Washington Office of Superintendent of
PUBLIC INSTRUCTION

Learning that works for Washington
CTE

Statewide Framework Document for: 150613

Core Plus

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 and leadership alignment may be developed at the local level. In order to earn state approval, performance assessments must be submitted within this framework. **This course is eligible for one credit of 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.

School District Name	
Course Title: Core Plus	**Total Framework Hours:** up to 540
CIP Code: 150613 ☐ Exploratory ☒ Preparatory	**Date Last Modified:** December 30, 2020
Career Cluster: Manufacturing	**Cluster Pathway:** Manufacturing Production Process Development
Course Summary: This CORE Plus course receives eligibility for one science credit as well as CTE credit. It is a preparatory course focusing on manufacturing segmented into 18 units totaling 540 class hours. The course uses multiple manufacturing technologies like hydraulics, rigging, fasteners. Students will apply scientific thinking and processes to troubleshoot fixes and refine manufacturing steps with scientific principles like determining electrical flow and determining the center of gravity for an asymmetrical load so that manufacturing processes are the most efficient. This course will challenge students to be able to master real world thinking with challenging units to help refine their employability and developmental goals.	
Eligible for Equivalent Credit in: Science	**Total Number of Units:** 18
Course Resources: Aerospace Joint Apprenticeship Committee (AJAC), American Society of Metals (ASM), Boeing, Federal Aviation Association (FAA), National STEM Consortium (NSC), Non-Destructive Resource Center (NDT), and other industry-accepted knowledge, skills and abilities (KSA).	

Unit 1: Materials Science	**Total Learning Hours for Unit:** 140

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

- Lab: Sulfur
- Lab: Rhombic Sulfur
- Lab: Amorphous Sulfur
- Activity 1: Copper Sulfate Demonstration (Growing single crystals)
- Activity 2: Phenyl Salicylate Demonstration
- Lab: Growing Silver Crystals
- Lab: Models of Crystals
- Activity: Iron Wire Demo
- Activity 3: Copper Wire Demonstration
- Lab: Heat – Treating Steel
- Lab: Heat Treating Iron
- Activity: Journaling
- Extra Activities: MAST Module Metals – Experiment 3 Processing Metals and Experiment 4 Tensile Strength Test for Various Metals
- Student Booklet: Reading, Writing, and Activities

Lesson 3:

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

Lesson 4:

Module 1: Chemistry for Composites

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

Addendum includes:

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

Module 2: Structure and Repair I

- Student Quiz

Module 3: Structure and Repair II

- Student Quiz

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students, through team-based Materials Science-based activities and laboratory experiments, should articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts.
- Students listen effectively to decipher meaning, including knowledge, values, attitudes and intentions.
- Students use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade).
- Students utilize multiple media and technologies and know how to judge their effectiveness a priority as well as assess their impact.
- Students 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 will be able to:

- Explain the importance of materials sciences.
- Apply basic chemistry to explain physical and chemical characteristics of the four categories of materials.
- Apply knowledge of materials science to explain materials choices in design.
- Use critical thinking to evaluate and apply appropriate materials choice for specific applications.
- Demonstrate practical reasoning, and hands-on/minds-on, problem-solving skills in designing, fabricating, and constructing projects during the course.
- Use writing to record observations, procedures, and experiments and as a tool for thinking, studying, and learning the subject matter.
- Define materials science and how it has changed through history.
- Classify matter.
- Summarize the spatial relationships found on the Periodic Table of Elements.
- Define types of structure, crystalline vs. amorphous.
- Define types of bonding.
- Identify types of properties.

- Relate properties to types of bonding.
- Describe through writing and discussion the basic properties of materials: mechanical, thermal, chemical, optical, and magnetic.
- Characterize materials on the basis of chemical bonding and crystal structure.
- Distinguish between crystal structure and crystal system.
- Describe the relationship between atomic radius and lattice parameter.
- Compare and contrast crystalline and amorphous structures.
- Provide examples of materials that change among amorphous and crystalline states.
- Describe the effect of crystal defects and imperfections in material properties.
- List several common materials used in the design and construction of structures.
- Define simple properties of materials, such as strength, flexibility, transparency.
- Select suitable materials for making a particular object based on their properties.
- Explain the advantages and disadvantages of common materials used in engineering structures.
- Distinguish between chemical and physical properties of a material.
- Differentiate between oxidation and reduction especially as they pertain to galvanic corrosion.
- Define thermal expansion.
- Evaluate the effects of thermal expansion on design considerations.
- Describe the response to force or stress using the terms: workability (malleability and ductility), brittleness, hardness, elasticity and plasticity, toughness and strength.
- Define mechanical properties: tensile strength, compression, fatigue, flexure, impact, torsion, hardness, and shear.
- Relate the physical characteristics of materials such as workability and brittleness to the mechanical properties such as tensile and compressive strength to impact design considerations.
- Describe composite materials.
- Explain the use of ancillary materials.
- Demonstrate basic fabrication techniques.
- Define fiber-reinforced composites.
- Discuss properties of composites.
- Recognize products made from fiber-reinforced composites.
- Explain the differences between polymers and composites.
- Explain the key differences between composites properties and metal properties.
- Calculate resin-fiber ratio.
- Fabricate a fiber reinforced composite part.
- Demonstrate safe fabrication practices.
- Define and prevent resin migration and materials contamination.

Aligned Washington State Academic Standards	
Science	HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the

	patterns of electrons in the outermost energy level of atoms. HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. 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-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials. 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. Cross-cutting. HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. Cross-Cutting.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Unit 2: Shop Tools	**Total Learning Hours for Unit:** 20
Performance Assessments: (Districts to complete for each unit) *Example assessments for this unit include:* Lesson 1: • Hand Tools ID Activity Lesson 2: • Class Discussion Lesson 3: • Power Shop Equipment Test	
Leadership Alignment: (Districts to complete for each unit) *Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.*	

Example:

- Students make presentations regarding shop tools and equipment. Through the assignment creation and presentation students will.
- Students work in small groups, on teams, with partners and as individuals to complete safety assignments.
- Students reflect on their decisions and actions through self-evaluations as related to work products and behavior in the shop/lab setting.
- Students rotate through various roles in their project groups which will require them to be responsible for the safety and wellbeing of their team.
- Students are empowered and expected to enforce all safety procedures in the shop/lab setting.
- Students lead to serve as peer evaluators and guides on basic skill development assignments.

Leadership Skills:

- Guide and Lead Others (11.A.1, 11.A.2)
- Be Responsible to Others (11.B.1)
- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3)
- Solve Problems (2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Work Independently (8.B.1)

Industry Standards and/or Competencies:

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

- Describe and select the appropriate power equipment to accomplish a particular workplace function.
- Explain the potential hazards of each individual power shop machine.
- List and point to the safety controls used for each power shop machine and items to inspect prior to use.
- Specify the features and major components of each shop machine in this Unit.
- Explain basic techniques and proper use of common power shop equipment and machinery, including the drill press, disk sander, belt sander, pedestal grinder, band saw, and the manual foot shear.

Aligned Washington State Academic Standards	
Science	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**

Unit 3: Safety	**Total Learning Hours for Unit:** 20

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

- Math Worksheet: Interpreting Occupational Injury and Illness Data
- Test

Lesson 2:

- Tombstone Project

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students make presentations regarding safety practices. Students will serve as peer evaluators on class assignments and projects.
- Students develop the ability to lead and guide others by serving as peer project guides and elbow partners.
- Students reflect on their decisions and behaviors through self-evaluations as related to work products and behavior in the shop/lab setting.
- Students are responsible for themselves and others while working in the shop environment and call out any unsafe behavior they witness.
- Students collaboratively with others in small groups, partnerships and as individuals to complete projects in a safe and effective manner.
- Students lead others in safety presentations and discussions.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)

- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)

Industry Standards and/or Competencies:

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

Aligned Washington State Academic Standards	
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**

Unit 4: Standard Operating Procedures	**Total Learning Hours for Unit:** 20

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students serve as peer evaluators on class assignments and projects.
- Students develop the ability to lead and guide others by serving as peer project guides and elbow partners.
- Students reflect on their decisions and behaviors through self-evaluations as related to work products and behavior in the shop/lab setting.
- Students are responsible for themselves and others while working in the shop environment and call out any unsafe behavior they witness.
- Students work collaboratively with others in small groups, partnerships and as individuals to complete projects in a safe and effective manner.
- Students lead others in safety presentations and discussions.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)

Industry Standards and/or Competencies:

Standard/Unit:

- 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	
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**

Unit 5: Precision Measurement | **Total Learning Hours for Unit:** 20

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

- Student Booklet: Geometric Dimensioning & Tolerancing

Lesson 3

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.
Example:

- Students serve as peer evaluators on class assignments and projects.
- Students develop the ability to lead and guide others by serving as peer project guides and elbow partners.
- Students reflect on their decisions and behaviors through self-evaluations as related to work products and behavior in the shop/lab setting.
- Students are responsible for themselves and others while working in the shop environment and call out any unsafe behavior they witness.
- Students work collaboratively with others in small groups, partnerships and as individuals to complete projects in a safe and effective manner.
- Students lead others in safety presentations and discussions.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Interact Effectively with Others (9.A.1, 9.A.2)
- Work Effectively in Diverse Teams (9.B.1, 9.B.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

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

- Identify the parts and read an outside Micrometer.

Aligned Washington State Academic Standards	
Science	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**

Unit 6: Fasteners	**Total Learning Hours for Unit:** 10

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1

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

Lesson 2

- Practice Review Quiz
- Permanent Fastener Installation Activity

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)

- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

- Identify the components of a fastening system using nuts & bolts
- Indicate and describe the standard features of bolts and nuts
- Specify the materials from which bolts & nuts are made
- Identify protruding bolt head style
- Summarize the use of lubricants and locking devices with nuts & bolts
- Distinguish between sheer and tension as types of stress/load on installed bolts
- List the four forces acting on installed bolts
- Explain the significance of measuring KSI Tensile strength and KSI Shear Strength
- Use a Grip Scale to verify bolt length
- Measure interior diameter of a drilled hole using a hole gage and micrometer
- Demonstrate the normal installation of bolts
- Categorize torque wrench types
- Properly operate a torque wrench
- Identify the components of a fastening system using hex-drive fasteners and lockbolts.
- Indicate and describe the standard features of hex-drive fasteners and lockbolts.
- Distinguish between Hi-Lite and Hi-Lok fasteners and explain the different uses for which they may installed.
- Using a power drill motor, socket and hex drive wrench, demonstrate the normal installation of hex-drive fasteners such as Hi-Lites and Hi-Loks.
- Distinguish protruding head from flush head fasteners.
- Explain the limitations and normal use of washers when installing fasteners on aircraft.
- Summarize inspection checks done after fastener installation.
- Demonstrate the proper removal of hex drive fasteners.
- Point out features of lockbolts, explaining how they are used to securely fasten parts or sheets of material together.
- State the safety considerations when using a lockbolt puller.

- Describe or demonstrate normal procedures for installation of lockbolt fasteners.
- Distinguish lockbolt installations that are acceptable from those that are unacceptable.

Aligned Washington State Academic Standards	
Science	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**

Unit 7: Drilling	**Total Learning Hours for Unit:** 10

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

- Practice Review Quiz
- Practical Drilling Activity

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)

- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

- 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

Science	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

Unit 8: Cutting and Grinding	**Total Learning Hours for Unit:** 20

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

- Lab Project: Making a Star

Lesson 2:

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

Lesson 3:

- Lab Project: Lathe Component

Lesson 4:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

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

- Demonstrate knowledge on how surface grinders work.
- Exhibit awareness of how to select the appropriate grinding wheel for a workpiece.
- Describe the SOP's of a surface grinder.
- Apply their knowledge of a surface grinder machine by grinding a part (assuming a surface grinder is available).

Aligned Washington State Academic Standards		
Science	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**

Unit 9: Riveting	**Total Learning Hours for Unit:** 10

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

- Practice Review

Lesson 2:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)

- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

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

Aligned Washington State Academic Standards	
Science	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

Unit 10: Print Reading	**Total Learning Hours for Unit:** 30

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

- PowerPoint Activities
- Activities: Identifying Lines and Interpreting Drawings

Lesson 2:

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

Lesson 3:

- Unit Project: Constructing and Drawing a Sliced Cube within Tolerance
- Group Activity: Guessing Production Tolerance

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students demonstrate their ability to interpret prints while assisting others as they develop their skill set.
- Students work in small groups, with partners and as individuals to complete assignments and projects from supplied prints.
- Students demonstrate professional communication and behavior be acting as peer evaluators on assigned projects.
- Students reflect on their decisions and skill development through self-evaluations on assigned projects.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab setting at all times.

Leadership Skills:

- Reason Effectively (2.A.1)
- Make Judgments and Decisions (2.C.1, 2.C.3)
- Solve Problems (2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.3)

- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Interact Effectively with Others (9.A.1, 9.A.2)
- Work Effectively in Diverse Teams (9.B.1, 9.B.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)
- Guide and Lead Others (11.A.1, 11.A.2)
- Be Responsible to Others (11.B.1)

Industry Standards and/or Competencies:

- Student will be able to:
- 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	
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**

Unit 11: Applied Physics	**Total Learning Hours for Unit:** 30

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

- Worksheet: Vectors
- Quiz

Lesson 3:

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

Lesson 4:

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

Lesson 5:

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

Lesson 6:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.
Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned in rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1

Industry Standards and/or Competencies:
Student will be able to:

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

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

Aligned Washington State Academic Standards	
Science	HA-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-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. HS-PS3-2 Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept

Unit 12: Math for Industry	**Total Learning Hours for Unit:** 30

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

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

Lesson 3:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively in small groups to complete projects that will require them to design, schedule and execute a math plans on assignments and projects.
- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.

- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned to rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students provide guidance and feedback to fellow work group members and classmates through peer evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students rotate through leadership roles in the class throughout the unit.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Work Creatively with Others (1.B.2)
- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Interact Effectively with Others (9.A.1, 9.A.2)
- Work Effectively in Diverse Teams (9.B.1, 9.B.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1a,10. B.1b,10. B.1c,10. B.1d,10. B.1e,10. B.1f,10. B.1g,10. B.1h)

Industry Standards and/or Competencies:

Student will be able to:

- Identify and name an angle.
- Measure an angle using a protractor.
- Classify triangles by their angles as right, obtuse, or equilateral.
- Classify triangles by their sides as equilateral, isosceles, or scalene.
- Use the triangle angle sum theorem to determine the measure of an angle in a triangle.
- Determine the measure of an angle by applying the concept of complementary or supplementary angles.
- Identify corresponding sides and angles in similar triangles.
- Determine corresponding angles and sides of similar triangles, using proportions.
- Apply the Pythagorean Theorem to calculate the length of a side of a right triangle.
- Calculate all angles and sides of a right triangle using trigonometry.
- Visualize relationships between two-dimensional and three-dimensional objects.

- Apply geometric concepts in modeling situations.
- Reason quantitatively and use units to solve problems.
- Describe the layout and identify the quadrants of the Cartesian coordinate system.
- Given the point on a graph, determine the ordered pair.
- Given a point on a graph, recognize whether an ordered pair is an x or y intercept.
- Graph points on the coordinate plane given an ordered pair.
- Visually identify whether the slope of a line is positive, negative, zero or undefined.
- Given the coordinates of two points on a line, determine the slope.
- Given data modeling a situation, interpret its slope.
- Given the coordinate of two points on a line, determine its linear equation.
- Given a linear equation, graph a line on the coordinate plane.
- Calculate the midpoint between two points on a line.
- Calculate the distance between two points.
- Given points on a graph, determine a best fit line.

Aligned Washington State Academic Standards	
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**

Unit 13: Rigging	**Total Learning Hours for Unit:** 30

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

- Knowledge Assessment Quiz

Lesson 3:

- Knowledge Assessment Quiz

Activity: Practice lift and movement of a load

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1a,10. B.1b,10. B.1c,10. B.1d,10. B.1e,10. B.1f,10. B.1g,10. B.1h)

Industry Standards and/or Competencies:

Student will be able to:

- Refer to the ANSI/ASME standards that are observed regarding lifting and moving loads
- List, explain and answer the four questions that must be asked before planning a lift or move.
- Given a set of circumstances, predict whether a proposed load movement would be classified as a critical lift, pre-engineered lift, or ordinary lift.
- State the four major steps in planning a move, including two elements of what to look for in each step.
- Apply elements of an ordinary lift plan to an actual lift.

- Measure and determine the volume of a load.
- Convert measurements expressed in different units into common units.
- Calculate the weight of a load.
- Determine the Center of Gravity(C/G) for a symmetrical load.
- Determine the Center of Gravity (C/G) for an asymmetric load.
- Recall and describe the four major steps in planning a move.
- Recall and list the elements of an ordinary lift plan
- Identify types of rigging, describe their features, and explain uses & inspection criteria.
- Differentiate in detail between three examples of steel rigging and three examples of synthetic rigging
- Select and inspect rigging for an actual load lift and movement
- Distinguish between the various types of cranes, hoists and lifting devices encountered at a worksites
- Conduct a pre-operational crane or hoist inspection.
- Rig a load for lift and movement
- State and describe the last of the four major steps in planning a move.
- Rig a load.
- Perform hand signals to direct the load movement.
- Lift and move a load safely using a hoist, or crane if available.

Aligned Washington State Academic Standards	
Science	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

Unit 14: Hydraulics and Pneumatics	**Total Learning Hours for Unit:** 30

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

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

Leadership Alignment: (Districts to complete for each unit)
Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.
Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:
Student will be able to:

- Explain the physics guiding hydraulics.
- Calculate problems related to fluid power using Pascal's Law, Force, Work, and Power equations.
- Identify the major historical events (and figures) behind the science of fluids.

- Describe the advantages and disadvantages of fluid power.
- Identify and explain the factors to consider when setting up a hydraulic system.
- Define terminology common to hydraulics.
- List the typical components of a basic hydraulics system.
- Recognize the fluid power components from schematics.
- Learn and practice safe handling procedures of hydraulics.
- Learn and practice safe handling procedures of hydraulics.
- Apply the knowledge of hydraulics with a hands-on project.

Aligned Washington State Academic Standards	
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**

Unit 15: Electrical	**Total Learning Hours for Unit:** 35

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

- Practice Review/Quiz

Lesson 2:

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

Lesson 3:

- Practice Review/Quiz

Lesson 4:

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

Student Handout

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

- Describe the basic structure of the atom.
- Define the term: Electron.
- Define the term: Proton.
- Define the term: Neutron.
- Define the term: Valence Shell.
- Define the term: Negative Ion.
- Explain the characteristics of insulators, semiconductors, and conductors.
- Describe how an atom becomes an ion.
- Explain the process of current flow.
- List the six sources of electricity and explain how they produce electrical pressure.

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

Aligned Washington State Academic Standards	
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**

Unit 16: Soldering	**Total Learning Hours for Unit:** 25

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

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

Lesson 3:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students collaboratively with others to complete assigned projects both in the classroom and lab setting.
- Students assume various roles and responsibilities in group work and will demonstrate the skills necessary to support the success of the group in assignment completion.
- Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students consider their own knowledge, skills and abilities through self-evaluations.
- Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.
- Students show up to class on time and prepared to work and except the same of their classmates.
- Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.

Leadership Skills:

- Reason Effectively (2.A.1)
- Use Systems Thinking (2.B.1)
- Make Judgments and Decisions (2.C.1, 2.C.3, 2.C.4)
- Solve Problems (2.D.1, 2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.2, 4.B.3)

- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:

Student will be able to:

- Define the process of soldering, distinguishing the difference between welding, brazing, and soldering
- Apply safety precautions when soldering
- Identify the base metal, solder and flux involved in a typical soldering task
- Explain the role of capillary action in the soldering process
- Distinguish between soft soldering, hard soldering and brazing, including differences in solder and temperatures required
- Relate typical applications where soldering is used
- List common solder alloys and sequence the ratios of common lead-tin alloy solders
- Explain eutectic solder and the properties that make it unique
- List the various forms of solder available and explain the applications in which each is used
- Identify at least three weights and gauges of commonly available solder wire
- Describe the purpose of flux and specify the differences between resin flux and acid flux
- List the general steps involved in the soldering process
- Describe soldering equipment and choose the best type for the assigned task
- Use the solder code to identify the solder type.
- Remove the wire insulation and Tin wires and components
- Solder the required number of prepared wires to terminations
- Rework discrepant soldered terminations
- Measure and cut a length of copper pipe using a pipe cutter or hacksaw
- Deburr and clean the base metal at the joint
- Apply flux and heat copper piping for soldering
- Solder a joint between two copper pipes according to industry standards
- Clean excess flux from a soldered copper piping joint

Aligned Washington State Academic Standards	
Science	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

Unit 17: Troubleshooting	**Total Learning Hours for Unit:** 25

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

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

Lesson 2:

- In-class Activity # 1: Troubleshooting Faulty Flashlights (Addendum)
- In-class Activity # 2: Statistical Process Control (Math Activity in Addendum))
- Knowledge Assessment Quiz (Addendum)

Lesson 3

- Practice Review/Quiz

Lesson 4

- In-class Activity: Troubleshooting Leaf Blowers

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively in small groups to develop a workplan and timeline for assigned group projects.
- Students work independently managing their time to complete skill development projects.
- Students work as a collective to maintain a safe work environment.
- Students demonstrate professional communication and through peer evaluations.

Leadership Skills:

- Reason Effectively (2.A.1)
- Make Judgments and Decisions (2.C.1, 2.C.3)
- Solve Problems (2.D.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.3)

- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Interact Effectively with Others (9.A.1, 9.A.2)
- Work Effectively in Diverse Teams (9.B.1, 9.B.2)
- Guide and Lead Others (11.A.1, 11.A.2
- Be Responsible to Others (11.B.1)

Industry Standards and/or Competencies:

Student will be able to:

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

- Define the concept of Root Cause Analysis.
- List the steps for performing Root Cause Analysis .
- Explain what is meant in Root Cause Analysis by the term “defining the problem.”
- Describe ways that evidence and data are gathered for analysis.
- Summarize the various basic tools and methods available for performing root cause analysis .
- Compare and explain examples of the “Five Whys” technique.
- Apply the “Five Whys” technique to determine the root cause of a problem.
- Draw a blank example of a Fishbone/Ishikawa diagram .
- Explain how a Fishbone diagram allows troubleshooters to determine root causes and contributing factors that create a fault or symptom.
- 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.
- Sequence and undertake each phase of the seven-phase troubleshooting process while conducting a hands-on troubleshooting activity on a multisystem machine (leaf blower).
- Record data, actions, assumptions, findings, tests, and results in a troubleshooting log.
- Predict a root cause based upon symptoms.
- Evaluate observations to determine the actual root cause of a faulty symptom.
- Determine corrective action to eliminate the root cause of the symptom.
- Interact collaboratively with other students to complete the activity assignment.

Aligned Washington State Academic Standards			
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**

Unit 18: Lean/Manufacturing Processes and Principles	**Total Learning Hours for Unit:** 35

Performance Assessments: (Districts to complete for each unit)

Example assessments for this unit include:

Lesson 1:

- Article and Questions: ‘Castings vs. Foundry: What’s the Difference?’ by Brad Done
- Designing and Making Whistles
- Worksheet: Modeling Production

Lesson 2:

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

Leadership Alignment: (Districts to complete for each unit)

Leadership alignment must include a unit specific project/activity that aligns with the 21st Century Leadership Skills.

Example:

- Students work collaboratively with others to complete assigned projects both in the classroom and shop/lab setting.
- Students reflect upon their own actions and decisions through self-evaluations on assigned projects.
- Students practice professional communication and behavior through peer evaluations on assigned projects.
- Students develop the ability to lead and guide others by serving as peer project guides and elbow partners.
- Students recognize their role in the health and wellbeing of all members of the class.

Leadership Skills:

- Think creatively (1.A.1, 1.A.3)
- Work Creatively with Others (1.B.2)
- Reason Effectively (2.A.1)
- Make Judgments and Decisions (2.C.1, 2.C.3)
- Solve Problems (2.D.2)
- Communicate Clearly (3.A.1, 3.A.2, 3.A.3, 3.A.4, 3.A.5)
- Assess and Evaluate Information (4.A.1, 4.A.2)
- Use and Manage Information (4.B.1, 4.B.3)
- Adapt to Change (7.A.1)
- Be Flexible (7.B.1, 7.B.2)
- Manage Goals and Time (8.A.3)
- Work Independently (8.B.1)
- Be Self-Directed Learners (8.C.1, 8.C.2)
- Collaborate with Others (3.B.1, 3.B.2, 3.B.3)
- Interact Effectively with Others (9.A.1, 9.A.2)
- Manage Projects (10.A.1, 10.A.2)
- Produce Results (10.B.1)

Industry Standards and/or Competencies:
Student will be able to:

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

Aligned Washington State Academic Standards	
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**