welding parameters or techniques to address and prevent identified defects in future welds.  **Quality Control Documentation Report** Students compile a report summarizing inspection outcomes, corrective actions taken, and final quality assessments. The report should communicate weld quality clearly and professionally, demonstrating their adherence to industry standards. | | | | | |
| **Leadership Alignment**: (Districts to complete for each unit)  **Team-Based Quality Inspection**  Students lead a team in conducting quality inspections of group projects, ensuring all team members contribute to analysis and reporting.   * Leadership Skill: 3.B.3: Effectively share responsibility in collaborative quality assessments.   **Organized Problem-Solving for Defect Correction**  Students analyze common defects, and propose solutions and corrective actions.   * Leadership Skill: 7.A.1: Adapt to problem-solving roles in complex quality challenges.   **Time Management in Inspection Procedures**  Students practice managing time effectively during inspection tasks, ensuring completion of assessments within set deadlines.   * Leadership Skill: 8.A.3: Prioritize and manage time for quality control tasks.   **Documentation Standards**  Students standardize reporting procedures, ensuring all inspection findings are presented clearly and professionally.  Leadership Skill: 10.A.2: Demonstrate accuracy and thoroughness in quality documentation. | | | | | |
| **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: Identify Welding Codes, Qualifications and Certifications**  1.1.1 Identify and explain weld imperfections and their causes.  1.1.2 Identify and explain welder qualification tests.  1.1.3 Explain the importance of quality workmanship.  1.1.4 Identify common destructive testing methods.  1.1.5 Perform a visual inspection of fillet welds.  **1.2: Demonstrate Welding Inspection and Testing Principles**  1.2.1 Define the role of welding inspection/inspector and testing in industry.  1.2.2 Examine cut surfaces and edges of prepared base metal parts.  1.2.3 Examine tack, root passes, intermediate layers, and completed welds. | | | | | |
| **Aligned Washington State Academic Standards** | | | | | |
| **Science** | **HS-ETS1-3:** Evaluate solutions based on criteria such as cost, safety, reliability, and industry quality standards. *Example:* Students assess welds by comparing each to American Welding Society (AWS) standards, examining factors like weld bead consistency, structural integrity, and defect rates to determine quality and compliance with industry benchmarks. | | | | |
| **Science and Engineering Practice** | | **Disciplinary Core Idea** | | **Crosscutting Concept** | |
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