

Statewide Framework Document for: 480511

**Core Plus Aerospace
540-hour Program**

Standards may be added to this document prior to submission but may not be removed from the framework to meet state credit equivalency requirements. Performance assessments may be developed at the local level. To earn state approval, performance assessments must be submitted within this framework. **This course is eligible for 1.0 of ELA, Mathematics, and Science.**

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

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

Washington English Language Arts Standards (Common Core State Standards) establish guidelines for literacy in history/social studies, science, and technical subjects. The College and Career Readiness Anchor Standards form the backbone of the ELA/literacy standards by articulating core knowledge and skills, while grade-specific standards provide additional specificity. The Anchor Standards are:

Anchor Standards for College and Career Readiness for Reading

Key Ideas and Details:

[.CCRA.R.1](#)

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

[.CCRA.R.2](#)

Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

[.CCRA.R.3](#)

Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

Craft and Structure:

[.CCRA.R.4](#)

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

[.CCRA.R.5](#)

Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text (e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

[.CCRA.R.6](#)

Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas:

[.CCRA.R.7](#)

Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.¹

[.CCRA.R.8](#)

Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

[.CCRA.R.9](#)

Analyze how two or more texts address similar themes or topics to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity:

[.CCRA.R.10](#)

Read and comprehend complex literary and informational texts independently and proficiently.

Anchor Standards for College and Career Readiness for Writing

Text Types and Purposes:

[.CCRA.W.1](#)

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

[.CCRA.W.2](#)

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

[.CCRA.W.3](#)

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

Production and Distribution of Writing:

[.CCRA.W.4](#)

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

[.CCRA.W.5](#)

Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

[.CCRA.W.6](#)

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge:[.CCRA.W.7](#)

Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

[.CCRA.W.8](#)

Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

[.CCRA.W.9](#)

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

Range of Writing:[.CCRA.W.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.

Anchor Standards for College and Career Readiness for Speaking and Listening**Comprehension and Collaboration:**[.CCRA SL.1](#)

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

[.CCRA SL.2](#)

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

[.CCRA SL.3](#)

Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Presentation of Knowledge and Ideas:[.CCRA SL.4](#)

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

[.CCRA SL.5](#)

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

[.CCRA SL.6](#)

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

Anchor Standards for College and Career Readiness for Language**Conventions of Standard English:**[.CCRA.L.1](#)

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

[.CCRA.L.2](#)

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

Knowledge of Language:

[.CCRA.L.3](#)

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

Vocabulary Acquisition and Use:

[.CCRA.L.4](#)

Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

[.CCRA.L.5](#)

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

[.CCRA.L.6](#)

Acquire and use accurately a range of 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 encountering an unknown term important to comprehension or expression.

The details about English Language Arts Standards can be found at [Common Core English Language Arts Standards](#).

***In this framework, *standards that are addressed but not specifically assessed are in italics*. All other standards are assessed as part of the student's achievement.**

School District Name		
Course Title: Core Plus Aerospace		Total Framework Hours: 540
CIP Code: 480511	<input type="checkbox"/> Exploratory <input checked="" type="checkbox"/> Preparatory	Date Last Modified: April 1, 2022
Career Cluster: Manufacturing		Cluster Pathway: All Pathways within the Cluster
Course Summary: The Core Plus Aerospace program consists of frameworks and curricular materials that are designed to incorporate academic learning into aerospace-related manufacturing. The units are designed to be taught during the design, manufacture, and testing of the Capstone Project (the SkillsUSA Assembler Competition, Skills Inc, Project 3) helping students recognize where each unit's information is important to the Aerospace Industry and Manufacturing, and how that information is best utilized during the various manufacturing processes. Due to the fact that communities are different in the ways that the Aerospace Industry might be seen and the many disciplines of Aerospace might be implemented, it is strongly recommended that teachers look to their Advisory Committees and the Core Plus Aerospace website for direct implementations and identifications of local impacts as students proceed through this Career Pathway.		
Course Resources: The Core Plus Aerospace program consists of frameworks and curricular materials that are designed to incorporate academic learning into aerospace manufacturing.		

The units are designed to be taught during the design, manufacture, and testing of the Capstone Project, helping students recognize where each unit's information is important to the Aerospace Industry and Manufacturing, and how that information is best utilized during the various manufacturing processes. Since communities are different in the ways that the Aerospace Industry might be seen, and the many disciplines of Aerospace might be implemented, it is strongly recommended that teachers look to their Advisory Committees for direct implementations and identifications of local impacts as students proceed through this Career Pathway.

In the **Core Plus Aerospace (540-hour Program)** course, the academic learning will occur within the following units:

Unit	Hours
Introduction to Aerospace	15
Materials Science	70
Applied Physics	20
Shop Tools	20
Safety	20
Standard Operating Procedures	20
Lean Manufacturing Processes and Principles	35
Precision Measurement	25
Electricity and Electric Circuits	30
Rigging	15
Math for Industry	35
Hydraulics and Pneumatics (Fluid Mechanics)	30
Troubleshooting	30
Soldering	15
Fasteners	20
Drilling	20
Cutting and Grinding	30
Riveting	20
Print Reading	35
Capstone Project	35
Total Hours	540

These units are designed to be taught during the design, manufacture, and testing of the Capstone Project, helping students recognize where each units' information is important to the Aerospace Industry and Manufacturing, and how that information is best utilized during the various manufacturing processes.

Unit 1 Introduction to Aerospace	Total Learning Hours for Unit: 15
<p>Unit Summary:</p> <p>In this unit, students focus on the development of flight through the centuries. Starting with imagining flight, we follow its development through modern day aviation and get a glimpse at what aviation may become. You'll find out more about basic principles of flight including basic aeronautics, aircraft design (including helicopters), and engine development. Students also learn the science behind flight, answering questions why airplanes fly, why they fly so high, and identifying the forces of flight. It begins with a quick review of the atmosphere and vectors and then discusses why planes fly based on Bernoulli's Principle and Newton's Third Law. Discussion includes the four forces of flight: lift, drag, thrust, and weight. Next, students learn how to control an aircraft's movements using pitch, roll and yaw. The lesson concludes by looking at the effects of flight on the human body.</p>	
<p>Performance Assessments:</p>	
<p><u>General</u></p> <p>Students:</p> <ul style="list-style-type: none"> • Identify noteworthy people in flight development. • Compare and contrast bird flight with airplane wings based on Bernoulli's Principle and Newton's Third Law. • Identify lighter-than-air developments. • Identify heavier-than-air early developments. • Explain the Cold War's significance to the advancement of aviation and space exploration. • Construct a working wind tunnel. • Design and construct a camber airfoil. • Simulate flying using an online application. 	
<p><u>English/Language Arts</u></p> <p>Students demonstrate ELA competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> • Describe how to counteract the effects of flight on the human body. 	
<p><u>Science</u></p> <p>Students demonstrate Science competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> • Explain the four forces an airplane encounters during flight. • Describe the effects of flight (aircraft and spacecraft) on the human body. 	
<p><u>Mathematics</u></p> <p>Students demonstrate mathematics competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> • Summarize how to control an airplane's motion (pitch, yaw and roll) around the three axis. 	
<p>Leadership Alignment:</p> <p>Through team-based activities relating to Aerospace, students:</p> <ul style="list-style-type: none"> • Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts. • Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions. • Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade). • Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact. 	

- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions
- 2.D Solve Problems.
- 4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Four forces of Flight – Weight, Drag, Thrust, and Lift
- Equal Net Forces
- Pitch, Yaw, and Roll
- Stabilization and Stabilizers
- Pressurization

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RI.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 matters uncertain.*
- RI.11-12.2 - Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.
- RI.11-12.3 - 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.
- RI.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).
- RI.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.*
- RI.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.*
- RI.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 to address a question or solve a problem.
- RI.11-12.8 - Delineate and evaluate the reasoning in seminal U.S. texts, including the application of constitutional principles and use of legal reasoning (e.g., in U.S. Supreme Court majority opinions and*

dissents) and the premises, purposes, and arguments in works of public advocacy (e.g., The Federalist, presidential addresses).

SL.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.

SL.11-12.1.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.

SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.

SL.11-12.1.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.

SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.

SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

SL.11-12.6 - Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.

L.11-12.1 - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

L.11-12.1.A - Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.

L.11-12.2 - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

L.11-12.2.A - Observe hyphenation conventions.

L.11-12.2.B - Spell correctly.

L.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.

L.11-12.4.A - Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

L.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*).

L.11-12.4.C - Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

L.11-12.4.D - Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary)

L.11-12.5 - Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

L.11-12.5.A - Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.

L.11-12.5.B - Analyze nuances in the meaning of words with similar denotations.

L.11-12.6 - 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.

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.4 - 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*.

RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.

RST.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.

RST.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.

RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

	<p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p><i>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</i></p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>

Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HS.N.VM.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, v, v, v).</p> <p>HS.N.VM.2 (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.</p> <p>HS.N.VM.3 (+) Solve problems involving velocity and other quantities that can be represented by vectors.</p> <p>HS.N.VM.4 (+) Add and subtract vectors.</p> <p>HS.N.VM.4a Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.</p> <p>HS.N.VM.4b Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.</p>		
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p> <p>MP3 - Construct viable arguments and critique the reasoning of others.</p> <p>MP4 - Model with mathematics.</p>		
Science	<p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>		
Science and Engineering Practice		Disciplinary Core Idea	Crosscutting Concept
Analyzing and Interpreting Data Using Mathematics and Computational Thinking <i>Connections to Nature of Science</i> Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena		PS2.A: Forces and Motion PS2.B: Types of Interactions	Patterns Cause and Effect Systems and System Models

Unit Summary:

The information found in this unit has been designed to help students identify and understand why and how the various materials utilized in systems and applications in the Aerospace Industry are selected and how they react to various manufacturing processes, what tools and equipment are used on those materials, including specialized tools, what finishes are recommended on those materials, how those materials impact manufacturing, assembly, and how they are impacted and/or changed by various environments.

Classroom and laboratory activities and experiences will be systems-based, where material science-related information is delivered during manufacturing procedures and aerospace applications, by having students defend why one material is used instead of another and how the selection of that material impacts manufacturing processes, tool selection, and equipment.

The materials that will be examined and the systems those materials effect throughout this course include:

- Ferrous and Non-ferrous Metals
 - Steel – structural systems, propulsion, fasteners, welding
 - Aluminum – structural systems, fasteners, welding
 - Copper – electrical systems, hydraulics/pneumatics/fluid lines, fasteners
- Gases and Fluids – hydraulic and pneumatic systems
- Nylon and Rope – (natural fiber, nylon, synthetics, wire) – rigging systems
- Plastics/PVC/CPVC/PEX//Fiberglass/Epoxy/Composites – structural systems, fluid lines

It is recommended that during this unit that students will be manufacturing a Capstone project, and that pertinent Material Science information be included during the planning, execution, and evaluation of that project.

To meet English Language Arts standards, journaling and other writing and student presentations are embedded into all Core Plus Aerospace units and materials.

Performance Assessments:**General**

Students:

- Interpret and speak in language relating to Materials Science.
- Explain and demonstrate knowledge of materials science concepts as they relate to Aerospace applications and systems.
- Compare and contrast the different materials:
 - metallic bonded Aerospace materials rusts and corrode.
 - wood and some polymers rot and degrade.
 - ceramics work great and are difficult or impossible to apply.
 - there are no perfect materials, and all products are designed taking cost and lifespan into consideration.
- Select and defend correct and accurate applications of materials science concepts in the performance of classroom and laboratory activities.

- Use technology-based tools, printed documentation, and other media sources to research and make presentations of materials science solutions in aerospace-related applications.
- Be able to list several common materials used in the design and manufacture of various products, identify simple properties of materials, such as strength, flexibility, and transparency, and describe advantages and limitations of those materials.
- Develop an understand and working knowledge of how the bonding in thermoplastics vs thermoset effect mechanical properties, cost, working time, and service life.
- Journal information that can be shared and interpreted at later times during the manufacturing of the Capstone Project and/or laboratory activities.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Outlining pertinent information relating to material properties.
- Create material profiles for three common aerospace materials, including applications, structural strength, composition, relative cost, and availability.
- For a given aerospace application, create a presentation that analyzes the advantages/disadvantages of three competing materials available for that purpose.
- Produce a procedure for a selected material, including installation techniques, tools and equipment required, fastening approach, and safety procedures that must be observed.
- Select a material that fosters sustainable principles and justify its use in a project.
- Creating narratives that can be used to generate manufacturing process documents.
- For a specific aerospace application, creating a presentation that analyzes the advantages/disadvantages of three competing materials available for that purpose.
- Creating and presenting classroom and community presentations relating to their results of research projects, identifying manufacturing processes, and steps used to evaluate materials used and the quality of the Capstone Project.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Understanding and sharing information related to the physical and chemical properties of various materials used in the Aerospace Industry, including:
 - Glues, Adhesives, and Finishes
 - Wood glue or Epoxy?
 - Types of Caulking
 - Paint
 - Gelcoat
 - How do they work?
 - How does temperature or other environmental conditions impact their effectiveness in Aerospace applications?
- Identifying the strengths and weaknesses of various materials used in Aerospace environments and selecting appropriate materials and processes for the application.

- Justifying the criteria used to select various materials to be used in the Capstone Project and explain their reasoning in their journals and during the design, manufacturing, and evaluation processes.
- Understanding and sharing information related to how various metal properties change due to the addition of other materials.
- Explaining how the physical and chemical properties of metals dictate how they might be used in Aerospace manufacturing.
- Identifying how the different materials react to changes in the environment.
- Recognizing how various materials bond and how those bonds react in various conditions.
- Modifying or changing various materials by adding other materials (composites).
- Identifying various physical characteristics of various composite materials.
- Predicting the types of physical and chemical reactions due to the addition of other materials (epoxy, adhesives, color pigments. etc.).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Analyzing the influences and impacts weather systems can have on Aerospace career opportunities and requirements for those careers.
- Interpreting and manipulating information related to individual parts of a system and then how those component parts impact the entire system. This information might impact total weight, and how a material or structure is designed or selected.
- Identifying distances, velocity, and force.
- Geometric applications related to digital programs that utilize computer-aided design, and layout and utilization of CNC equipment (laser cutter/engraver, plasma cutter, or milling equipment) would be incorporating these standards to create drawings and then converting those drawings into 2D and 3D manufacturing files.
- Demonstrating knowledge and understanding of amounts, forces, and direction as they are presented in various quantities and utilized in laboratory and/or manufacturing applications.
- Interpreting written and spoken information relating to Materials Science. Journaling that information into forms that can be shared and interpreted the same at various times during the course.
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Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Properties of Materials - Understand and articulate the properties of various materials.
- Types of Bonding - Show how various materials are created at the atomic and molecular levels and how this bonding impacts Aerospace manufacturing processes (adhesives, weight, etc.)
- Journaling and Documentation - Put their ideas and understanding into writing and review the impacts and changes that various materials and manufacturing processes that are utilized affect the Aerospace Industry.
- Identification of Material Structure - Articulate how the crystalline structure on various materials impacts their uses in Aerospace Manufacturing and how the structure might be modified or changed by various manufacturing processes.
- Manufacturing Processes and Procedures - Apply various manufacturing process to complete a Capstone Project.

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RST.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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
- WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

	<p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN-Q.A.1 - Use units 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.</p> <p>HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSN.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., \mathbf{v}, \mathbf{v}, $\ \mathbf{v}\$, v).</p> <p>HSN.VM.A.2 - (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.</p> <p>HSN.VM.A.3 - (+) Solve problems involving velocity and other quantities that can be represented by vectors.</p>

	<p>HSA.SSE.A.1 - Interpret expressions that represent a quantity in terms of its context.</p> <p>HSA.SSE.A.1.A - Interpret parts of an expression, such as terms, factors, and coefficients</p>
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p> <p>MP3 - Construct viable arguments and critique the reasoning of others.</p> <p>MP4 - Model with mathematics.</p> <p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>
Science	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-2 - Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</p> <p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.</p> <p>HS-ESS2-2 - Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.</p> <p>HS-ESS2-3 - Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.</p> <p>HS-ESS2-5 - Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.</p> <p>HS-ESS2-6 - Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.</p> <p>HS-ESS2-7 - Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.</p> <p>HS-ESS2-4 - Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.</p> <p>HS-ESS3-5 - Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.</p> <p>HS-ESS3-1 - Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.</p> <p>HS-ESS3-2 - Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.</p>

	<p>HS-ESS3-3 - Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.</p> <p>HS-ESS3-4 - Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.</p> <p>HS-ESS3-6 - Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.</p> <p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.C: Optimizing the Design Solution ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 3 Applied Physics

Total Learning Hours for Unit: 20

Unit Summary:

Students will be given the guiding principles of physics. Its purpose is to help students understand why things move and how machines operate based on these principles. Students will gain the knowledge of the primary laws of physics and how they apply to the design and construction of aerospace vessels, the operations conducted aboard, and the operation and manufacturing of the equipment found thereon.

This includes the primary laws of physics related to mass and measurement, liquid pressure, Archimedes' principle, density and specific gravity, air pressure and the atmosphere, the effects of concurrent or parallel forces, Newton's laws of motion, the motion of celestial bodies, mechanical and electromechanical waves, the principles of work, power and energy, simple machines, the principles of heat and expansion, transmission of heat, the nature and propagation of light, reflection of light, refraction of light, optical instruments, magnetism, static electricity, electrical current and magnetic effects, electrical energy and power, radio and electromagnetic waves, and the principles of physics on an airplane.

It is recommended that during this unit that students will be manufacturing a Capstone project, and this information will be continually instructed throughout the manufacturing process. It is recommended that this information be covered during manufacturing steps where the specific Applied Physics information is pertinent.

In order to meet English Language Arts standards, journaling and other writing and student presentations are embedded into all Core Plus Core Plus units and materials.

Performance Assessments:

General

Students:

- Understand and explain the guiding principles of physics related to mass, weight, gravity, force, power, work, machines, heat, pressure, gas laws, fluid mechanics and waves.
- Explain why things move and how machines operate based on these principles.
- Understand and explain the guiding principles of physics related to kinetic energy, thermal properties, gas laws, and how to solve for pressure, temperature, or volume.
- Identify the various components of air.
- Share their knowledge of the primary laws of physics and how they apply to manufacturing.
- Understand and explain the properties of optical instruments.
- Understand the fundamental units of measurement.
- Understand and explain the molecular forces in solids and liquids.
- Understand and explain the transmission of pressure.
- Understand center of gravity and stability.
- Understand the operation of a simple electrical circuit.
- Understand how a simple battery works.
- Understand the basic characteristics of sound.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Explaining the relationship between matter and mass and name the three states of matter.

- Defining weight and gravity, and how weight relates to mass.
- Defining Specific Gravity and calculate a Specific Gravity ratio given density or weight of an object.
- Defining energy and name the two types of energy in objects.
- Explaining the differences between force, work, and power.
- Describing the force of friction.
- Explaining the relationship between heat, and kinetic energy.
- Describing various forms of energy and their capacity to be converted to heat.
- Comparing methods of heat transfer and their uses in aerospace applications.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Defining machines and identifying simple machines.
- Distinguishing between different types of levers and inclined planes.
- Defining mechanical advantage and calculate it using force/distance variables.
- Solving for mechanical work using effort and resistance variables.
- Defining stress and its effects; define motion.
- Distinguishing between speed and velocity; explain how they are related to acceleration. Defining heat, its relation to kinetic energy, and its units in both English and Metric.
- Listing and describing forms of energy which can be converted to heat.
- Explaining how heat is transferred and list three methods of heat transfer.
- Defining Thermal Efficiency.
- Defining Specific Heat and solve for Thermal Expansion.
- Defining pressure, list different pressure gauges, and practice solving for psi.
- 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.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Explaining the relationship between matter and mass and name the three states of matter.
- Defining weight and gravity, and how weight relates to mass.
- Solving for weight, mass and gravity using the given formula(s) and using appropriate units.
- Defining density and solve for density, mass, volume using the given formula(s) and using appropriate units.
- Defining Specific Gravity and calculate a Specific Gravity ratio given density or weight of an object.
- Calculating conversion problems. Relating to:
 - Amplitude: Maximum distance the wave vibrates from the rest position

- Wavelength: The distance between any adjacent crests or troughs in a series of waves
- Crest and Trough: The high point and the low point of each wavelength
- Period: The time it takes to complete a cycle or wave oscillation
- Graphing Wave Frequency as it relates to the number of waves in a given amount of time.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Specific Gravity - Calculate a Specific Gravity ratio given density or weight of an object.
- Energy - Explain the differences between force, work, and power.
- Mechanical Advantage - Understand and calculate the ratio of the force produced by a machine to the force applied to it, and how this is used in assessing the performance of a machine.
- Torque - Articulate how the forces applied in a twisting motion are measured.
- Amplitude - Maximum distance the wave vibrates from the rest position.
- Wavelength - The distance between any adjacent crests or troughs in a series of waves.
- Crest and Trough - The high point and the low point of each wavelength.
- Period - The time it takes to complete a cycle or wave oscillation.
- Graphing Wave Frequency - the number of waves in a given amount of time.

Aligned Washington State Academic Standards

English Language Arts: Common Core

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

	<p>RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.</p> <p>RST.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 <i>grades 11-12 texts and topics</i>.</p> <p>RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.</p> <p>RST.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.</p> <p>RST.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.</p> <p>RST.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.</p> <p>RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	Standard 1: Ecological, Social, and Economic Systems

	<p>Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment</p> <p>Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility</p> <p>Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HS.N.VM.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, v, $\ v\$, v).</p> <p>HS.N.VM.2 (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.</p> <p>HS.N.VM.3 (+) Solve problems involving velocity and other quantities that can be represented by vectors.</p> <p>HS.N.VM.4 (+) Add and subtract vectors.</p> <p>HS.N.VM.4a Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.</p> <p>HS.N.VM.4b Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.</p> <p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters</p>
Mathematical Practices	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p>

	MP8 - Look for and express regularity in repeated reasoning.	
Science	HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.	
	HS-PS2-4 - Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.	
	HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.	
	HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).	
	HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	
	HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	
	HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	
	HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
	HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	
	HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as as possible social, cultural, and environmental impacts.	
	HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	
	Science and Engineering Practice	Disciplinary Core Idea

Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution.	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World
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Unit 4 Shop Tools	Total Learning Hours for Unit: 20
<p>Unit Summary: Students identify basic manufacturing tasks that hand tools, portable power tools, and installed power shop equipment and machinery may be used to accomplish. Students will have opportunity to up-skill on common power shop equipment, such as the drill press, disk sander, belt sander, pedestal grinder, bandsaw, and manual foot shear. They also will become familiar with safety considerations, normal operating, and common tool applications.</p> <p>Performance Assessments:</p> <p>General Students:</p> <ul style="list-style-type: none"> Understand and apply the criteria to inspect Shop Tools and implement appropriate procedures to notify supervisors of equipment maintenance needs. Explain and demonstrate knowledge of the hand tools, power tools, and stationary equipment found in the classroom and laboratory. Demonstrate observation of correct and safe applications of hand tools, power tools, and stationary equipment concepts in the performance of activities in the classroom and laboratory. Explain and demonstrate safety practices related to tool operation, maintenance, and storage. Demonstrate through written tasks and examinations the concepts and skills in using hand tools, power tools, and stationary equipment. Work groups to safely use hand tools, power tools, and stationary equipment. Use available technology-based tools, printed documentation, and other media sources to research and make presentations of hand tools, power tools. Understand and articulate how to safely handle waste from projects and classroom activities. <p>English/Language Arts Students demonstrate ELA competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> Classroom presentations relating to the safe use, steps in safe and appropriate use of tools, and how to handle changes to materials (heat, material construction, chemical and/or physical reactions, fumes, handling and disposing of waste materials, fuels and lubricants, etc.) and how their use could impact the environment. 	

- Reading information from commonly available sources and then creating an Operator's Manual for various construction tools. Students will include concepts, and information clearly and accurately through the selection, organization, and analysis of content.
- Developing an informative presentation on the safe operation of a power tool. The presentation will fully evaluate the usefulness power tool and identify potential hazards of improper tool use.
- Evaluating other written products and presentations' point of view, reasoning, and use of terminology when using the power tools.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Presenting the safe use of tools to include instruction on the human and machinery force required for the use of the tools. Students will need to understand how much force can safely be used to ensure shop tools are functional as well as safe.
- Identifying the materials that tools are made from and what materials those tools might safely be used (ex. "Can I use a tool made from aluminum to cut or shape a piece of steel? If so, how can it be done?")
- Analyzing real-world situations by presenting solutions based on specific criteria and limitations.
- Communicating technical information or ideas in multiple formats.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Understanding the correct use of shop tools requires an in-depth knowledge of units. It necessitates fluency in the English and Metric system and of the tool - just because the tool provides a measurement, one can't assume it's correct. There are many examples where incorrect units were recorded resulting in safety issues and wasted resources. In this unit, students will practice hands-on skills with a variety of shop tools – being challenged each time, what units to use, why, and what factors go into selecting the appropriate tool.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Safe Use of Hand Tools - Demonstrate an understanding of Hand Tool Safety and Care.
- Safe Use of Power Tools - Demonstrate an understanding of Power Tool Safety and Care.
- Proper Tag-Out Procedures - Inspect Shop Tools and implement appropriate procedures to notify supervisors of equipment maintenance needs.
- Environmental Safety - Understand how to safely handle waste related to Shop Tool use.

Aligned Washington State Academic Standards**English Language Arts: Common Core**

- RL.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 matters uncertain.
- RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
- SL.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.
- SL.11-12.1.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.
- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.

	<p>RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.</p> <p>WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility</p>

	Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.	
Mathematics: Common Core	HSN-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. HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.SSE.A.1 - Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A - Interpret parts of an expression, such as terms, factors, and coefficients	
Math Practices	MP.2 - Reason abstractly and quantitatively. MP.4 - Model with mathematics. MP.5 - Use appropriate tools strategically. MP.6 - Attend to precision. MP.8 - Look for and express regularity in repeated reasoning.	
Science	HS-PS2- Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration. HS-PS2-2 - Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system. HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World
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Unit 5 Safety	Total Learning Hours for Unit: 20
<p>Unit Summary: This unit covers OSHA and Environmental Health & Safety (EH&S) program design in Washington State including goals and practices. Topics include hazardous communication, ergonomics, safety regulations, human factors, and standard operating procedures as they relate to safety, personal protective equipment, and lockout-tag out, hand and power tool safety, industrial housekeeping, and environmental safety.</p> <p><i>It is recommended that teachers investigate the feasibility of having an outside agency provide First Aid Training and Certification as part of this unit.</i></p>	
<p>Performance Assessments: General Assessments will be formal and informal, written, verbal and practical: Lesson 1- Students:</p> <ul style="list-style-type: none"> • Discuss the benefits of an effective environment, health, and safety program. • Describe and apply the four elements of an effective environment, health, and safety program. • Describe and provide examples for each of the three methods to prevent and control workplace hazards. • Explain the term "safety culture." • Observation of correct and accurate applications of safety concepts in the performance of activities in the classroom and laboratory. • Demonstrate through written tasks and examinations the concepts and skills an understanding of safety awareness. • Use various technology-based tools, printed documentation, and other information sources to create aerospace-related presentations related to safety at the workplace and on the water. • Describe the safety requirements for working on shipboard and shoreside n electrical systems. • Describe the application of safe working practices in the workshop environment. • Recognize how safety is applied to the unique environment(s) where work and living spaces coexist. • Complete a job safety analysis for a critical work assignment or a Hot Work Permit for welding. • Demonstrate the use of personal protective equipment (PPE) in shop activities such as grinding, cutting, brazing, etc. • Demonstrate the proper selection and use of tools during shop activities. • Explain the emergency and safety signals. 	

- Explain the process and procedures required for Enclosed Space Entry.
- Describe inhalation hazards and effects of petroleum.
- Describe toxicity and the terms used to describe the toxicity of a substance.
- Describe the hazards associated with Benzene and Hydrogen Sulfide.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities similar to:

- Describe the four main employer responsibilities under the HazCom standard.
- Describe the five basic components of an appropriate HazCom program.
- Compare and contrast the various HazCom labeling requirements.
- Locate, select, and interpret Material Safety Data Sheets (MSDS) for various materials found in the lab or shop.
- Explain and interpret a "fire diamond." Compare and contrast federal, state, and local government safety regulations.
- Locate appropriate safety regulations that affect the individuals and employers.
- Interpret the uniform numbering system for the code of federal regulations and name at least 3 different disciplines from which human factors draws its base of study.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Understanding the MSDS is an individual or pair's activity which reviews the MSDS for Clorox, or other common household items students would be familiar.
- Explaining an Environmental Management System and the goals of the EPA for a facility EMS.
- Utilizing the safe and appropriate use of tools, and how to handle changes to materials (heat, material construction, chemical and/or physical reactions, fumes, handling and disposing of waste materials, etc.
- Analyzing real-world situations by identifying criteria and limits for successful solutions.
- Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- Communicate technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Interpreting Occupational Injury and Illness Data.
- Conduct a short research project to evaluate statistical data sets related to various aerospace-related safety accidents, frequencies, and causes. Organize the results to ensure comprehension by target audience, and present findings.
- Determine the impact of personal protective equipment on productivity by collecting evidence and compiling data.
- Locating and practicing the excavation safety plan for the classroom and laboratory established to ensure safe evacuation in case of emergency.
- Describe how ergonomics plays into manufacture of safety equipment and equipment used in the workplace.

Leadership Alignment:

Throughout this unit, students are being taught and encouraged to use 21st Century Skills such as Leadership and Accountability, Flexibility and Adaptability, Communication and Collaboration, Critical Thinking and Problem Solving as well as Productivity.

Through team-based activities relating to the safe use of shop tools, students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- EHS Program - Identify and understand the components of and reasons for an effective environment, health and safety program.
- Understanding MSDS - Locate, select, and interpret Material Safety Data Sheets (MSDS) for various materials found in the lab or shop.
- *PEAR* Model - Understand how People, Environment, Actions, and Resources (PEAR) can help in the development of a safety management system.
- Safety "Dirty Dozen" - Identify and minimize the 12 common causes of mistakes in Manufacturing and Aerospace.
- Standard Operating Procedures (SOP) - Understand and implement Standard Operating Procedures as they relate to safety and daily operations.
- Personal Protective Equipment (PPE) - Student will be able to demonstrate and use PPE.
- Lockout/Tagout - Student will be able to identify and implement appropriate lockout/tagout procedures.
- Lean Manufacturing and 5S - Apply Lean Manufacturing and 5S principles.
- Environmental Management System - Student will be able to practice environmental safety.

Aligned Washington State Academic Standards

- RL.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 matters uncertain.
- RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.

English Language Arts: Common Core

- SL.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.
- SL.11-12.1.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.
- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

	<p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSS.ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots).</p>

	<p>HSS.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.</p> <p>HSS.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).</p> <p>HSS.ID.A.4 - Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.</p> <p>HSS.IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</p> <p>HSS.IC.A.2 - Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.</p> <p>HSS.IC.B.3 - Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.</p>	
Mathematical Practices	MP2 - Reason abstractly and quantitatively.	
Science	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-2 - Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</p> <p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-ETS1-1. - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3. - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function
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Unit 6 Standard Operating Procedures (SOP)	Total Learning Hours for Unit: 20
<p>Unit Summary: Standard Operating procedures or SOPs are a set of clearly written instructions which outline the steps or tasks needed to complete a job, operation or operate a piece of machinery or plant. The instructions must be written in a brief manner in simple language that all operators and employees required to perform the task are able to read and understand. Students learn the common elements and practice the culture of Quality Management Systems (QMS), which document and analyze every step of a system to improve quality and increase customer satisfaction.</p> <p>In this lesson students will identify and practice the culture of Quality Management Systems (QMS) and will focus on writing and analyzing the Standard Operating Procedures necessary to promote efficiency, quality, safety, and customer satisfaction.</p>	
<p>Performance Assessments: General Students:</p> <ul style="list-style-type: none"> • Define QMS. • Describe Enterprise Level QMS. • Explain the hierarchy of a manufacturing production order. • Identify a standardized process in their environment. • Demonstrate knowledge of SOP and identify revisions required for increase/effective Enterprise QMS. • Define Root Cause Analysis in fundamental terms. 	
<p>English/Language Arts Students demonstrate ELA competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> • Articulating thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts. • Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions. • Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade). 	

- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Reporting and presenting information and drawing conclusions regarding why and how the geographic features of the Pacific Northwest has influenced native culture, exploration, and Aerospace development, past, present, and future.

Mathematics

Students demonstrate mathematics understanding by:

- Data collection and organization relating to root cause analysis to create and implement potential solutions.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- 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 Academic Standards

English Language Arts: Common Core

- RI.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 matters uncertain.
- RI.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.
- RI.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).
- RI.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.
- SL.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.
- SL.11-12.1.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.
- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- SL.11-12.1.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.
- SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
- SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
- SL.11-12.6 - Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.
- L.11-12.1 - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- L.11-12.1.A - Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.
- L.11-12.2 - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
- L.11-12.2.A - Observe hyphenation conventions.

L.11-12.2.B - Spell correctly.

L.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.

L.11-12.4.A - Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

L.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*).

L.11-12.4.C - Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.

L.11-12.4.D - Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary)

L.11-12.5 - Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

L.11-12.5.A - Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.

L.11-12.5.B - Analyze nuances in the meaning of words with similar denotations.

L.11-12.6 - 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.

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.4 - 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*.

RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.

RST.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.

RST.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.

	<p>RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.</p> <p>WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
<p>Environment and Sustainability</p>	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility</p>

	Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.	
Mathematics: Common Core	HSS.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). HSS.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.	
Mathematical Practices	MP2 - Reason abstractly and quantitatively MP4 - Model with mathematics.	
Science	HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems Using Mathematics and Computational Thinking	ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 7 Lean Manufacturing Processes and Principles	Total Learning Hours for Unit: 35
<p>Unit Summary:</p> <p>In this unit, students learn about manufacturing processes. Students will look at the difference between making and manufacturing, and then explore five specific processes, will explore different job shop functions, and will look at the cost and time it takes to produce a part. Students will then learn about how to manage business and processes efficiently and effectively - a Lean approach. They will also find out about how Six Sigma and the Theory of Constraints complement Lean to reduce waste, elevate customer satisfaction, increase profits, and make an overall better workplace.</p> <p><i>It is recommended that during this unit that students will be manufacturing a Capstone project, and this information will be continually instructed throughout the manufacturing process.</i></p> <p><u>In order to meet English Language Arts standards, journaling and other writing and student presentations are embedded into all Core Plus Core Plus units and materials.</u></p>	

Performance Assessments:

General

Students:

- Compare and contrast making vs. manufacturing.
- Select which manufacturing process(es) to use according to the workpiece specifications.
- Classify manufacturing shops by their function(s).
- Design and manufacture a whistle, simulating a job shop.
- Identify how Lean principles help companies compete in a global economy.
- Associate Lean tools with their ability to reduce manufacturing defects.
- 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.
- Define the Theory of Constraints and how it is used to improve a bottleneck scenario.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- 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.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Identify the eight wastes of Lean and how those wastes reduce an organization's profits, competitive edge and customer satisfaction.
- Compare and contrast traditional push and pull systems.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Explain how time and cost factor into the manufacturing process.
- Differentiate between value-added versus non-value-added activities.
- Utilize basic data analysis tools.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).

- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions
- 2.D Solve Problems
- 4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- 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.
- Learn and implement the "6S" Program.

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RI.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 matters uncertain.
- RI.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.
- RI.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).
- RI.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.
- SL.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.
- SL.11-12.1.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.

- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- SL.11-12.1.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.
- SL.11-12.4 - Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks.
- SL.11-12.5 - Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.
- SL.11-12.6 - Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when indicated or appropriate.
- L.11-12.1 - Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.
- L.11-12.1.A - Apply the understanding that usage is a matter of convention, can change over time, and is sometimes contested.
- L.11-12.2 - Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.
- L.11-12.2.A - Observe hyphenation conventions.
- L.11-12.2.B - Spell correctly.
- L.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.
- L.11-12.4.A - Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
- L.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*).
- L.11-12.4.C - Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.
- L.11-12.4.D - Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
- L.11-12.5 - Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.11-12.5.A - Interpret figures of speech (e.g., hyperbole, paradox) in context and analyze their role in the text.

L.11-12.5.B - Analyze nuances in the meaning of words with similar denotations.

L.11-12.6 - 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.

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.4 - 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*.

RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.

RST.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.

RST.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.

RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST.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;

	<p>synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HS.N.VM.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., v, v, $\ v\$, v).</p> <p>HS.N.VM.2 (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.</p> <p>HS.N.VM.3 (+) Solve problems involving velocity and other quantities that can be represented by vectors.</p> <p>HS.N.VM.4 (+) Add and subtract vectors.</p> <p>HS.N.VM.4a Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.</p>

	HS.N.VM.4b Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.	
Mathematical Practices	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.	
Science	HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution.	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 8 Precision Measurement	Total Learning Hours for Unit: 25
Unit Summary: Semi Precision and Precision Measurement is an essential overview of measurement techniques commonly found in manufacturing. Topics include precision measurement vs. semi-precision measurement, units, an introduction to geometric dimensioning and tolerances, and the use, care, and calibration of precision measurement tools. The lesson includes a variety of hands-on activities with several types of precision measurement tools, including English rules (machinist scales), gage blocks, different types of gages, Vernier tools, dial calipers, micrometers, and more. Following successful completion of this unit, students will be able to select and apply the appropriate measurement tool for an assigned task.	

It is recommended that the precision measurement tools be taught in relation to the materials being utilized during the unit. Since the primary measurement tool for wood is a tape measure, framing squares, or other measurement tools that are calibrated in fractions, it is recommended that instruction regarding fractions is taught while wood is the primary material. If metal is the material being utilized, the addition of micrometers and calipers, where the tools are calibrated in decimals, is recommended.

Performance Assessments:

General

Students:

- Properly document, use and maintain semi-precision and precision measurement tools.
- Describe the differences between inland and aerospace sector careers.
- Identify and describe job skills that enable people to enter Aerospace careers, including military opportunities.
- Demonstrate how to read a Vernier scale and/or a dial caliper, and Micrometers.
- Identify and explain the uses of precision measuring tools that are pertinent to the students' career interests.
- Understand basic instrumentation.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Properly document, use and maintain semi-precision and precision measurement tools.
- Describe the differences between inland and aerospace sector careers.
- Identify and describe job skills that enable people to enter Aerospace careers, including military opportunities.
- Identifying the **Geometric Dimensioning and Tolerancing (GD&T)** symbols that represent specific tolerances.
- Read and interpret a **Feature Control Frame**.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Successfully completing the Student Booklet as well as the application of the learning during the design, manufacturing, and testing during laboratory and/or manufacturing activities. Use mathematical representations of phenomena to describe explanations.
- Creating a computational model or simulation of a phenomenon, designed device, process, or system.
- Designing, evaluating, and/or refining a solution to a complex real-world construction problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Identifying and interpreting the information found on a **feature control frame** that is required to describe the conditions and tolerances of a geometric control on a part's feature.
- Creating and using a model based on evidence to predict the relationships between systems or between components of a system.
- Communicating technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Applying math to calculate measurement and tolerances found in industrial manufacturing and repair environments.
- Interpreting a set of geometric dimensioning symbols used to define relationships between a feature and a measurement reference.
- Accurately measuring using semi-precision and precision measurement tools.
- Choosing the appropriate semi-precision and precision measurement tool for an assigned task.
- Selecting appropriate units and level of precision as defined by industry standards.
- Comprehending and applying the concept of scale when reading construction drawings and prints, and when designing projects.
- Performing measurement and layout activities for various aerospace applications. Tasks will include dimensional mathematics, manipulating fractions, and extrapolating values from two-dimension representations to three dimensional products.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Students:

- Define Semi-Precision Measurement and identify units used.
- Explain the care and handling procedures of semi-precision measurement tools.
- Identify steel rules and explain how it is used (10th and 100th, metrics, fractional scales).
- 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 0-1 Micrometer.

- Identify and inside caliper and explain how it is used.
- Identify a feeler gauge and explain how it is used.
- Identify a hole gauge and explain how it is used.
- Identify a go/no go gauge and explain how it is used.

Aligned Washington State Academic Standards

English Language Arts: Common Core

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

RST.11-12.4 - 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*.

RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.

RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.

RST.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.

RST.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.

RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.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.

WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.

WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Environment and Sustainability	Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments. Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.	
Mathematics: Common Core	HSN-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. HSN-Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling. HSN-Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSA.SSE.A.1 - Interpret expressions that represent a quantity in terms of its context. HSA.SSE.A.1.A - Interpret parts of an expression, such as terms, factors, and coefficients	
Mathematical Practices	MP.2 - Reason abstractly and quantitatively. MP.4 - Model with mathematics. MP.5 - Use appropriate tools strategically. MP.6 - Attend to precision. MP.8 - Look for and express regularity in repeated reasoning.	
Science	HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 9 Electrical Systems	Total Learning Hours for Unit: 30
Unit Summary:	

The purpose of this unit is to provide students with the basics of electrical theory, so that those that proceed into careers that are mechanically focused can understand the related electrical circuits and assist electricians and electronics technicians with troubleshooting.

Performance Assessments:

General

Students:

- State the difference between electricity and electronics.
- List the parts of a molecule.
- State the meanings of and the relationship between matter, element, nucleus, compound, molecule, mixture, atom, electron, proton, neutron, energy, valence, valence shell, and ion.
- Describe the importance of observing electrical safety.
- Describe the fundamental concepts of electricity.
- Define open and short circuits and describe their effects on a circuit.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities similar to:

- Describing the laws of magnetic attraction and repulsion.
- Define the terms: retentivity, reluctance, permeability, ferromagnetism, natural magnet, and artificial magnet as used to describe magnetic materials.
- Describing how voltage polarities are assigned to the voltage drops across resistors when Kirchhoff's voltage law is used.
- Stating the meaning of the term source resistance and describe its effect on a circuit.
- Describing in terms of circuit values the circuit condition needed for maximum power transfer.

Science

Students demonstrate Science competencies through several classroom and laboratory activities similar to:

- Stating, in terms of valence, the differences between a conductor, an insulator, and a semiconductor, and list some materials which make the best conductors and insulators.
- Identifying the term power, and state three formulas for computing power.
- Drawing a sketch that depicts magnetic fields and lines of force.
- Identifying the characteristics of magnetic lines of force (magnetic flux), including their relation to magnetic induction and shielding.
- Describing why electrical safety hazards occur.
- Defining and describing electrical bonding or grounding.
- Describing how different current levels affect the human body.
- Describing the ways in which electric shock can be received.
- Identifying the term schematic diagram and identify the components in a circuit from a simple schematic diagram.
- Measuring the voltage at the reference point in a circuit.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Stating the equation for Ohm's law and describe the effects on current caused by changes in a circuit.
- Calculating resistance values, voltage and wattage using Ohm's Law.
- Given simple graphs of current versus power and voltage versus power, determining the value of circuit power for a given current and voltage.
- Computing circuit and component power in series, parallel, and combination circuits.
- Calculating the efficiency of an electrical device.
- Solving for unknown quantities of resistance, current, and voltage in a series circuit.
- Calculating efficiency of power transfer in a circuit.
- Solving for unknown quantities of resistance, current, and voltage in a parallel circuit.
- Computing resistance, current, voltage, and power in voltage dividers.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Science of Basic Electricity – Understanding how electrical current is created and used in Aerospace and manufacturing environments.
- Voltage, Current, and Resistance – How each is measured and utilized in electrical circuits.
- Electrical Circuits – How do design, install, and protect circuits and devices.
- Electrical Safety – Identifying potential hazards and protecting the circuit, devices, and people working on and/or using the electrical devices.

Aligned Washington State Academic Standards

English Language Arts:
Common Core

RI.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 to address a question or solve a problem.

	<p>SL.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.</p> <p>SL.11-12.2 - Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.</p> <p>RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</p> <p>RST.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.</p> <p>RST.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 <i>grades 11-12 texts and topics</i>.</p> <p>RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.</p> <p>RST.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.</p> <p>RST.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.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
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Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p> <p>HSA.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.</p> <p>HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p> <p>HSS.IC.B.6 - Evaluate reports based on data.</p>
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p> <p>MP3 - Construct viable arguments and critique the reasoning of others.</p> <p>MP4 - Model with mathematics.</p> <p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p>

	MP8 - Look for and express regularity in repeated reasoning.	
Science	<p>HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.</p> <p>HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</p> <p>HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).</p> <p>HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p> <p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering and Technology on Society and the Natural World Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems
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Unit 10 Rigging	Total Learning Hours for Unit: 15
Unit Summary: The Rigging unit is designed to provide students with information needed to prepare for and carry out a hands-on skill practice for rigging, lifting, and moving a load. Lesson content includes determining lifting task and job-site requirements, characterization of the load (volume, weight, and center of gravity), selection of rigging equipment, and techniques and procedures for lifting, maneuvering, and moving the load.	
Performance Assessments: General After completing this unit students: <ul style="list-style-type: none"> 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. Recall the four major steps in planning a move. Identify types of rigging, describe their features, and explain uses and inspection criteria. Distinguish between the various types of cranes, hoists and lifting devices encountered at worksites. State and describe the last of the four major steps in planning a move. Demonstrate how to make an eye splice and perform splices in various types of line. Calculate the safe working load (SWL) and select the proper size lifting gear, block, line, or wire. Determine mechanical advantage for common block and tackle arrangements used in the aerospace industry. How to maintain the integrity of lifting gear, routine maintenance, and overall blocks. 	

- Demonstrate how to put a temporary seizing on a wire rope.
- Demonstrate how to put a whipping on a line.
- Demonstrate how to put clamps on wire rope.
- How to measure the dimensions of wire rope.
- How to lash various types of cargo using chain, wire strops and/or fabric straps.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like

- Listing, explaining, and answering the four questions that must be asked before planning a lift or move.
- Identifying types of rigging, describe their features, and explain uses and inspection criteria.
- Formulate a written rigging plan by evaluating the relevant lift factors and selecting the appropriate hardware and rigging configurations.
- For a given lift scenario, assess the proposed lift options and explain/defend the best plan for the operation. Present the rationale and the relevant supporting data to persuade the audience of the decision.
- Distinguishing between the various types of cranes, hoists and lifting devices encountered at worksites.
- Stating and describing the last of the four major steps in planning a move.
- Research on the advances in rigging and their connection to increase trade and commerce.
- Research and presentation on the various methods of transporting cargo. The improvements to cargo handling which lead to containerization.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Developing and using models to predict and show relationships among variables between systems and their components.
- Planning and Carrying Out simulations of rigging applications.
- Obtaining, Evaluating, and Communicating Information related to securing, lifting, and moving loads.
- Designing new systems or structures including detailed examination of the properties of different materials, the structures of different components, and connections of components to solve problems.
- Demonstrating various methods used to reduce friction in rigging operations (chafing gear, grease, lubricants).
- Research the construction and manufacture of ultra-high density polypropylene lines.
- Demonstrate the stresses on the cargo boom at different angles of elevation from the horizontal.
- Demonstrate the effects of torsional resistance on a load.
- Research and demonstrate the effects of a such stop (dynamic load) has on cargo gear.
- Research the dynamic loads on cargo containers located at the top of the stack.
- Research how hooks, shackles, straps, and other lifting gear is manufactured and tested.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Measuring and determining the volume of a load.
- Converting measurements expressed in different units into common units.

- Calculating the weight of a load.
- Determining the Center of Gravity(C/G) for a symmetrical load.
- Determining the Center of Gravity (C/G) for an asymmetric load.
- Determine the appropriate material (rope, strap, cable, etc.) needed to lift designated loads.
- Calculate the forces at each critical part of the lifting arrangement (head block, heel block, strain at winch).
- Calculate the proper size wire rope (diameter)or line (circumference) to be used to provide proper breaking stress and SWL.
- Calculating the SWL of hooks and shackles, other lifting devices.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Organize a lift using techniques learned and instruction to persons about their duties.
- Perform a root cause analysis to determine the failure of a lift.
- Stop work instruction when critical items of lift preparation omitted.
- Demonstrating to another student the techniques for reeving blocks or splicing lines or tying a knot.
- When given a list of lift parameters, picking the proper equipment for the job.
- When given an inoperative lifting arrangement or gear, develop a solution to make it operational.
- Demonstrate how to perform routine maintenance on lifting equipment.

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- ANSI/ASME Standards – Identify and implement the standards regarding lifting and moving loads.
- Classifications of Lifts – Explain how various loads would be classified as a critical lifts, pre-engineered lifts, or ordinary lifts.
- Volume of a Load – Measure and then determine the volume of loads and articulating the requirements and/or constraints of that load.
- Center of Gravity – Determine the Center of Gravity (C/G) for symmetrical and asymmetrical loads.
- Steel Rigging vs. Synthetic Rigging – Differentiate in detail between steel and synthetic rigging materials.

- Hand Signaling - Perform hand signals to direct the load movement.
- Washington State Construction Crane Certification and Crane Operator Certification (see WA L&I website for more info).
- General Industry Cranes – General Safety and Health Standard (see WA L&I website for more info).

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.3 - 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.
- RST.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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
- WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.*
- WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- WHST.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.
- WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific*

	<p><i>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.</i></p> <p><i>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</i></p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.Q.A.1 - Use units 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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
Mathematical Practices	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>
Science	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p>

HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).

HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practice

Disciplinary Core Idea

Crosscutting Concept

Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering and Technology on Society and the Natural World Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems
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Unit 11 Math for Industry	Total Learning Hours for Unit: 35
<p>Unit Summary: This unit helps students recognize where and how mathematics has been and is used in the Aerospace Industry. This unit has been designed to help students see where and how mathematics is used, not only as a process for making various calculations and decisions, but as a means of communication with and between similar disciplines in Aerospace and manufacturing applications.</p>	
<p>Performance Assessments:</p> <p><u>General</u> Students:</p> <ul style="list-style-type: none"> • Explain and demonstrate knowledge of mathematical concepts of as they relate to Aerospace activities. • Observation of correct and accurate applications of mathematic concepts in the performance of practical activities in the classroom and laboratory. • Demonstrate through written tasks and examinations the concepts and skills in using mathematics. • Work in groups to apply mathematics principles. • Use technology-based tools, printed documentation, and other media sources to research and make presentations of mathematical solutions to various aerospace-related activities. <p><u>English/Language Arts</u> Students demonstrate ELA competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> • Synthesizing into coherent written products the culmination of mathematical activities related to manufacturing operations such as estimating, scheduling, or budgeting. 	

- Participating in collaborative activities to solve construction problems with mathematical techniques and present findings to the larger group.
- Writing reports on the biographies of inventors, physicists, chemist, mathematicians, natural scientist, philosophers whose contributions led to the discoveries and principles applied in the classroom, laboratory and real-world activities.
- Synthesizing into coherent written products the culmination of mathematical activities related to aerospace and aerial navigation applications.
- Synthesizing into coherent written products the culmination of mathematical activities related to aerospace engineering operations.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Analyzing complex real-world problems by specifying criteria and constraints for successful solutions.
- Designing, evaluating, and/or refining a solution to a complex real-world Aerospace or manufacturing problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
- Using a model based on evidence to predict the relationships between systems or between components of a system.
- Using mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
- Communicating technical information or ideas (e.g., about events and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).

Mathematics

Math is essential and necessary to be successfully employed in the Aerospace and Manufacturing Industries, and thus has application throughout the Core Plus Aerospace program. Specific "math" performance assessments are included in all units that are part of the Core Plus Aerospace frameworks and curricular materials.

Students demonstrate Math competencies through several classroom and laboratory activities like:

- Mathematical activities related to aerospace and aerial navigation applications such as compass correction, set, drift and leeway, air temperature, pressure and altitude, tides and tidal currents, landing distances and basic piloting.
- Mathematical activities related to aerospace engineering operations such as work, horsepower, and speed.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).
- Working within a team to provide mathematical solutions and interpretations.
- Sharing with teammates their diverse knowledge to better understand mathematical equations.
- Helping others and building team spirit

- Show continuous improvement and gain confidence in providing mathematical solutions in real time in real world applications.

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions
- 2.D Solve Problems
- 4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Equations and Inequalities:
 - Apply properties of real numbers.
 - Evaluate and simplify algebraic expressions.
 - Solve linear equations.
 - Rewrite formulas and equations
 - Use problem solving strategies and models.
 - Solve linear inequalities.
 - Solve absolute values.
- Linear Equations and Functions:
 - Represent relations and functions.
 - Find slope and rate of change.
 - Graph equations of lines.
 - Write equations of lines.
 - Model direct variation
 - Draw scatter plots and best fitting lines.
- Linear Systems and Matrices:
 - Solve linear systems graphically.
 - Solve linear systems algebraically.
- Quadratic Functions:
 - Write quadratic functions and models and use to solve problems.
- Attributes and Relationships of Geometric Objects:
 - Define Pythagorean Theorem and solve problems involving right triangles.
 - Understand and apply theorems about circles.
 - Explain volume formulas and use them in solving problems.
 - Apply geometric concepts in modeling situations.
- Counting Methods and Probability:

- Apply counting principles and permutations.
- Define and use probability.
- Determine expected values.
- Data Analysis and Statistics:
 - Collect and interpret quantitative data.
 - Use normal distributions.
 - Draw conclusions from samples.
- Trigonometric Functions:
 - Apply right triangle trigonometry.
 - Write and apply trigonometric functions and models

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.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.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
- WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.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

	<p>appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.CED.A.2 - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p> <p>HSA.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.</p> <p>HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>HSA.REI.B.4 - Solve quadratic equations in one variable.</p> <p>HSA.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).</p> <p>HSF.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.</p> <p>HSG.CO.B.6 - Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.</p>

	<p>HSG.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.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.</p> <p>HSG.SRT.A.1 - Verify experimentally the properties of dilations given by a center and a scale factor:</p> <p>HSG.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.</p> <p>HSG.C.A.1 - Prove that all circles are similar.</p> <p>HSG.C.A.2 - Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</p> <p>HSG.GPE.A.1 - Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.</p> <p>HSG.GPE.B.6 - Find the point on a directed line segment between two given points that partitions the segment in a given ratio.</p> <p>HSG.GPE.B.7 - Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.</p> <p>HSS.ID.A.1 - Represent data with plots on the real number line (dot plots, histograms, and box plots).</p> <p>HSS.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.</p> <p>HSS.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).</p> <p>HSS.IC.A.1 - Understand statistics as a process for making inferences about population parameters based on a random sample from that population.</p> <p>HSS.IC.B.6 - Evaluate reports based on data.</p>
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p> <p>MP3 - Construct viable arguments and critique the reasoning of others.</p> <p>MP4 - Model with mathematics.</p> <p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>

Science	HS-ETS1-2. - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-ETS1-3. - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts. HS-ETS1-4. - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Developing and Using Models Using Mathematics and Computational Thinking Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Systems and System Models

Unit 12 Hydraulics, Pneumatics, Fluid Lines, and Fittings

Total Learning Hours for Unit: 30

Unit Summary:

In this unit, students learn the physics guiding hydraulics; solve problems using the Pascal's Law, the history of the science of fluids, the terminology common in hydraulics, and safe handling procedures of hydraulic systems, and then learn the fundamentals of a pneumatics system and how it compares to a hydraulics system. Students will learn about basic components, how pneumatic systems work, terminology, and proper safety procedures related to pneumatics.

Students learn the essentials of metal (rigid fluid lines) tubing and what rigid tubing is used for and where they may be used on vessels and shoreside. Students will learn proper installation techniques, including how to repair and replace rigid tubing. The repair and replacement process includes cutting, deburring, bending, and flaring / beading. Students will explore how different fittings are used depending on the type and use of the tubing and inspection techniques and what is and what isn't acceptable. Students will also learn how flexible hosing can fail and the repercussions of failure, the functions of flexible hosing. Students will also learn about proper and improper installation of hoses and fittings, what to look for in a hose inspection, and the importance of hose testing are discussed. At the end, students will be given a hands-on activity working with flexible hosing.

Performance Assessments:

General

Students:

- 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.
- Define pneumatics.
- Describe air compression, air receivers and air preparation.
- Identify typical components of pneumatics.
- Compare and contrast rigid tubing and flexible tubing.
- Build a rigid tubing system using proper cutting, bending, and flaring techniques.
- Discuss how to professionally cut, bend, flare / bead and fit rigid tubing.
- Examine the differences between flaring, double-flaring, and beading.
- Design a flexible hosing system with multiple outputs.
- Build a flexible hosing system with multiple outputs.
- Using correct tools to install the appropriate fittings as stated in installation/repair documents.
- Explain why hoses and piping systems are tested at 1.5 times the working pressure.
- Understand Nominal Pipe Size (NPS) and how they are used to select appropriate sizes of fluid lines.
- Understand the need for flushing and cleaning piping systems.
- Determine whether fluid lines should be repaired or replaced.
- Identifying the need for and procedure to "pickle" a hydraulic system.
- Explaining why and where to use chafing gear on fluid lines.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities similar to:

- Identifying the major historical events (and figures) behind the science of fluids.
- Compare and contrast pneumatics to hydraulics.
- Explaining Open and Closed Circuits.
- Compare and contrast flow rate and velocity of compressed air.
- Explain how a pneumatics system works.
- Explain series parallel rules regarding fluid flow.
- Describe where fluid lines are used on vessels and shoreside.
- Explain the factors to be considered when inspecting and testing rigid tubing.
- Summarize what may cause tubing to burst, crack or leak.
- Compare and contrast pipe threads to machine threads.
- Summarize the repair process, including removing dents and scratches.
- Explain the different options to join metal tubing.
- Describe where flexible hosing is used on vessels and shoreside.
- Summarize what factors should be considered when inspecting and testing flexible hose.
- Explain how to correctly fit flexible hoses and what to avoid (e.g., twisting).
- Comparing and contrasting how and when flexible and/or flexible tubing is used in various manufacturing systems (Aerospace, construction, etc.).

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Explaining the physics guiding hydraulics.
- Describing the advantages and disadvantages of fluid power.
- Practicing safe handling procedures of hydraulics.
- Understanding and calculating Mechanical Advantage.
- Describe vacuum types used in pneumatic systems.
- Demonstrate pneumatics safety when handling components.
- Identifying environmental conditions that influence pressure.
- Selecting proper fluid line materials for various purposes (air, team, oil, water, fuel, cooling, firefighting systems, HVAC, etc.)
- Explain why Teflon™ is a preferred material.
- Discuss how to professionally install a hose clamp.
- Selecting appropriate flexible tubing and various solutions using tubing reactivity and breakdown as criteria.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities similar to:

- Calculating problems related to fluid and pneumatic power using Pascal's Law, Force, Work, and Power equations.
- Explaining and calculating Transmission and Multiplication of Force.
- Explaining and calculating for how pressure is influenced by method of transmission and distance of transmission.
- Calculating Mechanical Advantage.
- Solving problems relating to pressure, compression, and vacuum.
- Calculating Absolute Pressure as it relates to air pressure and Vacuum pressure.
- Identifying and calculate the inside diameter of rigid tubing.
- Measuring and identifying the wall thickness of various fluid lines.
- Calculating and executing the correct angles of bending rigid tubing.
- Calculating the pressure inside of a line to select the appropriate type and material of the lines and select the appropriate type of fittings.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively
2.B Use Systems Thinking
2.C Make Judgments and Decisions
2.D Solve Problems
4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Hydraulic Terminology – Understand and use terminology common to hydraulics.
- Pneumatic Terminology – Understand and use terminology common to pneumatics.
- Compression – Articulate how compression is created and utilized in hydraulics and pneumatics.
- Vacuum – Understand and articulate how vacuum is created and manipulated in manufacturing and the Aerospace industry.
- Pressure – Understand and articulate how pressure is created and manipulated in manufacturing and the Aerospace industry.
- Mechanical Advantage – Understand and calculate the ratio of the force that performs the useful work to the force that is applied.
- Rigid tubing and flexible tubing – Characteristics and appropriate uses
- Cut, bend, flare / bead, and fit rigid tubing – Correctly performing repair tasks.
- Understand Nominal Pipe Size (NPS) - Used to select appropriate sizes of fluid lines.
- Repair or Replace – Making the correct determination and performing the task.

Aligned Washington State Academic Standards

English Language Arts: Common Core

RI.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 to address a question or solve a problem.

SL.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.

SL.11-12.2 - Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.

RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.3 - 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.

RST.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*.

RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.

	<p>RST.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.</p> <p>RST.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.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility</p>

	Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p> <p>HSA.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.</p> <p>HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p> <p>HSA.REI.C.7 - Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.</p> <p>HSF.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.</p> <p>HSF.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.</p> <p>HSF.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.*</p> <p>HSF.IF.C.7.A - Graph linear and quadratic functions and show intercepts, maxima, and minima.</p> <p>HSS.IC.B.6 - Evaluate reports based on data.</p>
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p>

	<p>MP3 - Construct viable arguments and critique the reasoning of others.</p> <p>MP4 - Model with mathematics.</p> <p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>	
Science	<p>HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.</p> <p>HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</p> <p>HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).</p> <p>HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p> <p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering and Technology on Society and the Natural World Connections to Nature of Science Scientific Knowledge Assumes an Order and Consistency in Natural Systems
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Unit 13 Troubleshooting	Total Learning Hours for Unit: 30
<p>Unit Summary: This unit is divided into four related subjects: Basic Troubleshooting Concepts, Troubleshooting Application, Root Cause Analysis, and a Multisystem Troubleshooting Activity.</p> <p>In Basic Troubleshooting Concepts, students learn how to apply the seven phases of troubleshooting: 1) Symptom Recognition, 2) Symptom Verification & Elaboration, 3) Precautionary Actions, 4) Localization: Root Cause Isolation, 5) Corrective Actions, 6) Test, and 7) Prevention of Future Problems. In addition, they will learn concepts such as reproducible symptoms, intermittent symptoms, and distinguishing between degraded operability versus total operational failure. Use of documentation and technical references in the troubleshooting process will also be explained.</p> <p>The Troubleshooting Application section includes presentation and class discussion of an imaginary scenario or case study that illustrates application of concepts learned in the previous lesson. This section has an activity where students apply concepts and procedures of troubleshooting by investigating symptoms of a faulty flashlight and analyzing them to determine the root cause, so effective repairs can be made. The troubleshooting activity includes a statistical process control component, using mathematics concepts, to encourage the school option for mathematics course equivalency credit.</p> <p>In the Root Cause Analysis section, the focus is about approaches and techniques involved in root cause analysis. Although viewed in this unit primarily from the troubleshooting perspective are knowledge of root cause analysis, which is also valuable for quality improvement and process control.</p>	

Designed primarily a capstone, hands-on, guided practice activity, the **Multisystem Troubleshooting Activity** will help students troubleshoot faulty operation of leaf blowers, using techniques and methods learned during this unit. The machines will have faults in the electrical system, the fuel system, and with mechanical parts, making this activity more complex than a single system troubleshooting activity.

To meet English Language Arts standards, journaling and other writing and student presentations are embedded into all Core Plus Core Plus units and materials.

Performance Assessments:

General

Students:

- State the seven phases in logical troubleshooting in the proper sequence.
- State the advantages of using a logical troubleshooting process.
- Explain how to distinguish between intermittent symptoms and reproducible symptoms.
- Differentiate between symptom recognition and symptom elaboration.
- 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.
- 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.
- Explain what is meant in Root Cause Analysis by the term “defining the problem.”
- 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.
- Identify 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.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Define in their own words each phase of the seven-phase troubleshooting process.
- 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.

- Research, design, create and prepare informal documents suitable for the workplace.
- Design a usable, clear, accessible document to capture relevant information needed to reconstruct the troubleshooting process.
- Record data, actions, assumptions, findings, tests, and results in a troubleshooting log.
- Evaluate observations to determine the actual root cause of a faulty symptom.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Specify the questions that must be answered to confirm that the problem and associated symptoms have been corrected.
- Recommend actions to prevent future problems.
- Predict a root cause based upon symptoms.
- Determine corrective action to eliminate the root cause of the symptom.
- Sequence and undertake each phase of the seven-phase troubleshooting process while conducting a hands-on troubleshooting activity on a multisystem machine (leaf blower).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Data collection, organization, and interpretation, and then using that interpretation to determine potential solutions.
- Constructing viable arguments, evaluate, and critique the reasoning of others.
- Utilizing dot plots, various graphs, and other data sources to measure the performance and efficiencies of systems.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Troubleshooting Concepts

Root Cause Analysis

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
- WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- WHST.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.
- WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the

	<p>specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p> <p>HSA.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.</p> <p>HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p>

	<p>HSA.REI.C.7 - Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.</p> <p>HSF.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.</p> <p>HSF.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.</p>	
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p> <p>MP3 - Construct viable arguments and critique the reasoning of others.</p> <p>MP4 - Model with mathematics.</p> <p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>	
Science	<p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution.	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 14 Soldering**Total Learning Hours for Unit: 15****Unit Summary:**

The Soldering Unit is designed to provide students with information needed to prepare for and carry out hands-on soldering activities. There are three lessons. In the first lesson, students will be provided instruction on the basic concepts on soldering, common terminology, and the fundamental science of soldering. In the second lesson, students learn more about soldering, and have a chance to practice soldering. Lesson two topics include: soldering equipment, solder selection, wire prep and inspection techniques. In the last lesson, students will learn more about the soldering and sweating process, use of flux, preparation of pipes, and the heating of base metal.

It is recommended that, before beginning this unit, students complete the following units:

- Materials Science
 - Hand and Power Tools
 - Safety
 - Standard Operating Procedures
 - Precision Measurement
 - Print Reading
 - Applied Physics

Performance Assessments:**General**

Students:

- 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, tin wires, and components.
- Solder the required number of prepared wires to terminations.
- Rework discrepant soldered terminations.
- 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.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Understanding, interpreting, and demonstrating both the manufacturer's safety procedures and the shop's safety procedures with 100% accuracy and consistency.
- Identifying all safety features of the machine, discuss characteristic tool wear and failure, and state how this information can protect the user and others in the shop.
- Given an assembly drawing, the student will be able to use number symbols to match part descriptions on the parts list with the detail of that part on the drawing.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Identifying the characteristics of magnetic lines of force (magnetic flux), including their relation to magnetic induction, and shielding.
- Describing why electrical safety hazards occur.
- Identify the base metal, solder and flux involved in a typical soldering task.
- Explain the role of capillary action in the soldering process.
- 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.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Interpreting and, subsequently, laying out a part to within $\pm .015"$ of drawing specifications.
- Measuring and cutting a length of copper pipe using a pipe cutter or hacksaw.
- Identifying types and wire sizes of solder by composition and gauge and determine their preferred applications.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments, including technical-based language (schematic, pictorial, diagrammatic, etc.).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

- Personal Safety Measures
- Workplace Safety Measures
- Types of Solder, Flux, and Applications

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RI.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 to address a question or solve a problem.
- SL.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.
- SL.11-12.2 - Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.3 - 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.
- RST.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*.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.

	<p>RST.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.</p> <p>RST.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.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility</p>

	Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.CED.A.4 - Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.</p> <p>HSA.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.</p> <p>HSA.REI.A.2 - Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>HSA.REI.C.6 - Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p> <p>HSF.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.</p> <p>HSF.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.</p> <p>HSS.IC.B.6 - Evaluate reports based on data.</p>
Mathematical Practices	<p>MP1 - Make sense of problems and persevere in solving them.</p> <p>MP2 - Reason abstractly and quantitatively.</p> <p>MP4 - Model with mathematics.</p> <p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>

Science	HS-PS1-5 - Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	
	HS-PS2-5. - Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	
	HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	
	HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	
	HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	
	HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	
	HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.	
	HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing Explanations and Designing Solutions Planning and Carrying Out Investigations Developing and Using Models Using Mathematics and Computational Thinking Analyzing and Interpreting Data Obtaining, Evaluating, and Communicating Information	PS1.B: Chemical Reactions PS2.B: Types of Interactions PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Cause and Effect Systems and System Models Energy and Matter Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering and Technology on Society and the Natural World

Unit Summary:

This unit shows students the various types of fasteners used in the Aerospace manufacturing processes. The unit includes information about materials, types of threads, shapes of threads, how they are made, thread-related terms, various types of fasteners, advantages and disadvantages, materials fasteners are made from, and possible production problems associated with the manufacturing of fasteners.

Performance Assessments:**General**

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

- Identify the components of a fastening system using nuts & bolts.
- Indicate and describe the standard features of bolts and nuts.
- 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/loads on installed bolts.
- Use a Grip Scale to verify bolt length.
- Demonstrate the normal installation of bolts.
- Categorize torque wrench types.
- Properly operate a torque wrench.
- 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.
- Describe or demonstrate normal procedures for installation of lockbolt fasteners.
- Distinguish lockbolt installations that are acceptable from those that are unacceptable.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Summarize the use of lubricants and locking devices with nuts & bolts.
- Distinguish between sheer and tension as types of stress/loads on installed bolts.
- Explain the significance of measuring KSI Tensile strength and KSI Shear Strength.
- Explain the limitations and normal use of washers when installing fasteners on aircraft.
- Summarize inspection checks done after fastener installation.
- State the safety considerations when using a lockbolt puller.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- 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.

- List the four forces acting on installed bolts.
- Categorize torque wrench types.
- Properly operate a torque wrench

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Using a Grip Scale to verify bolt length.
- List the four forces acting on installed bolts.
- Measure interior diameter of a drilled hole using a hole gage and micrometer.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions
- 2.D Solve Problems
- 4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Students:

- 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/loads 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 Hi-Loks.
- Indicate and describe the standard features of hex-drive fasteners 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.
- Describe or demonstrate normal procedures for installation of lockbolt Hi-Lok fasteners.
- Distinguish Hi-Lok installations that are acceptable from those that are unacceptable.

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RI.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 to address a question or solve a problem.
- SL.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.
- SL.11-12.2 - Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.
- RST.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.
- RST.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*.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.*
- RST.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.*
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

	<p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p><i>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</i></p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p><i>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</i></p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>

	<p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
Mathematical Practices	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>
Science	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.</p> <p>HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.</p> <p>HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</p> <p>HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).</p> <p>HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p> <p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p>

	<p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit 16 Drilling	Total Learning Hours for Unit: 20
<p>Unit Summary: In this unit, students learn the importance, necessary skills, and precision needed to locate, drill, and evaluate holes according to specifications. Students will learn to identify sharp and/or dull drill bits, round and/or oval holes, off-center holes, and the ergonomic impacts of drilling with corded and non-corded drills and pneumatic tooling.</p> <p>Performance Assessments: General Assessments will be formal and informal, written, verbal and practical. Lesson 1: <ul style="list-style-type: none"> Worksheet: Keep Batch or Not? Standard Deviation Practice Review Quiz Lesson 2: <ul style="list-style-type: none"> Practice Review Quiz Practical Drilling Activity – Aerospace Assembly Project #3 or Equivalent project </p> <p>English/Language Arts Students demonstrate ELA competencies through several classroom and laboratory activities like:</p>	

- 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.
- Provide definition and function to the acceptable and preferred deburring tools.
- Define fastener relief requirements.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Identify proper drilling equipment (Size, Type and Speed) required for drilling.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Converting 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.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Student:

- 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.

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RL.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 matters uncertain.
- RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
- SL.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.
- SL.11-12.1.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.
- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
- WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
- WHST.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.
- WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
- WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.

	WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
Mathematical Practices	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>
	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p>

Science

- HS-PS2-4 - Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.
- HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
- HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
- HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
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Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models <i>Connections to Engineering, Technology, and Applications of Science</i> Influence of Science, Engineering, and Technology on Society and the Natural World
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Unit 17 Cutting and Grinding	Total Learning Hours for Unit: 30
<p>Unit Summary: In this unit, students learn about the foundation for manufacturing methods and processes as related to cutting and grinding. It will require the student to understand and practice shop safety rules, project planning, feeds and speeds, metal cutting saws, lathes, milling machines, and surface grinders. Student will have the opportunity to practice skills through a variety of hands-on projects.</p>	
<p>Performance Assessments: General Students:</p> <ul style="list-style-type: none"> • Identify various metal cutting and grinding equipment and describe situations where one is preferred over another. • Understand and demonstrate the proper and safe use of various cutting and grinding equipment. • Understand the primary uses and benefits of a milling machine. • Calculate the RPM and Feed Rate of a milling machine. • Draw diagrams using the Cartesian 3-D plane (x, y, z). • Critically examine which factors to consider before using a milling machine. • Demonstrate knowledge the safety SOPs of a milling machine. • List the parts of a milling machine. • Build a project using a milling machine. Identify the primary uses of a lathe. • Describe a lathe's operating procedure. • Demonstrate knowledge of the safety SOPs of a lathe. • Use appropriate tooling to produce the project part. <p>English/Language Arts Students demonstrate ELA competencies through several classroom and laboratory activities like:</p> <ul style="list-style-type: none"> • Demonstrate knowledge of sawing vocabulary. 	

- Select the appropriate cutting tool.
- Compare and contrast horizontal and vertical band saws.
- Demonstrate knowledge and appropriate use of milling and lathe vocabulary.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Select the appropriate cutting tool.
- Apply their knowledge of band saws with a hands-on project.
- Understand the primary uses and benefits of a milling machine.
- Understanding the primary uses and benefits of a lathe.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Calculate the RPM and Feed Rate of a milling machine.
- Draw and model plotting on the Cartesian 2-D and 3-D planes.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Students:

- 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 SOPs of a milling machine.
- List the parts of a milling machine.
- Build a project using a milling machine.
- Use appropriate tooling to produce the project part.

Aligned Washington State Academic Standards

English Language Arts: Common Core

- RL.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 matters uncertain.
- RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
- SL.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.
- SL.11-12.1.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.
- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
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RST.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.

RST.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.

RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

WHST.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.

WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.

WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
Mathematical Practices	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>
Science	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.</p>

	<p>HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.</p> <p>HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</p> <p>HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).</p> <p>HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p> <p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and Using Models Planning and Carrying Out Investigations Obtaining, Evaluating, and Communicating Information Asking Questions and Defining Problems Using Mathematics and Computational Thinking	PS1.A: Structure and Properties of Matter PS1.C: Nuclear Processes PS2.B: Types of Interactions ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution	Patterns Energy and Matter Structure and Function Systems and System Models Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World

Unit Summary:

This unit is designed to provide students with information needed to prepare for and carry out a hands-on skill practice for measurement, lay-up, drilling for quality, sheet metal bending, assembly, and riveting. Lesson content includes rivet features, measurement & classification of rivets, safety review, functional reading of instructions, project planning, and execution of the project, use of rivet gun, die, retaining spring, and bucking bar, along with personal protective equipment (PPE). Quality standards of rivet installation are shown, along with the method to remove a rivet if necessary.

Performance Assessments:**General**

Students:

- 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 rivets 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.

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- 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.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Apply knowledge to select and use the appropriate bucking bar for a particular rivet installation.
- Demonstrate the rivet removal process and when it might be required.
- Explain how to rivet parts together permanently using a rivet gun and bucking bar.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Measure and lay-up a sheet metal project.
- Drill holes at correct points.
- Operate a box brake to bend sheet metal.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

1.A Think Creatively

1.B Work Creatively with Others

2.A Reason Effectively

2.B Use Systems Thinking

2.C Make Judgments and Decisions

2.D Solve Problems

4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Students:

- 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.
- Demonstrate 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 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.

English Language Arts: Common Core

- RL.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 matters uncertain.
- RL.11-12.2 - Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
- SL.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.
- SL.11-12.1.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.
- SL.11-12.1.B - Work with peers to promote civil, democratic discussions and decision-making, set clear goals and deadlines, and establish individual roles as needed.
- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

	<p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>

<p>Mathematics: Common Core</p>	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
<p>Mathematical Practices</p>	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>
<p>Science</p>	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-PS2-4 - Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.</p> <p>HS-PS3-1 - Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.</p> <p>HS-PS3-2 - Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).</p> <p>HS-PS3-3 - Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.</p> <p>HS-PS3-4 - Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).</p>

	<p>HS-PS3-5 - Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p> <p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
<p>Developing and Using Models</p> <p>Planning and Carrying Out Investigations</p> <p>Obtaining, Evaluating, and Communicating Information</p> <p>Asking Questions and Defining Problems</p> <p>Using Mathematics and Computational Thinking</p> <p>Constructing Explanations and Designing Solutions</p>	<p>PS1.A: Structure and Properties of Matter</p> <p>PS1.C: Nuclear Processes</p> <p>PS2.B: Types of Interactions</p> <p>ETS1.A: Defining and Delimiting Engineering Problems</p> <p>ETS1.B: Developing Possible Solutions</p> <p>ETS1.C: Optimizing the Design Solution</p>	<p>Patterns</p> <p>Energy and Matter</p> <p>Structure and Function</p> <p>Systems and System Models</p> <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p>

Unit 19 Print Reading	Total Learning Hours for Unit: 35
<p>Unit Summary:</p> <p>This unit includes basic terminology, drawing categories and authorities, all about the picture sheet, including the title block, the geometric elements found in a drawing and the Alphabet of Lines. Students will also learn to interpret different pictorial views of print readings. And then they will practice drawing and constructing these views. These include the most common views, isometric and orthographic, but also include detail, section, auxiliary and cutting views. In addition, students will learn to identify the many drawing symbols found in industry. The more commonly used symbols are included in this lesson: flag notes, holes, materials, shapes, and electric symbols.</p>	
<p>Performance Assessments:</p> <p>General</p> <p>Students:</p> <ul style="list-style-type: none"> Understand fundamental terminology related to prints and drawings. 	

- Recognize different drawing categories.
- Recognize and apply different drawing authorities.
- Recognize the purpose and interpret the various 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.
- Identify the location of safety equipment on a fire control plan.
- Identify key symbols used in specific schematics and drawings.
- Compare a print/drawing to its real-world installation.
- Simulate a procedure/operation which requires reading a print or schematic.
- Creating a print/drawing for their Capstone project (if applicable).
- Recognizing how the principles of Quality assurance apply to the procedures for making changes/corrections to a print/schematic.

English/Language Arts

Students will demonstrate ELA competencies through several classroom and laboratory activities like:

- Understanding fundamental terminology related to sketches, blueprints, and drawings.
- Recognizing drawing categories.
- Translate a simple construction drawing from its symbolic and dimensional representation into a written description that presents the form and function of each element.
- Given a set of specifications, sketch a representation using correct symbols and dimensions, then present your project to the class.
- Apply drawing authorities.
- Recognizing and interpret the elements found on a picture sheet.
- Locating the Title Block on a drawing and identify the name, purpose of a drawing, and other fields depicted.
- Given a drawing, correctly prepare a Request for Information (RFI) that accurately describes the problem and the specifics of the information being sought.
- Researching the “who, what, where, when, why, and how” about CAD drawings and their applications in the aerospace industry.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Describing the safe use of tools, including instruction on the human and machinery force required for the use of the tools.
- Including mathematical representations of events to describe explanations and potential solutions.
- Creating a computational model or simulation of an event, device, process, or system.
- Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
- Use a model based on evidence to predict the relationships between systems or between components of a system.
- Communicate technical information or ideas (e.g., about events and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).
- Reading a print/schematic identifying the equipment and process that is occurring.

- Reading a print/schematic and using knowledge of the function being performed; locate and identify critical points for diagnostic solutions and problem solving i.e., closed/open valves, faulty pressure sensors, bypass valves/lines, etc.

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Creating and using drawings and prints that exhibit perspective, multiple planes, two and three dimensions, blown-up and enlarged views, and details of the drawing.
- Using drawings and blueprints to determine material quantities, convert units of measure, place orders, and construct budgets.
- Consistently and accurately converting measurement values between imperial and metric units and decimals when calculating values
- Using the Pythagorean Theorem to determine and verify square and plumb layout.
- Creating full size or scaled models from prints/schematics used for their Capstone projects.
- Estimating the changes in electrical resistance, amperes, etc. from reading a print/schematic drawing
- Redrawing print/schematic is a different scale or redrawing a specific portion of the schematic.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions
- 2.D Solve Problems
- 4.A Access and Evaluate Information

Industry Standards and/or Competencies:

Students:

- 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 Academic Standards

English Language Arts: Common Core

- RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
- RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
- RST.11-12.4 - 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*.
- RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
- RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.
- RST.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.
- RST.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.
- RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
- WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
- WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.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.

	<p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>
Mathematics: Common Core	<p>HSG.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.</p> <p>HSG.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.</p> <p>HSG.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)</p>
Mathematical Practices	<p>MP.2 - Reason abstractly and quantitatively.</p> <p>MP.4 - Model with mathematics.</p> <p>MP.5 - Use appropriate tools strategically.</p> <p>MP.6 - Attend to precision.</p> <p>MP.8 - Look for and express regularity in repeated reasoning.</p>
Science	<p>HS-PS2-1 - Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.</p> <p>HS-PS2-2 - Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</p>

	<p>HS-PS2-3 - Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.</p> <p>HS-ETS1-1. - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3. - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
<p>Developing and Using Models</p> <p>Planning and Carrying Out Investigations</p> <p>Obtaining, Evaluating, and Communicating Information</p> <p>Asking Questions and Defining Problems</p> <p>Using Mathematics and Computational Thinking</p> <p>Constructing Explanations and Designing Solutions</p>	<p>PS1.A: Structure and Properties of Matter</p> <p>PS1.C: Nuclear Processes</p> <p>PS2.B: Types of Interactions</p> <p>ETS1.A: Defining and Delimiting Engineering Problems</p> <p>ETS1.B: Developing Possible Solutions</p> <p>ETS1.C: Optimizing the Design Solution</p>	<p>Patterns</p> <p>Energy and Matter</p> <p>Structure and Function</p> <p>Systems and System Models</p> <p><i>Connections to Engineering, Technology, and Applications of Science</i></p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p>

Unit 20 Capstone Project	Total Learning Hours for Unit: 35
<p>Unit Summary:</p> <p>It is recommended that to complete this unit students will be manufacturing a Capstone project, which is the SkillsInc CTE project #3.</p> <p><u>It is recommended that this information be covered during manufacturing steps where the specific information is pertinent.</u></p> <p><u>In order to help meet English Language Arts standards, journaling, other writing (lab reports, manufacturing documentation, etc.), and student presentations are embedded into all Core Plus Aerospace units and materials.</u></p> <p>Capstone project ideas may include individual student projects, group projects, community-based projects, presentations, preparation for and participation in CTSO events, and the manufacture of teaching aids for various units that may be used during the instruction of Aerospace units in the future.</p>	
<p>Performance Assessments:</p> <p>General</p> <p>Students:</p> <ul style="list-style-type: none"> Describe various career opportunities in the Aerospace industry. Identify and describe job skills that enable people to enter Aerospace careers, including military opportunities. 	

English/Language Arts

Students demonstrate ELA competencies through several classroom and laboratory activities like:

- Researching and presenting information in various formats that pertain to the current and potential career opportunities available in the Pacific Northwest relating to the Aerospace Industry. Students will incorporate into these presentations social, environmental, and economic impacts of various careers and identify the skills and experience needed for various certifications and advancement in these career opportunities.
- Creating and presenting classroom and community presentations.

Science

Students demonstrate Science competencies through several classroom and laboratory activities like:

- Reporting and presenting information and drawing conclusions regarding why and how the geographic features of the Pacific Northwest has influenced Aerospace development, past, present, and future.
- Designing a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- Evaluating a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- Providing a practical demonstration or documentation supporting the scientific aspects of their Capstone project.
- Applying scientific principles to design and construction of their Capstone project.
- Working within a team to develop and defend arguments based upon scientific reasoning and deduction.
- Apply the principles of simple machines and the laws of physics in the rigging or physical construction of their Capstone project.
- Selecting the appropriate construction materials relevant to their Capstone project (wood, aluminum, steel, non-magnetic, etc.).

Mathematics

Students demonstrate mathematics competencies through several classroom and laboratory activities like:

- Evaluating a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- Applying appropriate precision during the design, manufacturing, and testing of the Capstone Project.
- Using appropriate formulae and performing required mathematical calculations to support the physics of their Capstone project.
- Performing material cost analysis, cost of ancillary equipment and calculation of production time of their Capstone project.
- Mathematical calculations related to measurements required in their Capstone project.
- Evaluating and calculating the cost of revisions/alterations from the original design of their Capstone project.

Leadership Alignment:

Through team-based activities relating to Aerospace Careers students:

- Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts.
- Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions.
- Use communication for a range of purposes (e.g., to inform, instruct, motivate, and persuade).
- Utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.

- Communicate effectively in diverse environments (including multi-lingual).

Leadership Skills:

- 1.A Think Creatively
- 1.B Work Creatively with Others
- 2.A Reason Effectively
- 2.B Use Systems Thinking
- 2.C Make Judgments and Decisions
- 2.D Solve Problems
- 4.A Access and Evaluate Information

Industry Standards and/or Competencies:

The Design Process - Design, cost analysis, manufacturing, testing, and quality assurance documentation.

Safety – Knowledge and understanding of safe conditions and procedures.

Standard Operating Procedures – Understanding and applying standard procedures.

Precision Measurement – Using correct tools and standards to manufacture within appropriate precision, accuracy, and tolerance.

Print Reading – Creating and/or interpreting design specifications.

Material Science – Selection of appropriate materials to be used in the manufacturing of the Capstone Project.

Aligned Washington State Academic Standards

English Language Arts: Common Core	<p>RST.11-12.1 - Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.</p> <p>RST.11-12.2 - Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.</p> <p>RST.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 <i>grades 11-12 texts and topics</i>.</p> <p>RST.11-12.5 - Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.</p> <p>RST.11-12.7 - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) to address a question or solve a problem.</p> <p>RST.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.</p> <p>RST.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.</p> <p>RST.11-12.10 - By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.</p>
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	<p>WHST.11-12.1.A - Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.</p> <p>WHST.11-12.2.E - Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).</p> <p>WHST.11-12.4 - Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.</p> <p>WHST.11-12.5 - Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.</p> <p>WHST.11-12.6 - Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.</p> <p>WHST.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.</p> <p>WHST.11-12.8 - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.</p> <p>WHST.11-12.9 - Draw evidence from informational texts to support analysis, reflection, and research.</p> <p>WHST.11-12.10 - Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.</p>
Environment and Sustainability	<p>Standard 1: Ecological, Social, and Economic Systems Students develop knowledge of the interconnections and interdependency of ecological, social, and economic systems. They demonstrate understanding of how the health of these systems determines the sustainability of natural and human communities at local, regional, national, and global levels.</p> <p>Standard 2: The Natural and Built Environment Students engage in inquiry and systems thinking and use information gained through learning experiences in, about, and for the environment to understand the structure, components, and processes of natural and human-built environments.</p> <p>Standard 3: Sustainability and Civic Responsibility Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.</p>

Mathematics: Common Core	<p>HSN.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.</p> <p>HSN.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSN.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>HSA.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.</p> <p>HSA.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.</p> <p>HSA.REI.B.3 - Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters</p>	
Mathematical Practices	<p>MP5 - Use appropriate tools strategically.</p> <p>MP6 - Attend to precision.</p> <p>MP7 - Look for and make use of structure.</p> <p>MP8 - Look for and express regularity in repeated reasoning.</p>	
Science	<p>HS-ETS1-1 - Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-ETS1-2 - Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ETS1-3 - Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4 - Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p>	
Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking Questions and Defining Problems Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	<p>ETS1.A: Defining and Delimiting Engineering Problems</p> <p>ETS1.B: Developing Possible Solutions</p> <p>ETS1.C: Optimizing the Design Solution</p>	<p>Systems and System Models</p> <p>Connections to Engineering, Technology, and Applications of Science</p> <p>Influence of Science, Engineering, and Technology on Society and the Natural World</p>