EVERETT PUBLIC SCHOOLS
FOUNDATIONS OF MANUFACTURING

Course: Foundations of Manufacturing		**Total Framework Hours:** 540
CIP Code: 150613	☐Exploratory ☐Preparatory	**Date Last Modified:** 07.2019
Career Cluster: Manufacturing		**Cluster Pathway:** Manufacturing Production Process Development

Industry-Recognized Certificates:

Work-Based Learning:

Course Information:
Resources Used: Aerospace Joint Apprenticeship Committee (AJAC), American Society of Metals (ASM), Boeing, Federal Aviation Association (FAA), National STEM Consortium (NSC), Non-Destructive Resource Center (NDT), and other industry-accepted knowledge, skills and abilities (KSA).

COMPONENTS AND ASSESSMENTS

Performance Assessments:
Assessments will be formal and informal, written, verbal and practical:
Lesson 1:

- Handout: Scope and Sequence for Classifying Matter
- Activity: General Comparison of Properties: Metals, Ceramics, Polymers Overhead
- Introductory Activity – Oobleck
- Activity: The Stuff of History
- Lab: A Physical Challenge Lab – Can elements be classified by physical properties?
- Lab: White Powder
- Lab: Materials ID
- Overheads/handouts: Classification of Materials
- Overheads/handouts: Types of Bonding
- Overheads/handouts: Types of Properties
- Handout: Materials ID Descriptions
- Student Booklet: Reading, Writing, and Activities

Lesson 2:

- Lab: Sulfur
- Lab: Rhombic Sulfur
- Lab: Amorphous Sulfur
- Activity 1: Copper Sulfate Demonstration (Growing single crystals)
- Activity 2: Phenyl Salicylate Demonstration

- Lab: Growing Silver Crystals
- Lab: Models of Crystals
- Activity: Iron Wire Demo
- Activity 3: Copper Wire Demonstration
- Lab: Heat – Treating Steel
- Lab: Heat Treating Iron
- Activity: Journaling
- Extra Activities: MAST Module Metals – Experiment 3 Processing Metals and Experiment 4 Tensile Strength Test for Various Metals
- Student Booklet: Reading, Writing, and Activities

Lesson 3:

- Lab: Metal Stations
  - Cost of a Penny
  - Brassing a Penny
  - Penny and Electricity (Rolling of a Penny)
- Lab: Reactivity of Metals
- Lab: Fruit Juice
- Lab: NACE Kit Labs
- Activity: Compression Ignition Demonstration
- Activity: Demonstration – Aluminum and HCI
- Activity: Aluminum Coating and Protection
- Student Booklet: Reading, Writing, and Activities

Lesson 4:

Module 1: Chemistry for Composites

Note: There are multiple activities and labs to choose from. Select which ones are appropriate for your class and where you have the equipment and supplies.

Addendum includes:

- Activity 1: Nylon Polymerization
- Activity 2: Match the Fabric to the Label
- Activity 3: Weaves
- Activity 4: Cardboard Laminate
- Lab: Honeycomb Panel
- Lab: Fiberglass Hand Layup
- Lab: Composite Panel Repair
- Lab: Foam Core Composites
- Lab: Wet Lay-Up
- Lab: Wet Lay-Up with Foam Core
- Lab: Wet Lay-Up in Mold
- Lab: Vacuum Bagging Wet Lay-Up
- Lab: Resin Infusion
- Lab: Vacuum Bagging PrePreg
- Lab: Vacuum Bagging PrePreg with Foam Core
- Lab: Vacuum Bagging PrePreg with Honeycomb
- Lab: Isotropic Panel (Clipboard), 2-Day Minimum

Module 2: Structure and Repair I

- Student Quiz

Module 3: Structure and Repair II
Student Quiz

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects (individual and group), activities, and class discussions.

Standards and Competencies

Unit: Materials Science

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 140

- Explain the importance of materials sciences.
- Apply basic chemistry to explain physical and chemical characteristics of the four categories of materials.
- Apply knowledge of materials science to explain materials choices in design.
- Use critical thinking to evaluate and apply appropriate materials choice for specific applications.
- Demonstrate practical reasoning, and hands-on/minds-on, problem-solving skills in designing, fabricating, and constructing projects during the course.
- Use writing to record observations, procedures, and experiments and as a tool for thinking, studying, and learning the subject matter.
- Define materials science and how it has changed through history.
- Classify matter.
- Summarize the spatial relationships found on the Periodic Table of Elements.
- Define types of structure, crystalline vs. amorphous.
- Define types of bonding.
- Identify types of properties.
- Relate properties to types of bonding.
- Describe through writing and discussion the basic properties of materials: mechanical, thermal, chemical, optical, and magnetic.
- Characterize materials on the basis of chemical bonding and crystal structure.
- Distinguish between crystal structure and crystal system.
- Describe the relationship between atomic radius and lattice parameter.
- Compare and contrast crystalline and amorphous structures.
- Provide examples of materials that change among amorphous and crystalline states.
- Describe the effect of crystal defects and imperfections in material properties.
- List several common materials used in the design and construction of structures.
- Define simple properties of materials, such as strength, flexibility, transparency.
- Select suitable materials for making a particular object based on their properties.
- Explain the advantages and disadvantages of common materials used in engineering structures.
- Distinguish between chemical and physical properties of a material.
- Differentiate between oxidation and reduction especially as they pertain to galvanic corrosion.
- Define thermal expansion.
- Evaluate the effects of thermal expansion on design considerations.
- Describe the response to force or stress using the terms: workability (malleability and ductility), brittleness, hardness, elasticity and plasticity, toughness, and strength.
- Define mechanical properties: tensile strength, compression, fatigue, flexure, impact, torsion, hardness, and shear.
- Relate the physical characteristics of materials such as workability and brittleness to the mechanical properties such as tensile and compressive strength to impact design considerations.
- Describe composite materials.
- Explain the use of ancillary materials.
- Demonstrate basic fabrication techniques.

• Define fiber-reinforced composites. • Discuss properties of composites. • Recognize products made from fiber-reinforced composites. • Explain the differences between polymers and composites. • Explain the key differences between composites properties and metal properties. • Calculate resin-fiber ratio. • Fabricate a fiber reinforced composite part. • Demonstrate safe fabrication practices. • Define and prevent resin migration and materials contamination	
Aligned Washington State Learning Standards	
Educational Technology	5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions. 1.a. Students articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes
English Language Arts	**CCSS English Language Arts: *Informational Text*** 4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). 5 Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging. 7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. **CCSS English Language Arts: Writing** 2. Text Types and Purposes Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. 2a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. 2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). 3. Text Types and Purposes Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences. 3d. Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters. 3e. Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative. 10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences. **CCSS English Language Art: *Speaking & Listening*** 1a. Comprehension and Collaboration-Initiate and participate effectively in a range of collaborative discussions (one on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

	1c. Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives. 2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data **CCSS English Language Arts: Language** 1. Conventions of Standard English Demonstrate command of the conventions of Standard English grammar and usage when writing or speaking. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. 2a. Observe hyphenation conventions. 2b. Spell correctly. 4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, choosing flexibly from a range of strategies. 4c. Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage. 6. Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. **CCSS English Language Arts: Social Studies and Science & Technical Subjects** RH 1 Cite specific textual evidence to support analysis of primary and secondary sources, connecting insights gained from specific details to an understanding of the text as a whole. RH 2 Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas. RH 7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem. RH 9 Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources. RST 3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. RST 4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. RST 7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. RST 8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. RST 9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3. The student analyzes and evaluates the impact of real-life influences on health. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1. Make sense of problems and persevere in solving them

	MP 2. Reason abstractly and quantitatively. MP 4. Model with mathematics. MP 5. Use appropriate tools strategically. MP 6. Attend to precision. MP 7. Look for and make use of structure. MP 8. Look for and express regularity in repeated reasoning. N-Q.A Reason Quantitatively and use units to solve problems. N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. G-CO.A Experiment with transformation in the plane. G-SRT.AUnderstand similarity in terms of similarity transformation

COMPONENTS AND ASSESSMENTS

Performance Assessment(s):

Assessments will be formal and informal, written, verbal and practical:

Lesson 1:

- Hand Tools ID Activity

Lesson 2:

- Class Discussion

Lesson 3:

- Power Shop Equipment Test

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Shop Tools

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 20

- Articulate tool use hazards and main causes for hand tool mishaps.
- List the workplace tasks that require hand tools to accomplish.
- Describe and select the appropriate hand tool to accomplish a particular workplace task.
- Distinguish between tools that are similar in appearance, stating the commonly used terms for each tool and normal routine application.
- Explain basic techniques and proper use of hand tools.
- Identify and use equipment and tools for manufacturing.
- Use portable power hand tools, including pistol grip drill motor, rivet gun, ratchet wrench, Microstop Countersink Cage, Lockbolt Puller, and Hi-Lok Ratchet Wrench, Nut Runner and Torque Wrench appropriately and safely.
- Interpret a drawing to lay out a job, including the placement of holes, and selection of appropriate tools and fasteners to perform the job.
- Use gages appropriately.
- Install Lockwire.
- Complete the job, per drawing specifications, in accord with the instructor’s performance criteria.
- Articulate general safety hazards associated with the operation of installed power shop equipment.
- List workplace tasks or functions that require power shop equipment to accomplish.
- Describe and select the appropriate power equipment to accomplish a particular workplace function.
- Explain the potential hazards of each individual power shop machine.
- List and point to the safety controls used for each power shop machine and items to inspect prior to use.

- Specify the features and major components of each shop machine in this Unit.
- Explain basic techniques and proper use of common power shop equipment and machinery, including the drill press, disk sander, belt sander, pedestal grinder, band saw, and the manual foot shear.

Aligned Washington State Learning Standards	
Educational Technology	5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving. 6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations. 7.c. Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.
English Language Arts	**CCSS English/Language Arts: *Reading-Informational Text*** 3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text. 4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). 7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. 10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range. **CCSS English/Language Arts: *Writing*** 2 Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. 2A Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. 2C Use appropriate and varied transitions and syntax to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. 2D Use precise language, domain-specific vocabulary, and techniques such as metaphor, simile, and analogy to manage the complexity of the topic. 4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience (Grade-specific expectations for writing types are defined in standards 1-3 above.) 7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. 10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences. **CCSS English Language Arts: Speaking & Listening** 1.a Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. 1.c Propel conversations by posing and responding to questions that probe reasoning and evidence; ensure a hearing for a full range of positions on a topic or issue; clarify, verify, or challenge ideas and conclusions; and promote divergent and creative perspectives.

	2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. 3 Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used. **CCSS English Language Arts: Language** 4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, choosing flexibly from a range of strategies 4A Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. 4B Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable). 4C Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage. 4D Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary). 6 Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. **CCSS English Language Arts: Science and Technical Subjects** 11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. 11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics. 11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. 11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. 11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Health and Physical Education	1. The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3. The student analyzes and evaluates the impact of real-life influences on health. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.Q.A: Reason quantitatively and use units to solve problems. N-Q.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N-Q.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

COMPONENTS AND ASSESSMENTS
Performance Assessments: Assessments will be formal and informal, written, verbal and practical:

Lesson 1:
- [1]Math Worksheet: Interpreting Occupational Injury and Illness Data
- Test

Lesson 2:
- [1]Tombstone Project

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Safety

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 20

- Student will be able to describe EHS programs
- Student will be able to practice HazCom
- Student will be able to practice Erognomics
- Student will be able to describe regulations
- Student will be able to model Human Factors
- Student will be able to practice SOP
- Student will be able to demonstrate and use PPE
- Student will be able to identify lockout/tagout
- Student will be able to practice hand power tool safety
- Student will be able to practice industrial housekeeping
- Student will be able to practice environmental safety
- Demonstrate safe practices, including choice of proper PPE, in the use of hand tools such as punch, files, deburring tools, shear, and brake.
- Demonstrate safe practices, including choice of proper PPE, in the use of handheld power tools such as drills.
- Demonstrate safe practices in the use of floor-mounted horizontal band saw and drill press.
- Locate, select, and interpret Material Safety Data Sheets (MSDS) for various materials called out in a project.
- Explain SOPs of the school laboratory.
- Evaluate a situation and design a safety alternative accounting for a range of constraints.
- Appropriately document the use of materials and manufacture of a project consistent with institution policy Quality Management System (QMS).

Aligned Washington State Learning Standards

Educational Technology	1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways. 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. 3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits. 3.c. Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions. 3.d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. 4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. 4.c. Students develop, test and refine prototypes as part of a cyclical design process. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.

	5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
English Language Arts	**CCSS English/Language Arts: *Reading*** Integration of Knowledge and Ideas Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. **CCSS English Language Arts: *Writing*** 2. Text Types and Purposes Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. 2a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. 2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). Range of Writing Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences. **CCSS English Language Arts: Speaking & Listening** 1a. Comprehension and Collaboration 1. Initiate and participate effectively in a range of collaborative discussions (one on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. **CCSS English Language Arts: Language** 1. Conventions of Standard English Demonstrate command of the conventions of Standard English grammar and usage when writing or speaking. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. a. Observe hyphenation conventions. b. Spell correctly.
Health and Physical Education	1. The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3. The student analyzes and evaluates the impact of real-life influences on health. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP2: Reason abstractly and quantitatively S-IC.B Making inference and justifying conclusions S-IC.B.3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. MP4 Model with mathematics MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.Q.A: Reason quantitatively and use units to solve problems. N-Q.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

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

COMPONENTS AND ASSESSMENTS

Performance Assessments:
Assessments will be formal and informal, written, verbal and practical:
Lesson 1:

- Math Worksheet: Late to Work
- Student Booklet: Readings, Questions, Assignments and Activities

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Standard Operating Procedures

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 20

- Define QMS.
- Describe the “enterprise level” of QMS.
- Explain the hierarchy of a manufacturing production order.
- Identify and document a standardized process in their environment.
- Demonstrate knowledge of SOP.
- Evaluate and design revisions required for increase/effective the enterprise QMS.
- Define Root Cause Analysis in fundamental terms

Aligned Washington State Learning Standards

Educational Technology	5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making. 5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving. 5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions. 6.a. Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication. 6.b. Students create original works or responsibly repurpose or remix digital resources into new creations. 6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations. 6.d. Students publish or present content that customizes the message and medium for their intended audiences.
English Language Arts	**CCSS English Language Arts: Reading** Integration of Knowledge and Ideas Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. **CCSS English Language Arts: Writing** 2. Text Types and Purposes Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. 2a. Introduce a topic; organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.

	2f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). Range of Writing Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences. **CCSS English Language Arts: Speaking & Listening** 1a. Comprehension and Collaboration 1. Initiate and participate effectively in a range of collaborative discussions (one on-one, in groups, and teacher-led) with diverse partners on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. CCSS English Language Arts: Language 1. Conventions of Standard English Demonstrate command of the conventions of Standard English grammar and usage when writing or speaking. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. 2. Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing. a. Observe hyphenation conventions. b. Spell correctly.
Mathematics	MP2: Reason abstractly and quantitatively S-IC.B Making inference and justifying conclusions S-IC.B.3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical:

Lesson 1:

- Math Worksheet: Solving for Radical Solutions
- Student Booklet: Semi-Precision Measurement:
  - Using a Scale
  - Reading a Scale

Lesson 2:

- Student Booklet: Geometric Dimensioning & Tolerancing

Lesson 3

- Worksheets 1 and 2: Reading a Micrometer
- Lab Activity: Practicing Precision Measurement
- Exam: Measurement covers Lessons 1, 2, and 3
- Student Booklet: Precision Measurement
  - 6-Inch Dial Calipers
  - Micrometers
  - Ball Gages

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Precision Measurement

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 20

- Define Semi-Precision Measurement and identify units used.
- Explain the care and handling procedures of semi-precision measurement tools.
- Read a 1/64th English Rule (machinist's scale).
- Identify the Geometric Dimensioning and Tolerancing (GD&T) symbols that represent specific tolerances.
- Read a Feature Control Frame
- Define Precision Measurement and units used.
- Explain care and handling procedures of Precision Measurement tools, and the need and procedure for calibration.
- Identify the parts and read a caliper (Vernier and/or dial).
- Identify the parts and read an outside Micrometer.

Aligned Washington State Learning Standards	
Educational Technology	7.a. Students use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning. 7.b. Students use collaborative technologies to work with others, including peers, experts, or community members, to examine issues and problems from multiple viewpoints. 7.c. Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal. 7.d. Students explore local and global issues and use collaborative technologies to work with others to investigate solutions.
English Language Arts	**CCSS English Language Arts: *Reading-Informational Text*** 11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). 11-12.5 Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging. 11-12.6 Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness, or beauty of the text. 11-12.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. 11-12.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range. **CCSS English Language Arts: *Writing*** 11-12.2 Text Type and Purposes: Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content. 11-12.6 Production and Distribution of Writing: Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information. 11-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation 11-12.8 Research to Build and Present Knowledge Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. **CCSS English/Language Arts: *Speaking & Listening***

	11-12.1 Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 11-12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively. 11-12.2 Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas. 11-12.1D Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what additional information or research is required to deepen the investigation or complete the task.
Mathematics	1Math Worksheet: Solving for Radical Solutions (Addendum) MP1: Make sense of problems and persevere in solving them. A-REI.B: Reasoning with Equations and Inequalities. A-REI.B.4: Solve quadratic equations in one variable. 1 Semi-Precision Measurement Practice: Using and Reading a Scale MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.A: Reason quantitatively and use units to solve problems. N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N-Q.A.3: C1hoose a level of accuracy appropriate to limitations on measurement when reporting quantities. MP6: Attend to precision. G-GMD.B: Visualize relationships between two-dimensional and three-dimensional objects. G-MG.A: Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects. MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.A: Reason quantitatively and use units to solve problems. N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical:

Lesson 1

- Worksheet - Thread Measurement: Three Wire Method
- Practice Review Quiz
- Nut & Bolt Installation Activity

Lesson 2

- Practice Review Quiz
- Permanent Fastener Installation Activity

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Fasteners

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 10
• Identify the components of a fastening system using nuts & bolts • Indicate and describe the standard features of bolts and nuts • Specify the materials from which bolts & nuts are made • Identify protruding bolt head style • Summarize the use of lubricants and locking devices with nuts & bolts • Distinguish between sheer and tension as types of stress/load on installed bolts • List the four forces acting on installed bolts • Explain the significance of measuring KSI Tensile strength and KSI Shear Strength • Use a Grip Scale to verify bolt length • Measure interior diameter of a drilled hole using a hole gage and micrometer • Demonstrate the normal installation of bolts • Categorize torque wrench types • Properly operate a torque wrench • Identify the components of a fastening system using hex-drive fasteners and lockbolts. • Indicate and describe the standard features of hex-drive fasteners and lockbolts. • Distinguish between Hi-Lite and Hi-Lok fasteners and explain the different uses for which they may installed. • Using a power drill motor, socket, and hex drive wrench, demonstrate the normal installation of hex-drive fasteners such as Hi-Lites and Hi-Loks. • Distinguish protruding head from flush head fasteners. • Explain the limitations and normal use of washers when installing fasteners on aircraft. • Summarize inspection checks done after fastener installation. • Demonstrate the proper removal of hex drive fasteners. • Point out features of lockbolts, explaining how they are used to securely fasten parts or sheets of material together. • State the safety considerations when using a lockbolt puller. • Describe or demonstrate normal procedures for installation of lockbolt fasteners. • Distinguish lockbolt installations that are acceptable from those that are unacceptable	
Aligned Washington State Learning Standards	
Educational Technology	1.b. Students build networks and customize their learning environments in ways that support the learning process. 2.b. Students engage in positive, safe, legal, and ethical behavior when using technology, including social interactions online or when using networked devices. 4.d. Students exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions. 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
English Language Arts	***CCSS English/Language Arts: Reading*** 11-12.3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text. 11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). 11-12.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.

	11-12.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range. **CCSS English/Language Arts: *Writing*** 11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10). 11-12.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. 11-12.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range. **CCSS English/Language Arts: *Speaking & Listening*** 11-12.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matter uncertain. 11-12.3 Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text. Analyze a complex set of ideas or sequence of events and explain how specific individuals, ideas, or events interact and develop over the course of the text. 11-12.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings; analyze how an author uses and refines the meaning of a key term or terms over the course of a text (e.g., how Madison defines faction in Federalist No. 10) 11-12.7 Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem. 11-12.10 By the end of grade 11, read and comprehend literary nonfiction in the grades 11-CCR text complexity band proficiently, with scaffolding as needed at the high end of the range. **CCSS English/Language Arts: *Language*** 11-12.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11-12 reading and content, choosing flexibly from a range of strategies. 11-12.4AUse context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase. 11-12.4 B Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable). 11-12.4C Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, it's part of speech, its etymology, or its standard usage. 11-12.4D Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
Mathematics	1Worksheet - Thread Measurement: Three Wire Method MP4 Model with mathematics. MP5 Use appropriate tools strategically. F-BF.A.1.A Write a function that describes a relationship between two quantities.

	F-BF.A.1.B Build new functions from existing functions. 1Nut & Bolt Installation Activity MP4 Model with mathematics MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.B: Reason quantitatively and use units to solve problems. N-Q.B.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects. 1 Permanent Fastener Activity MP4 Model with mathematics MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.A: Reason quantitatively and use units to solve problems. N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.

COMPONENTS AND ASSESSMENTS

Performance Assessments:
Assessments will be formal and informal, written, verbal and practical.
Lesson 1:

- Worksheet: Keep Batch or Not? Standard Deviation
- Practice Review Quiz

Lesson 2:

- Practice Review Quiz

Practical Drilling Activity

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Drilling

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 10

- Identify the characteristics of a properly drilled hole in aluminum in accordance with specifications and industry standards.
- State the importance of creating quality holes in aluminum structure.
- State the qualities of a properly drilled and accurate hole.
- Identify proper drilling equipment (Size, Type and Speed) required for drilling.
- Convert available fractional drill sizes to the required decimal equivalent drill bit needed, using the decimal equivalency card.
- Correctly select the drill guide for the drill bit being used.
- Define and explain the function to the component parts of a counter sink.
- Identify countersink cutters.
- Set a stop countersink for a specific fastener hole location.
- Identify the correct deburring / chamfering tool.
- Provide definition and function to the acceptable and preferred deburring tools.
- Define fastener relief requirements.

- Identify proper drilling equipment (Size, Type and Speed) required for drilling.
- Convert available fractional drill sizes to the required decimal equivalent drill bit needed for a task, using the decimal equivalency card to convert.
- Correctly select the appropriate drill guide for the drill bit being used.
- Set-up a stop countersink for a specific fastener hole location.
- Select and apply the correct deburring / chamfering tool.
- Identify and wear Personal Protection Equipment (PPE) and safe drilling apparel.
- Demonstrate proper drill motor ergonomics while drilling fastener holes in aluminum structures.
- Drill holes in Aluminum that meet quality requirements.
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Aligned Washington State Learning Standards	
Educational Technology	4.d. Students exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems. 5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions. 6.a. Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
Mathematics	MP 1 Reason abstractly and quantitatively. MP6 Attend to precision. S-ID.A Summarize, represent, and interpret data on a single count or measurement variable. S-IC.B Make inferences and justify conclusions from sample surveys, experiments and observational studies. S-MD.A Calculate expected values and use them to solve problems. MP4 Model with mathematics MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.A: Reason quantitatively and use units to solve problems. N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical.

Lesson 1:

- Lab Project: Making a Star

Lesson 2:

- Lab Project: Square Up a Block, Including Tramming
- Booklet includes:
  - Worksheet: Calculating the RPM for Milling Machines
  - Worksheet: Feed Rate
  - Worksheet: Identify Parts of Milling Machine
  - Notes and Worksheet: Cartesian Plane Practice

Lesson 3:

- Lab Project: Lathe Component

Lesson 4:

- Cutting & Grinding Quiz
- Lab Project: Surface Grinding Project

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Cutting & Grinding

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 20

- Adhere to machine shop safety guidelines.
- Demonstrate knowledge of sawing vocabulary.
- Select the appropriate cutting tool.
- Compare and contrast horizontal and vertical band saws.
- Demonstrate safety guidelines specific to horizontal and vertical band saws.
- Apply their knowledge of band saws with a hands-on project.
- Understand the primary uses and benefits of a milling machine.
- Calculate the RPM and Feed Rate of a milling machine.
- Draw and model plotting on the Cartesian 2-D and 3-D planes.
- Critically examine the factors to consider before using a milling machine.
- Demonstrate knowledge of the safety SOP's of a milling machine.
- List the parts of a milling machine.
- Build a project using a milling machine.
- Describe the features of an engine lathe.
- Identify the primary uses of a lathe.
- Describe a lathe's operating procedure.
- Demonstrate knowledge of the safety SOP's of a lathe.
- Use appropriate tooling to produce the project part.
- Explain the primary uses of a surface grinder.
- Demonstrate knowledge on how surface grinders work.
- Exhibit awareness of how to select the appropriate grinding wheel for a workpiece.
- Describe the SOP's of a surface grinder.
- Apply their knowledge of a surface grinder machine by grinding a part (assuming a surface grinder is available).

Aligned Washington State Learning Standards

Educational Technology	1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways. 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. 4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
Mathematics	Lab Project: Making a Star MP1 Make sense of a problem and persevere in solving them. MP4 Model with mathematics N-Q.A Quantities - Reason quantitatively and use units to solve problems. A-SSE.A Interpret the structure of expressions. A-SSE.A.1.A Interpret parts of an expression, such as terms, factors, and coefficients. A-SSE.A.2 Write expressions in equivalent forms to solve problems. G-SRT.D Apply trigonometry to general triangles.

	G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects. G-MG.A Apply geometric concepts in modeling situations. G-MG.A.3 Apply geometric methods to solve design problems. Lab Project: Square Up a Block, Including Tramming (in Addendum) MP4 Model with mathematics MP5 Use appropriate tools strategically MP6 Attend to precision N-Q.A Quantities - Reason quantitatively and use units to solve problems. N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. G-MG.A Visualize relationships between two-dimensional and three-dimensional objects. G-MG.A.3 Apply geometric methods to solve design problems. Instructor and Student Booklet Worksheets: RPM and Feed Rate calculations MP6 Attend to precision. N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. Cartesian Plane MP4 Model with mathematics G-MD.B Visualize relationships between two-dimensional and three-dimensional objects. Lab Project: Lathe Component MP4 Model with mathematics MP5 Use appropriate tools strategically MP6 Attend to precision N-Q.A Quantities - Reason quantitatively and use units to solve problems. N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. G-MG.A Visualize relationships between two-dimensional and three-dimensional objects. G-MG.A.3 Apply geometric methods to solve design problems. Lab Project: Surface Grinder MP5 Use appropriate tools strategically MP6 Attend to precision N-Q.A Quantities - Reason quantitatively and use units to solve problems. N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical.

Lesson 1:

- Practice Review

Lesson 2:

- Riveting Installation Activity
- Riveting Project Questions
- Worksheet: Rivets – What's the Chance?

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions

Standards and Competencies

Unit: Riveting	
Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 10

- Understand basic rivet gun usage and rivet die selection.
- Identify and describe the features of solid shank rivets.
- Distinguish between the two most common types of rivet heads.
- Demonstrate how rivet length is measured with a grip gage.
- Apply knowledge to select and use the appropriate bucking bar for a particular rivet installation.
- Specify the rivet removal process and when it might be required.
- Explain how to rivet parts together permanently using a rivet gun and bucking bar.
- Classify rivet installations as acceptable or unacceptable according to industry standards.
- Measure and lay-up a sheet metal project.
- Drill holes at correct points.
- Operate an automatic hole punch.
- Operate a Throatless shear.
- Operate a box brake to bend sheet metal.
- Assemble parts using Cleco fasteners.
- Rivet parts together permanently using a rivet gun and bucking bar.

Aligned Washington State Learning Standards	
Educational Technology	2.c. Students demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property. 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. 1.a. Students articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.
Mathematics	Riveting Installation Activity MP5 Use appropriate tools strategically MP6 Attend to precision N-Q.A Quantities - Reason quantitatively and use units to solve problems. N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. Worksheet: Rivets – What's the Chance? MP8 Look for and express regularity in repeated reasoning. SS-CPA.A Understand independence and conditional probability and use them to interpret data. SS-CPA.A.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. SS-CP.B Use the rules of probability to compute probabilities of compound events. SS-CP.B.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A and interpret the answer in terms of the model. SS-CP.B.8 (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.

COMPONENTS AND ASSESSMENTS
Performance Assessments: Assessments will be formal and informal, written, verbal and practical.

Lesson 1:
- PowerPoint Activities
- Activities: Identifying Lines and Interpreting Drawings

Lesson 2:
- PowerPoint Activities
- Activity: Orthographic View Drawing Worksheet #1: Drawing a Book
- Activities: Creating Cutouts, Isometric and Orthographic Drawings of Cut-Outs, More Orthographic Drawings
- Activity: Identifying Sectional Views Worksheet
- Activity: Practice Review on Views
- Activity: Lines and Symbols Worksheet

Lesson 3:
- Unit Project: Constructing and Drawing a Sliced Cube within Tolerance

Group Activity: Guessing Production Tolerance

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Print Reading

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 30

- Understand fundamental terminology related to prints and drawings.
- Recognize drawing categories.
- Apply drawing authorities.
- Recognize and interpret the elements found on a picture sheet.
- Locate the Title Block on a drawing and identify the name, purpose of a drawing, and other fields depicted.
- Interpret geometric elements in a drawing.
- Identify the Alphabet of Lines.
- Interpret and construct isometric views.
- Interpret and construct an orthographic view.
- Identify types of views, including detail views, sectional views, auxiliary views, and be able to interpret cutting lines.
- Interpret common drawing symbols used in industry.
- Identify types of dimensioning: linear, progressive, typical, equally spaced, angles, arcs, cylinders, holes, size, location, baseline, and tabular.
- Explain the purpose of tolerances.
- Calculate decimal and fraction tolerances.
- Identify classes of fits.
- Construct a model within tolerance, given a drawing.

Aligned Washington State Learning Standards

Educational Technology	1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. 2.c. Students demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property. 3.b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources. 3.c. Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.

Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices
Mathematics	MP4: Model with mathematics. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. MP4: Model with mathematics. MP5: Use appropriate tools strategically. N-Q.A Reason quantitatively and use units to solve problems. G-CO.A Experiment with transformations in the plane G-CO.A.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. G-MG.A Apply geometric concepts in modeling situations G-MG.A.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).* Unit Project: Constructing and Drawing a Sliced Cube within Tolerance MP1: Make sense of problems and persevere in solving them. MP4: Model with mathematics. MP5: Use appropriate tools strategically. MP6: Attend to precision. N-Q.A Reason quantitatively and use units to solve problems. G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. G-MG.A Apply geometric concepts in modeling situations G-MG.A.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder). Group Activity: Guessing Production Tolerance MP2: Reason abstractly and quantitatively. MP6: Attend to precision. N-Q.A Reason quantitatively and use units to solve problems. N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. S-IC.B Make inferences and justify conclusions from sample surveys, experiments, and observational studies S-IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

COMPONENTS AND ASSESSMENTS
Performance Assessments:

Assessments will be formal and informal, written, verbal and practical.

Lesson 1:

- Worksheets 1 and 2: Mass/Weight/Gravity and Density/Mass/Volume Calculations
- Lab: Which is Denser?
- Quiz

Lesson 2:

- Worksheet: Vectors
- Quiz

Lesson 3:

- Mechanical Advantage Try These (PowerPoint)
- Torque/Lever Activity (Addendum)
- Simple and Complex Machines Lab Activity (Addendum)
- Paper Airplane Contest (PowerPoint)

Lesson 4:

- Dust-Off Activity: Measuring Temperature (embedded in PowerPoint)
- Worksheet: Converting BTU to ft-lb and vice versa (found in Addendum)
- Worksheet: Calculate Thermal Expansion (found in Addendum)
- Psi Activity (embedded in PowerPoint)
- Worksheet: Calculate Pressure (found in Addendum)
- Suction Cup Activity (embedded in PowerPoint)

Lesson 5:

- Worksheet: Gas Law Calculations (found in Booklet)
- Buoyancy Force 'Try These' (embedded in PowerPoint)
- Buoyancy Force Activity (found in Booklet)
- Worksheet: Physics Conversions (found in Booklet)

Lesson 6:

- Laser Article and Question (found in Booklet)
- Laser Level Activity (found in Booklet)
- Final Physics Exam (found in Addendum)

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Applied Physics

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 30

- Define physics.
- Explain the relationship between matter and mass and name the three states of matter.
- Define weight and gravity, and how weight relates to mass.
- Solve for weight, mass and gravity using the given formula(s) and using appropriate units.
- Define density and solve for density, mass, volume using the given formula(s) and using appropriate units.
- Define Specific Gravity and calculate a Specific Gravity ratio given density or weight of an object.
- Define energy and name the two types of energy in objects.
- Define force, work, and power.
- Apply the appropriate English and Metric units to force, work, and power.

- Describe the force of friction.
- Apply torque and identify its units.
- Convert between Horsepower and watts.
- Define machines and identify simple machines.
- Distinguish between different types of levers and inclined planes.
- Define mechanical advantage and calculate it using force/distance variables.
- Solve for mechanical work using effort and resistance variables.
- Define stress and its effects; define motion.
- Distinguish between speed and velocity; explain how they are related to acceleration.
- Define heat, its relation to kinetic energy, and its units in both English and Metric.
- List and describe forms of energy which can be converted to heat.
- Explain how heat is transferred and list three methods of heat transfer.
- Define Thermal Efficiency.
- Define Specific Heat and solve for Thermal Expansion.
- Define pressure, list different pressure gauges, and practice solving for psi.
- Define gas laws, and use them to solve for pressure, temperature, or volume.
- Identify the various components of air.
- Explain wave phenomena.
- Define wave vocabulary, including units.
- Identify the classifications of waves.
- Explain the electromagnetic spectrum in terms of why some waves are visible and others are not visible by the naked eye.
- Learn how light waves are used in industry.
- Summarize how lasers work and their uses in industry.
- Paraphrase specific safety guidelines when working with lasers.
- Explain how density is dependent on temperature and pressure.
- Define buoyancy and determine if something will sink or float using the buoyancy formula.
- Calculate conversion problems.
- Explain wave phenomena.
- Define wave vocabulary, including units.
- Identify the classifications of waves.
- Explain the electromagnetic spectrum in terms of why some waves are visible and others are not visible by the naked eye.
- Learn how light waves are used in industry.
- Summarize how lasers work and their uses in industry.
- Paraphrase safety guidelines when working with lasers.
- Construct a measurement tool using lasers.

Aligned Washington State Learning Standards	
Educational Technology	6.a. Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication. 6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models, or simulations. 7.a. Students use digital tools to connect with learners from a variety of backgrounds and cultures, engaging with them in ways that broaden mutual understanding and learning. 7.b. Students use collaborative technologies to work with others, including peers, experts, or community members, to examine issues and problems from multiple viewpoints.

	7.c. Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal. 7.d. Students explore local and global issues and use collaborative technologies to work with others to investigate solutions.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	Worksheets 1 and 2: Mass/Weight/Gravity and Density/Mass/Volume Calculations N.Q.A Reason quantitatively and use units to solve problems. N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. A.CED.A Create equations that describe numbers or relationships. A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. A.REI.A Understand solving equations as a process of reasoning and explain the reasoning. A.REI.B Solve equations and inequalities in one variable. A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. Embedded in PowerPoint and Assessed in Quiz MP7: Look for and make use of structure. MP8: Look for and express regularity in repeated reasoning. N.Q.A Reason quantitatively and use units to solve problems. N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. A.CED.A Create equations that describe numbers or relationships A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. Worksheet: Vectors MP2: Reason abstractly and quantitatively. N-VM.A Represent and model with vector quantities. N-VM.A.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). N-V.B Perform operations on vectors. N-V.B.4 (+) Add and subtract vectors. Mechanical Advantage Try These MP1: Make sense of problems and persevere in solving them. A-REI.B Solve equations and inequalities in one variable A-REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. High School: Modeling Torque/Lever Activity MP1: Make sense of problems and persevere in solving them. MP4: Model with mathematics. MP5: Use appropriate tools strategically.

	MP6: Attend to precision. A-REI.B Solve equations and inequalities in one variable A-REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. High School: Modeling Worksheets: BTU Conversions, Thermal Expansion, Pressure Calculations (see Addendum for Worksheets) and Suction Cup Activity (embedded in PowerPoint) MP5: Use appropriate tools strategically. MP7: Look for and make use of structure. MP8: Look for and express regularity in repeated reasoning. N.Q.A Reason quantitatively and use units to solve problems. N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. A.CED.A Create equations that describe numbers or relationships. A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. A.REI.A Understand solving equations as a process of reasoning and explain the reasoning. A.REI.B Solve equations and inequalities in one variable. A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.. Gas Law Calculations (Booklet) MP6: Attend to precision. MP7: Look for and make use of structure. A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. Conversions (Booklet) MP6: Attend to precision. MP7: Look for and make use of structure. N.Q.A Reason quantitatively and use units to solve problems. N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. Student Project: Laser Levels MP2: Reason abstractly and quantitatively. MP4: Model with mathematics. MP5: Use appropriate tools strategically. MP6: Attend to precision. N.Q.A Reason quantitatively and use units to solve problems. G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects. G-MG.A Apply geometric concepts in modeling situations G-MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

COMPONENTS AND ASSESSMENTS
Performance Assessments: Assessments will be formal and informal, written, verbal and practical. Lesson 1:

- Online Work: oli.cmu.edu STEM Readiness, Module 8: Triangles
- Lab Project: 'Designing a Footbridge with Trusses'.

Lesson 2:

- Lab Project: 'Building a Footbridge with Trusses'.

Lesson 3:

- Online Work: oli.cmu.edu STEM Readiness, Module 9: Cartesian Plane
- Lab Project: Testing Your Footbridge

Lesson 4:

- 18 Tasks
- 6 Smarter Balanced Math Lesson Plans
- SBA Math Practice Assessment

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Math for Industry

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 30

- Identify and name an angle.
- Measure an angle using a protractor.
- Classify triangles by their angles as right, obtuse, or equilateral.
- Classify triangles by their sides as equilateral, isosceles, or scalene.
- Use the triangle angle sum theorem to determine the measure of an angle in a triangle.
- Determine the measure of an angle by applying the concept of complementary or supplementary angles.
- Identify corresponding sides and angles in similar triangles.
- Determine corresponding angles and sides of similar triangles, using proportions.
- Apply the Pythagorean Theorem to calculate the length of a side of a right triangle.
- Calculate all angles and sides of a right triangle using trigonometry.
- Visualize relationships between two-dimensional and three-dimensional objects.
- Apply geometric concepts in modeling situations.
- Reason quantitatively and use units to solve problems.
- Describe the layout and identify the quadrants of the Cartesian coordinate system.
- Given the point on a graph, determine the ordered pair.
- Given a point on a graph, recognize whether an ordered pair is an x or y intercept.
- Graph points on the coordinate plane given an ordered pair.
- Visually identify whether the slope of a line is positive, negative, zero or undefined.
- Given the coordinates of two points on a line, determine the slope.
- Given data modeling a situation, interpret its slope.
- Given the coordinate of two points on a line, determine its linear equation.
- Given a linear equation, graph a line on the coordinate plane.
- Calculate the midpoint between two points on a line.
- Calculate the distance between two points.
- Given points on a graph, determine a best fit line.
- Represent a constraint by shading the correct side of the inequality line.
- Understand how combining inequalities affects a solution space.

- Interpret a situation and represent the constraints and variables mathematically.
- Select appropriate mathematical methods to use.
- Explore the effects of systematically varying the constraints.
- Interpret and evaluate generated data and identify the optimum case, checking it for confirmation.
- Communicate mathematical reasoning clearly.
- Find, based on equations, lines that are parallel and perpendicular.
- Identify and use intercepts.
- Understanding how the factored form of the function can identify a graph's roots.
- Understanding how the completed square form of the function can identify a graph's maximum or minimum point.
- Understanding how the standard form of the function can identify a graph's intercept.
- Articulate verbally the relationships between variables arising in everyday context.
- Translate between everyday situations and sketch graphs of relationships between variables.
- Interpret algebraic functions in terms of the contexts in which they arise.
- Reflect on the domains of everyday functions and in particular whether they should be discrete or continuous.

Aligned Washington State Learning Standards	
Educational Technology	5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions. 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making. 5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving. 5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1: Make sense of problems and persevere in solving them. MP2: Reason abstractly and quantitatively. MP3: Construct viable arguments and critique the reasoning of others. MP4: Model with mathematics. MP5: Use appropriate tools strategically. MP6: Attend to precision. MP5: Use appropriate tools strategically. MP7: Look for and make use of structure. MP8: Look for an express regularity in repeated reasoning. N-Q.A Reason quantitatively and use units to solve problems. N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N-Q.2A. Define appropriate quantities for the purpose of descriptive modeling. A.REI.B Solve equations and inequalities in one variable. A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. G.CO.D Make geometric constructions

	G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). G.SRT.A Understand similarity in terms of similarity transformations G.SRT.A.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides. G.SRT.C Define trigonometric ratios and solve problems involving right triangles. G.SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects. G.MG.A Apply geometric concepts in modeling situations G.MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). N-Q.A Reason quantitatively and use units to solve problems. G.CO.D Make geometric constructions G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects. G.MG.A Apply geometric concepts in modeling situations G.MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). N-Q.A Reason quantitatively and use units to solve problems. A.REI.B Solve equations and inequalities in one variable. A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. F.IF.B Interpret functions that arise in applications in terms of the context. F.IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. F.IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. * F.LE.B Interpret expressions for functions in terms of the situation they model. F.LE.B.5 Interpret the parameters in a linear or exponential function in terms of a context. G.GPE.B Use coordinates to prove simple geometric theorems algebraically G.GPE.B.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula. S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables. S.ID.B.6 Represent data on two quantitative variables on a scatter plot and describe how the variables are related. S.ID.B.6.a Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. S.ID.B.6.b Informally assess the fit of a function by plotting and analyzing residuals. S.ID.B.6.c Fit a linear function for a scatter plot that suggests a linear association. Interpret linear models S.ID.C Interpret linear models. S.ID.C.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. N.RN.A Extend the properties of exponents to rational exponents.

	N.RN.A.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define to be the cube root of 5 because we want = to hold, so must equal 5 . N.RN.A.2 Rewrite expressions involving radicals and rational exponents using properties of exponents. N-RN.B Use properties of rational and irrational numbers A-SSE.A Interpret the structure of expressions. A-SSE.A.2 Use the structure of an expression to identify ways to rewrite it. For example, see as , thus recognizing it as a difference of squares that can be factored as . A-SSE.B Write expressions in equivalent forms to solve problems. A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain A-SSE.B.3.a Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. A-APR.A Perform arithmetic operations on polynomials. A-APR.A.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. A.APR.B Understand the relationship between zeros and factors of polynomials. A.APR.B.2 Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x - a is p(a), so p(a) = 0 if and only if (x - a) is a factor of p(x). A.APR.B.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. A-CED.A Create equations that describe numbers or relationships. A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. A.REI.B Solve equations and inequalities in one variable. A.REI.B.4 Solve equations and inequalities in one variable. A.REI.C Solve systems of equations. A.REI.C.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line and the circle A.REI.D Represent and solve equations and inequalities graphically A.REI.D.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). *A.REI.D.11 Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. F-IF.C Analyze functions using different representations. F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. F-IF.C.7.a Graph linear and quadratic functions and show intercepts, maxima, and minima. F-IF.C.7.c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. F-LE.A Construct and compare linear, quadratic, and exponential models and solve problems. S.IC.B Make inferences and justify conclusions from sample surveys, experiments, and observational studies. S.IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

COMPONENTS AND ASSESSMENTS

Performance Assessments:
Assessments will be formal and informal, written, verbal and practical.
Lesson 1:

- Load Characterization Activity Worksheets:
  - Converting Dimensions
  - Practicing Volume and Weight
  - Center of Gravity
- Practice Review/Quiz

Lesson 2:

- Knowledge Assessment Quiz

Lesson 3:

- Knowledge Assessment Quiz

Activity: Practice lift and movement of a load

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Rigging

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 30

- Refer to the ANSI/ASME standards that are observed regarding lifting and moving loads
- List, explain and answer the four questions that must be asked before planning a lift or move.
- Given a set of circumstances, predict whether a proposed load movement would be classified as a critical lift, pre-engineered lift, or ordinary lift.
- State the four major steps in planning a move, including two elements of what to look for in each step.
- Apply elements of an ordinary lift plan to an actual lift.
- Measure and determine the volume of a load.
- Convert measurements expressed in different units into common units.
- Calculate the weight of a load.
- Determine the Center of Gravity(C/G) for a symmetrical load.
- Determine the Center of Gravity (C/G) for an asymmetric load.
- Recall and describe the four major steps in planning a move.
- Recall and list the elements of an ordinary lift plan
- Identify types of rigging, describe their features, and explain uses & inspection criteria.
- Differentiate in detail between three examples of steel rigging and three examples of synthetic rigging
- Select and inspect rigging for an actual load lift and movement
- Distinguish between the various types of cranes, hoists and lifting devices encountered at a worksites
- Conduct a pre-operational crane or hoist inspection.
- Rig a load for lift and movement
- State and describe the last of the four major steps in planning a move.
- Rig a load.
- Perform hand signals to direct the load movement.
- Lift and move a load safely using a hoist, or crane if available.

Aligned Washington State Learning Standards

Educational Technology	4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

	5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving. 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models, and algorithmic thinking in exploring and finding solutions.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	Worksheet: Converting Dimensions MP2: Reason abstractly and quantitatively. MP6: Attend to precision. N-Q.A Reason quantitatively and use units to solve problems. N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. Worksheet: Practicing Volume and Weight MP1: Make sense of problems and persevere in solving them. MP6: Attend to precision. N-Q.A Reason quantitatively and use units to solve problems. N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. G.GMD.A Explain volume formulas and use them to solve problems. G.GMD.A.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects. Worksheet: Center of Gravity MP1: Make sense of problems and persevere in solving them. MP2: Reason abstractly and quantitatively. MP4: Model with mathematics. MP6: Attend to precision. N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects. MP4: Model with mathematics. G-MG.A Apply geometric concepts in modeling situations. G-MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios). MP1: Make sense of problems and persevere in solving them. MP6: Attend to precision. N-Q.A Reason quantitatively and use units to solve problems. G.GMD.A Explain volume formulas and use them to solve problems. G.GMD.A.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. G-MG.A Apply geometric concepts in modeling situations G-MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

COMPONENTS AND ASSESSMENTS

Performance Assessments:
Assessments will be formal and informal, written, verbal and practical.
Lesson 1:

- Quiz: A hydraulics quiz is available (Addendum)
- Worksheet 1: Pascal's Law Calculations (Booklet)
- Worksheet 2: More Pascal's Law (Booklet)
- Worksheet 3: More Formulas, More Practice (Booklet)
- Reading and Journaling: How Hydraulic Machines Work by Marshall Brain (Booklet)

Lesson 2:

- Activity: Have students take apart some cheap air compressors to see how they work.
- Activity: What Would It Cost to Set Up a Simple Pneumatic System?
- Lab Activity: Tennis Balls Up in the Air

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Hydraulics and Pneumatics

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 30

- Explain the physics guiding hydraulics.
- Calculate problems related to fluid power using Pascal's Law, Force, Work, and Power equations.
- Identify the major historical events (and figures) behind the science of fluids.
- Describe the advantages and disadvantages of fluid power.
- Identify and explain the factors to consider when setting up a hydraulic system.
- Define terminology common to hydraulics.
- List the typical components of a basic hydraulics system.
- Recognize the fluid power components from schematics.
- Learn and practice safe handling procedures of hydraulics.
- Apply the knowledge of hydraulics with a hands-on project.

Aligned Washington State Learning Standards

Educational Technology	4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks. 5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving. 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1: Make sense of problems and persevere in solving them. MP2: Reason abstractly and quantitatively.

	MP7: Look for and make use of structure. N.Q.A Reason quantitatively and use units to solve problems. N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. A.CED.A Create equations that describe numbers or relationships. A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. MP4: Model with mathematics. N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. High School Modeling

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical.

Lesson 1:

- Practice Review/Quiz

Lesson 2:

- Practice Review/Quiz
- In-class activity: Visualizing a Magnetic Field

Lesson 3:

- Practice Review/Quiz

Lesson 4:

- Knowledge Assessment
- In-class activity: Creating a Basic Bread Board Electrical Circuit
- Math Worksheet
- Student Handout

Leadership Alignment:

Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Electrical

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 35

- Describe the basic structure of the atom.
- Define the term: Electron.
- Define the term: Proton.
- Define the term: Neutron.
- Define the term: Valence Shell.
- Define the term: Negative Ion.
- Explain the characteristics of insulators, semiconductors, and conductors.
- Describe how an atom becomes an ion.
- Explain the process of current flow.
- List the six sources of electricity and explain how they produce electrical pressure.
- List the requirements of an electrical circuit.
- Define voltage and its unit of measurement, then write the letter abbreviation for the unit.
- Define current and its unit of measurement, then write the letter abbreviation for the unit.

- Define resistance and its unit of measurement, then write the letter abbreviation for the unit.
- Define power and its unit of measurement, then write the letter abbreviation for the unit.
- Define conductance and its unit of measurement, then write the letter abbreviation for the unit.
- List the factors that determine resistance of wires, their current carrying capacity, and be able to size them.
- Describe the construction of various types of variable resistors and explain the applications they are used for.
- Describe the operation, terms and symbols of circuit protection devices.
- Identify standardized symbols used in schematic diagrams that represent various electronic components.
- Following a schematic diagram, assemble a simple electric circuit.
- Describe the relationships of current, voltage, and resistance.
- Use Ohm's Law equations to solve for electrical circuit values.
- Describe the importance of observing electrical safety.
- Describe the fundamental concepts of electricity.
- Describe grounding.
- Describe how different current levels affect the human body.
- Describe the ways in which electric shock can be received.
- List the steps that should be followed when treating an individual who receives an electric shock.
- Describe the causes and dangers of burns caused by electricity.
- Describe various practices that should be followed to prevent electrical hazards.
- Describe how certain types of electrical devices are engineered to prevent electrical hazardous conditions from occurring.
- Summarize the laws of magnetic attraction and repulsion.
- List the five characteristics of magnetic flux lines.
- Define magnetomotive force (MMF)
- Define magnetic flux.
- Define reluctance as a phenomenon regarding magnetism.
- Define permeability as a phenomenon regarding magnetism.
- Discuss residual magnetism and retentivity.

Aligned Washington State Learning Standards	
Educational Technology	4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems. 4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks. 4.c. Students develop, test, and refine prototypes as part of a cyclical design process. 4.d. Students exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems. 5.d. Students understand how automation works and use algorithmic thinking to develop a sequence of steps to create and test automated solutions.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1: Make sense of problems and persevere in solving them. MP7: Look for and make use of structure. N.Q.A Reason quantitatively and use units to solve problems.

	N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. A.CED.A Create equations that describe numbers or relationships. A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R. A.REI.A Understand solving equations as a process of reasoning and explain the reasoning. A.REI.A.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. A.REI.A.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. A.REI.B Solve equations and inequalities in one variable. A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical.

Lesson 1:

- Worksheet: Eutectic Functions (Addendum)
- Practice Review Assessment

Lesson 2:

- Practice Review/Quiz
- In-class activity # 1: Hand soldering wires to terminals

Lesson 3:

- Practice Review/Quiz
- In-class activity # 2: Sweating Plumbing Connections

Leadership Alignment:

Standards and Competencies

Unit: Soldering

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 25

- Define the process of soldering, distinguishing the difference between welding, brazing, and soldering
- Apply safety precautions when soldering
- Identify the base metal, solder and flux involved in a typical soldering task
- Explain the role of capillary action in the soldering process
- Distinguish between soft soldering, hard soldering and brazing, including differences in solder and temperatures required
- Relate typical applications where soldering is used
- List common solder alloys and sequence the ratios of common lead-tin alloy solders
- Explain eutectic solder and the properties that make it unique
- List the various forms of solder available and explain the applications in which each is used
- Identify at least three weights and gauges of commonly available solder wire
- Describe the purpose of flux and specify the differences between resin flux and acid flux
- List the general steps involved in the soldering process
- Describe soldering equipment and choose the best type for the assigned task
- Use the solder code to identify the solder type.

- Remove the wire insulation and Tin wires and components
- Solder the required number of prepared wires to terminations
- Rework discrepant soldered terminations
- Measure and cut a length of copper pipe using a pipe cutter or hacksaw
- Deburr and clean the base metal at the joint
- Apply flux and heat copper piping for soldering
- Solder a joint between two copper pipes according to industry standards
- Clean excess flux from a soldered copper piping joint

Aligned Washington State Learning Standards	
Educational Technology	6.a. Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication. 5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving. 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1: Make sense of problems and persevere in solving them. MP2: Reason abstractly and quantitatively. N.Q.A Reason quantitatively and use units to solve problems. N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. F.IF.A Understand the concept of a function and use function notation. F.IF.A.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph off is the graph of the equation y = f(x). F.IF.B Interpret functions that arise in applications in terms of the context. F.IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. * F.IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

COMPONENTS AND ASSESSMENTS

Performance Assessments:

Assessments will be formal and informal, written, verbal and practical.

Lesson 1:

- Practice Review/Quiz
- In-class Activity: Online Research

Lesson 2:

- In-class Activity # 1: Troubleshooting Faulty Flashlights (Addendum)

- In-class Activity # 2: Statistical Process Control (Math Activity in Addendum))
- Knowledge Assessment Quiz (Addendum)

Lesson 3

- Practice Review/Quiz

Lesson 4

- In-class Activity: Troubleshooting Leaf Blowers

Leadership Alignment:

Standards and Competencies

Unit: UNIT OF STUDY

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 25

- State the seven phases in logical troubleshooting in the proper sequence.
- Define in their own words each phase of the seven-phase troubleshooting process.
- State the advantages of using this logical troubleshooting process.
- Explain how to distinguish between intermittent symptoms and reproducible symptoms.
- Differentiate between symptom recognition and symptom elaboration.
- Evaluate the advantages of keeping a troubleshooting log.
- Describe the types of information that are normally recorded in a troubleshooting log.
- Articulate the questions that need to be asked during the troubleshooting tech's face-to-face interview with the operator.
- Describe the correct way to record operator speculation about the root cause problem.
- Distinguish between electrical schematics and wiring diagrams.
- Relate how a troubleshooter "brackets" or "traps" the problem by conducting a series of tests to progressively pin down the root cause within the smallest possible function, sub-assembly, area, circuit, or component.
- Order the tests and checks logically once the probable faulty functions have been listed.
- Specify the questions that must be answered to confirm that the problem and associated symptoms have been corrected.
- Recommend actions to prevent future problems.
- Research, design, create and prepare informal documents suitable for the workplace.
- Interact collaboratively with other students to complete the activity assignment.
- Design a usable, clear, accessible document to capture relevant information needed to reconstruct the troubleshooting process
- Evaluate their documents to be sure that the documents fulfill their purpose and to ensure that they can be revised if necessary.
- Evaluate a case study and identify the proper sequence of the seven phases in logical troubleshooting.
- Sequence and undertake each phase of the seven-phase troubleshooting process while conducting a hands-on troubleshooting activity.
- Record data, actions, assumptions, findings, tests, and results in a troubleshooting log.
- Predict a root cause based upon symptoms.
- Evaluate observations to determine the actual root cause of a faulty symptom.
- Interact collaboratively with other students to complete the activity assignment.
- Define the concept of Root Cause Analysis.
- List the steps for performing Root Cause Analysis.
- Explain what is meant in Root Cause Analysis by the term "defining the problem."
- Describe ways that evidence and data are gathered for analysis.
- Summarize the various basic tools and methods available for performing root cause analysis.
- Compare and explain examples of the "Five Whys" technique.
- Apply the "Five Whys" technique to determine the root cause of a problem.

- Draw a blank example of a Fishbone/Ishikawa diagram.
- Explain how a Fishbone diagram allows troubleshooters to determine root causes and contributing factors that create a fault or symptom.
- 1Identify a Pareto chart and indicate the root causes displayed that have the biggest negative impact on quality or the manufacturing process.
- Recognize features of the Six Sigma approach and explain the acronym DAMAIC.
- Sequence and undertake each phase of the seven-phase troubleshooting process while conducting a hands-on troubleshooting activity on a multisystem machine (leaf blower).
- Record data, actions, assumptions, findings, tests, and results in a troubleshooting log.
- Predict a root cause based upon symptoms.
- Evaluate observations to determine the actual root cause of a faulty symptom.
- Determine corrective action to eliminate the root cause of the symptom.
- Interact collaboratively with other students to complete the activity assignment.

Aligned Washington State Learning Standards	
Educational Technology	1.a. Students articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes. 1.b. Students build networks and customize their learning environments in ways that support the learning process. 1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways. 1.d. Students understand the fundamental concepts of technology operations, demonstrate the ability to choose, use and troubleshoot current technologies and are able to transfer their knowledge to explore emerging technologies. 3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits. 3.b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data, or other resources. 3.c. Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions. 3.d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories, and pursuing answers and solutions. 4.d. Students exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems 5.c. Students break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1: Make sense of problems and persevere in solving them. MP2: Reason abstractly and quantitatively. MP3: Construct viable arguments and critique the reasoning of others. S.ID.A Summarize, represent, and interpret data on a single count or measurement variable S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots). S.ID.A.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. S.ID.A.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). MP2: Reason abstractly and quantitatively. S-IC.B Making inference and justifying conclusions.

	S-IC.B.3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

COMPONENTS AND ASSESSMENTS

Performance Assessments:
Assessments will be formal and informal, written, verbal and practical.
Lesson 1:

- Article and Questions: 'Castings vs. Foundry: What's the Difference?' by Brad Done
- [1]Designing and Making Whistles
- [1]Worksheet: Modeling Production

Lesson 2:

- Reading: 'Waste' in Student Booklet, answer questions that follow.
- Reading: 'The Value of Time' in Student Booklet, answer questions that follow.
- Reading: 'Team Evolution' in Student Booklet, answer questions that follow.
- Marshmallow Game
- Four Cup Activity.
- [1]5S Game
- [1]Lean Gummy Bears in Space
- Bottleneck Activity
- Quiz

Leadership Alignment:
Leadership activities are embedded in curriculum and instruction and is exhibited through student projects, activities, and class discussions.

Standards and Competencies

Unit: Lean/Manufacturing Processes and Principles

Industry Standards and/or Competencies	**Total Learning Hours for Unit:** 35

- Compare and contrast making vs. manufacturing.
- Describe a brief history of manufacturing.
- Summarize manufacturing processes: Casting and Foundry, Forming and Metalworking, Machining, Joining and Assembly, Rapid Prototyping, Material Specific (plastics and ceramics) and Surface Treatment.
- Select which manufacturing process(es) to use according to the workpiece specifications.
- Classify manufacturing shops by their function(s).
- Explain how time and cost factor into the manufacturing process.
- Design and manufacture a whistle, simulating a job shop.
- Identify how Lean principles help companies compete in a global economy.
- Differentiate between value-added versus non-value-added activities.
- Identify the eight wastes of Lean and how those wastes reduce an organization's profits, competitive edge and customer satisfaction.
- Associate Lean tools with their ability to reduce manufacturing defects.
- Compare and contrast traditional push and pull systems.
- Understand how Lean principles allow companies to move toward just-in-time production.
- Define Six Sigma and explain how it complements Lean.
- List each step of the Six Sigma DMAIC methodology.
- Utilize basic data analysis tools.

• Define the Theory of Constraints and how it is used to improve a bottleneck scenario.	
Aligned Washington State Learning Standards	
Educational Technology	1.a. Students articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes. 1.c. Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways. 3.a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits. 3.d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions. 4.a. Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems. 4.b. Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks. 4.c. Students develop, test and refine prototypes as part of a cyclical design process. 5.a. Students formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions. 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
Health and Physical Education	1.1 The student acquires the knowledge and skills necessary to maintain an active life: movement, physical fitness, and nutrition. 1.2.1 Applies how to perform activities and tasks safely and appropriately. 1.4.2 Analyzes components of skill-related fitness as related to careers/occupations/recreation. 3.1.2 Analyzes how environmental factors affect health. 3.1.3 Evaluates environmental risks associated with certain occupational, residential, and recreational choices.
Mathematics	MP1 Make sense of problems and persevere in solving them. MP2 Model with mathematics Mathematical Modeling N-Q.A: Reason quantitatively and use units to solve problems. N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. MP1 Make sense of problems and persevere in solving them MP4 Model with mathematics Mathematical Modeling F-IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

21st Century Skills
Check those that students will demonstrate in this course:

LEARNING & INNOVATION	INFORMATION, MEDIA & TECHNOLOGY SKILLS	LIFE & CAREER SKILLS
Creativity and Innovation ☒Think Creatively ☒Work Creatively with Others ☒Implement Innovations **Critical Thinking and Problem Solving** ☒Reason Effectively ☒Use Systems Thinking ☒Make Judgments and Decisions ☒Solve Problems **Communication and Collaboration** ☒Communicate Clearly ☒Collaborate with Others	**Information Literacy** ☒Access and /evaluate Information ☐Use and Manage Information **Media Literacy** ☐Analyze Media ☐Create Media Products **Information, Communications and Technology (ICT Literacy)** ☐Apply Technology Effectively	**Flexibility and Adaptability** ☒Adapt to Change ☒Be Flexible **Initiative and Self-Direction** ☒Manage Goals and Time ☒Work Independently ☒Be Self-Directed Learners **Social and Cross-Cultural** ☒Interact Effectively with Others ☒Work Effectively in Diverse Teams **Productivity and Accountability** ☒Manage Projects ☒Produce Results **Leadership and Responsibility** ☒Guide and Lead Others ☒Be Responsible to Others