

## 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 3<sup>rd</sup> year math.** 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](#).

School District Name		
<b>Course Title:</b> Core Plus		<b>Total Framework Hours:</b> 540
<b>CIP Code:</b> 150613	<input type="checkbox"/> Exploratory <input checked="" type="checkbox"/> Preparatory	<b>Date Last Modified:</b> December 30, 2020
<b>Career Cluster:</b> Manufacturing		<b>Cluster Pathway:</b> Manufacturing Production Process Development
<b>Course Summary:</b> This CORE Plus preparatory course is eligible for one credit of a third-year mathematics equivalency. The course which is 540 hours long is broken into 18 units focusing on manufacturing coupled with rigorous math learning and practice. Students will use mathematical principles in applying algebraic and geometric principles to solving real world manufacturing problems. The course will focus on interpreting mathematical components to define, solve and formulate solutions to a more streamlined manufacturing process. This course will help students become a valuable asset by setting them on the path to the creation, maintenance, and for the refining a manufacturing processes at a very high level. Students should expect to be challenged with multi-dimensional units of learning and study that challenge all types of learning while ensuring that they become hireable employees of the future.		
<b>Eligible for Equivalent Credit in:</b> Math		<b>Total Number of Units:</b> 18

**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 21<sup>st</sup> 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**

##### **Math Practices and Standards**

N-Q.A Reason Quantitatively and use units to solve problems.

	<p>N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>G-CO.A Experiment with transformation in the plane.</p> <p>G-SRT.A Understand similarity in terms of similarity transformation</p>
	<p>MP1. Make sense of problems and persevere in solving them</p> <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 7. Look for and make use of structure.</p> <p>MP 8. Look for and express regularity in repeated reasoning.</p>

Unit 2: Shop Tools	Total Learning Hours for Unit: 20
<p><b>Performance Assessments:</b> (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li>• <sup>1</sup>Hand Tools ID Activity</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>• Class Discussion</li> </ul> <p>Lesson 3:</p> <ul style="list-style-type: none"> <li>• Power Shop Equipment Test</li> </ul>	
<p><b>Leadership Alignment:</b> (Districts to complete for each unit)</p> <p><i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i></p> <p><i>Example:</i></p> <ul style="list-style-type: none"> <li>• Students make presentations regarding shop tools and equipment. Through the assignment creation and presentation students will.</li> <li>• Students work in small groups, on teams, with partners and as individuals to complete safety assignments.</li> <li>• Students reflect on their decisions and actions through self-evaluations as related to work products and behavior in the shop/lab setting.</li> <li>• Students rotate through various roles in their project groups which will require them to be responsible for the safety and wellbeing of their team.</li> <li>• Students are empowered and expected to enforce all safety procedures in the shop/lab setting.</li> <li>• Students lead to serve as peer evaluators and guides on basic skill development assignments.</li> </ul> <p>Leadership Skills:</p> <ul style="list-style-type: none"> <li>○ Guide and Lead Others (11.A.1, 11.A.2)</li> <li>○ Be Responsible to Others (11.B.1)</li> </ul>	

- 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**

##### **Math Practices and Standards**

N-Q.Q.A: Reason quantitatively and use units to solve problems.  
 N-Q.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  
 N-Q.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

	MP5: Use appropriate tools strategically. MP6: Attend to precision.
--	--

**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:

- <sup>1</sup>Math Worksheet: Interpreting Occupational Injury and Illness Data
- Test

Lesson 2:

- <sup>1</sup>Tombstone Project

**Leadership Alignment:** (Districts to complete for each unit)*Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> 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 Ergonomics
- 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

<b>Math Practices and Standards</b>	<p>S-IC.B Making inference and justifying conclusions  S-IC.B.3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.</p> <p>N-Q.Q.A: Reason quantitatively and use units to solve problems.  N-Q.Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>G-GMD.B Visualize relationships between two-dimensional and three-dimensional object  G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.</p>
	<p>MP2: Reason abstractly and quantitatively  MP4 Model with mathematics  MP5: Use appropriate tools strategically.  MP6: Attend to precision.</p>

#### 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:

- <sup>1</sup>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 21<sup>st</sup> 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**

**Math Practices and Standards**

1.2.1 Communicate and collaborate to learn with others.

	1.3.3 Analyze, synthesize and ethically use information to develop a solution, make informed decisions and report results. 2.1.1 Practice personal safety. 2.1.2 Practice ethical and respectful behavior. 2.4.1 Formulate and synthesize new knowledge S-IC.B Making inference and justifying conclusions S-IC.B.3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each
	MP2: Reason abstractly and quantitatively

Unit 5: Precision Measurement	Total Learning Hours for Unit: 20
<p><b>Performance Assessments:</b> (Districts to complete for each unit)  <i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li>• <sup>1</sup>Math Worksheet: Solving for Radical Solutions</li> <li>• <sup>1</sup>Student Booklet: Semi-Precision Measurement: <ul style="list-style-type: none"> <li>○ Using a Scale</li> <li>○ Reading a Scale</li> </ul> </li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>• <sup>1</sup>Student Booklet: Geometric Dimensioning &amp; Tolerancing</li> </ul> <p>Lesson 3</p> <ul style="list-style-type: none"> <li>• <sup>1</sup>Worksheets 1 and 2: Reading a Micrometer</li> <li>• <sup>1</sup>Lab Activity: Practicing Precision Measurement</li> <li>• <sup>1</sup>Exam: Measurement covers Lessons 1, 2, and 3</li> <li>• <sup>1</sup>Student Booklet: Precision Measurement <ul style="list-style-type: none"> <li>○ 6-Inch Dial Calipers</li> <li>○ Micrometers</li> <li>○ Ball Gages</li> </ul> </li> </ul> <p><b>Leadership Alignment:</b> (Districts to complete for each unit)  <i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i>  <i>Example:</i></p> <ul style="list-style-type: none"> <li>• Students serve as peer evaluators on class assignments and projects.</li> <li>• Students develop the ability to lead and guide others by serving as peer project guides and elbow partners.</li> <li>• Students reflect on their decisions and behaviors through self-evaluations as related to work products and behavior in the shop/lab setting.</li> </ul>	

- 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

<b>Math Practices and Standards</b>	<p>Lesson 1</p> <p><u><a href="#">1Math Worksheet: Solving for Radical Solutions (Addendum)</a></u></p> <p>MP1: Make sense of problems and persevere in solving them.</p>
-------------------------------------	---

	<p>A-REI.B: Reasoning with Equations and Inequalities.  A-REI.B.4: Solve quadratic equations in one variable.</p> <p>Lesson 2</p> <p><u><sup>1</sup>Semi-Precision Measurement Practice: Using and Reading a Scale</u></p> <p>MP5: Use appropriate tools strategically.  MP6: Attend to precision.  N-Q.A: Reason quantitatively and use units to solve problems.  N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  N-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>Lesson 3</p> <p>MP6: Attend to precision.  G-GMD.B: Visualize relationships between two-dimensional and three-dimensional objects.  G-MG.A: Apply geometric concepts in modeling situations. Use geometric shapes, their measures, and their properties to describe objects.</p> <p>MP5: Use appropriate tools strategically.  MP6: Attend to precision.  N-Q.A: Reason quantitatively and use units to solve problems.  N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  N-Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>
--	--

<b>Unit 6:</b> Fasteners	<b>Total Learning Hours for Unit:</b> 10
<p><b>Performance Assessments:</b> (Districts to complete for each unit)  <i>Example assessments for this unit include:</i></p> <p>Lesson 1</p> <ul style="list-style-type: none"> <li><sup>1</sup>Worksheet - Thread Measurement: Three Wire Method</li> <li>Practice Review Quiz</li> <li><sup>1</sup>Nut &amp; Bolt Installation Activity</li> </ul> <p>Lesson 2</p>	

- Practice Review Quiz
- <sup>1</sup>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 21<sup>st</sup> 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 expect 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

##### Math Practices and Standards

##### Lesson 1

<sup>1</sup>Worksheet - Thread Measurement: Three Wire Method

MP4 Model with mathematics.

MP5 Use appropriate tools strategically.

F-BF.A.1.A Write a function that describes a relationship between two quantities.

F-BF.A.1.B Build new functions from existing functions.

##### Lesson 2

<sup>1</sup>Nut & Bolt Installation Activity

MP4 Model with mathematics

MP5: Use appropriate tools strategically.

MP6: Attend to precision.

N-Q.B: Reason quantitatively and use units to solve problems.

N-Q.B.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

	<p>G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.</p> <p>Lesson 3</p> <p><sup>1</sup> Permanent Fastener Activity</p> <p>MP4 Model with mathematics</p> <p>MP5: Use appropriate tools strategically.</p> <p>MP6: Attend to precision.</p> <p>N-Q.A: Reason quantitatively and use units to solve problems.</p> <p>N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.</p>
--	--

Unit 7: Drilling	Total Learning Hours for Unit: 10
<p><b>Performance Assessments:</b> (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li><sup>1</sup>Worksheet: Keep Batch or Not? Standard Deviation</li> <li>Practice Review Quiz</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>Practice Review Quiz</li> <li><sup>1</sup>Practical Drilling Activity</li> </ul>	
<p><b>Leadership Alignment:</b> (Districts to complete for each unit)</p> <p><i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i></p> <p><i>Example:</i></p> <ul style="list-style-type: none"> <li>Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.</li> <li>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.</li> <li>Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.</li> <li>Students reflect upon their own actions and decisions through self-evaluations on assigned projects.</li> <li>Students consider their own knowledge, skills and abilities through self-evaluations.</li> <li>Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.</li> <li>Students show up to class on time and prepared to work and except the same of their classmates.</li> <li>Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.</li> </ul> <p>Leadership Skills:</p> <ul style="list-style-type: none"> <li>Reason Effectively (2.A.1)</li> </ul>	



- 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	
<b>Math Practices and Standards</b>	<p>Lesson 1</p> <p>MP 1 Reason abstractly and quantitatively.</p> <p>MP6 Attend to precision.</p> <p>S-ID.A Summarize, represent, and interpret data on a single count or measurement variable.</p> <p>S-IC.B Make inferences and justify conclusions from sample surveys, experiments and observational studies.</p> <p>S-MD.A Calculate expected values and use them to solve problems.</p> <p>Lesson 2</p> <p>MP4 Model with mathematics</p> <p>MP5: Use appropriate tools strategically.</p> <p>MP6: Attend to precision.</p> <p>N-Q.A: Reason quantitatively and use units to solve problems.</p> <p>N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems: choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.</p>

Unit 8: Cutting and Grinding	Total Learning Hours for Unit: 20
<p><b>Performance Assessments:</b> (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li><sup>1</sup>Lab Project: Making a Star</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li><sup>1</sup>Lab Project: Square Up a Block, Including Trammig</li> <li><sup>1</sup>Booklet includes: <ul style="list-style-type: none"> <li>Worksheet: Calculating the RPM for Milling Machines</li> <li>Worksheet: Feed Rate</li> <li>Worksheet: Identify Parts of Milling Machine</li> <li>Notes and Worksheet: Cartesian Plane Practice</li> </ul> </li> </ul> <p>Lesson 3:</p> <ul style="list-style-type: none"> <li><sup>1</sup>Lab Project: Lathe Component</li> </ul> <p>Lesson 4:</p> <ul style="list-style-type: none"> <li>Cutting &amp; Grinding Quiz</li> </ul>	

- <sup>1</sup>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 21<sup>st</sup> 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 expect 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

#### Math Practices and Standards

##### Lesson 1

##### <sup>1</sup>Lab Project: Making a Star

MP1 Make sense of a problem and persevere in solving them.

MP4 Model with mathematics

N-Q.A Quantities - Reason quantitatively and use units to solve problems.

A-SSE.A Interpret the structure of expressions.

A-SSE.A.1.A Interpret parts of an expression, such as terms, factors, and coefficients.

A-SSE.A.2 Write expressions in equivalent forms to solve problems.

G-SRT.D Apply trigonometry to general triangles.

G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.

G-MG.A Apply geometric concepts in modeling situations.

G-MG.A.3 Apply geometric methods to solve design problems.

##### <sup>1</sup>Lab Project: Square Up a Block, Including Tramming (in Addendum)

MP4 Model with mathematics

MP5 Use appropriate tools strategically

MP6 Attend to precision

N-Q.A Quantities - Reason quantitatively and use units to solve problems.

	<p>N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.  G-MG.A Visualize relationships between two-dimensional and three-dimensional objects.  G-MG.A.3 Apply geometric methods to solve design problems.</p> <p>Lesson 2  <sup>1</sup><i>Instructor and Student Booklet</i>  <i>Worksheets: RPM and Feed Rate calculations</i>  MP6 Attend to precision.  N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p><i>Cartesian Plane</i>  MP4 Model with mathematics  G-MD.B Visualize relationships between two-dimensional and three-dimensional objects.</p> <p>Lesson 3  <sup>1</sup><i>Lab Project: Lathe Component</i>  MP4 Model with mathematics  MP5 Use appropriate tools strategically  MP6 Attend to precision  N-Q.A Quantities - Reason quantitatively and use units to solve problems.  N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>Lesson 4  <sup>1</sup><i>Lab Project: Surface Grinder</i>  MP5 Use appropriate tools strategically  MP6 Attend to precision  N-Q.A Quantities - Reason quantitatively and use units to solve problems.  N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities</p>
--	--

<b>Unit 9: Riveting</b>	<b>Total Learning Hours for Unit: 10</b>
<p><b>Performance Assessments:</b> (Districts to complete for each unit)  <i>Example assessments for this unit include:</i>  Lesson 1:</p> <ul style="list-style-type: none"> <li>Practice Review</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li><sup>1</sup>Riveting Installation Activity</li> </ul>	

- Riveting Project Questions
- <sup>1</sup>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 21<sup>st</sup> 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 expect 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

#### Math Practices and Standards

#### <sup>1</sup>Riveting Installation Activity

MP5 Use appropriate tools strategically

MP6 Attend to precision

N-Q.A Quantities - Reason quantitatively and use units to solve problems.

N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

#### <sup>1</sup>Worksheet: Rivets – What's the Chance?

MP8 Look for and express regularity in repeated reasoning.

SS-CPA.A Understand independence and conditional probability and use them to interpret data.

SS-CPA.A.3 Understand the conditional probability of  $A$  given  $B$  as  $P(A \text{ and } B)/P(B)$ , and interpret independence of  $A$  and  $B$  as saying that the conditional probability of  $A$  given  $B$  is the same as the probability of  $A$ , and the conditional probability of  $B$  given  $A$  is the same as the probability of  $B$ .

SS-CP.B Use the rules of probability to compute probabilities of compound events.

SS-CP.B.6 Find the conditional probability of  $A$  given  $B$  as the fraction of  $B$ 's outcomes that also belong to  $A$ , and interpret the answer in terms of the model.

SS-CP.B.8 (+) Apply the general Multiplication Rule in a uniform probability model,  $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$ , and interpret the answer in terms of the model.

### 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
- <sup>1</sup> Activities: Identifying Lines and Interpreting Drawings

Lesson 2:

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

Lesson 3:

- <sup>1</sup>Unit Project: Constructing and Drawing a Sliced Cube within Tolerance
- <sup>1</sup>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 21<sup>st</sup> 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 by 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****Math Practices and Standards**

MP4: Model with mathematics.  
G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects  
G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

MP4: Model with mathematics.  
MP5: Use appropriate tools strategically.  
N-Q.A Reason quantitatively and use units to solve problems.  
G-CO.A Experiment with transformations in the plane  
G-CO.A.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.

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

G-MG.A Apply geometric concepts in modeling situations  
G-MG.A.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).\*

	<p><i><sup>1</sup>Unit Project: Constructing and Drawing a Sliced Cube within Tolerance</i></p> <p>MP1: Make sense of problems and persevere in solving them.</p> <p>MP4: Model with mathematics.</p> <p>MP5: Use appropriate tools strategically.</p> <p>MP6: Attend to precision.</p> <p>N-Q.A Reason quantitatively and use units to solve problems.</p> <p>G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.</p> <p>G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects</p> <p>G-GMD.B.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.</p> <p>G-MG.A Apply geometric concepts in modeling situations</p> <p>G-MG.A.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).*</p> <p><i><sup>1</sup>Group Activity: Guessing Production Tolerance</i></p> <p>MP2: Reason abstractly and quantitatively.</p> <p>MP6: Attend to precision.</p> <p>N-Q.A Reason quantitatively and use units to solve problems.</p> <p>N-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.</p> <p>N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p> <p>S-IC.B Make inferences and justify conclusions from sample surveys, experiments, and observational studies</p> <p>S-IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.</p>
--	--

## 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:

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

Lesson 2:

- <sup>1</sup>Worksheet: Vectors
- Quiz

#### Lesson 3:

- <sup>1</sup>Mechanical Advantage Try These (PowerPoint)
- <sup>1</sup>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)
- <sup>1</sup>Worksheet: Converting BTU to ft-lb and vice versa (found in Addendum)
- <sup>1</sup>Worksheet: Calculate Thermal Expansion (found in Addendum)
- Psi Activity (embedded in PowerPoint)
- <sup>1</sup>Worksheet: Calculate Pressure (found in Addendum)
- <sup>1</sup>Suction Cup Activity (embedded in PowerPoint)

#### Lesson 5:

- <sup>1</sup>Worksheet: Gas Law Calculations (found in Booklet)
- Buoyancy Force 'Try These' (embedded in PowerPoint)
- Buoyancy Force Activity (found in Booklet)
- <sup>1</sup>Worksheet: Physics Conversions (found in Booklet)

#### Lesson 6:

- Laser Article and Question (found in Booklet)
- <sup>1</sup>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 21<sup>st</sup> 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 expect 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

<b>Math Practices and Standards</b>	<p>Lesson 1</p> <p><i><sup>1</sup>Worksheets 1 and 2: Mass/Weight/Gravity and Density/Mass/Volume Calculations</i></p> <p>N.Q Reason quantitatively and use units to solve problems.</p> <p>N.Q.A Reason quantitatively and use units to solve problems.</p>
-------------------------------------	--

N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

A.CED.A Create equations that describe numbers or relationships.

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law  $V = IR$  to highlight resistance  $R$ .

A.REI.A Understand solving equations as a process of reasoning and explain the reasoning.

A.REI.B Solve equations and inequalities in one variable.

A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

#### Lesson 2

##### *<sup>1</sup>Embedded in PowerPoint and Assessed in Quiz*

MP7: Look for and make use of structure.

MP8: Look for and express regularity in repeated reasoning.

N.Q.A Reason quantitatively and use units to solve problems.

N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

A.CED.A Create equations that describe numbers or relationships

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law  $V = IR$  to highlight resistance  $R$ .

A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

#### Lesson 3

##### *<sup>1</sup>Worksheet: Vectors*

MP2: Reason abstractly and quantitatively.

N-VM.A Represent and model with vector quantities.

N-VM.A.1 (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g.,  $\mathbf{v}$ ,  $|\mathbf{v}|$ ,  $\|\mathbf{v}\|$ ,  $v$ ).

N-V.B Perform operations on vectors.

N-V.B.4 (+) Add and subtract vectors.

##### *<sup>1</sup>Mechanical Advantage Try These*

MP1: Make sense of problems and persevere in solving them.

A-REI.B Solve equations and inequalities in one variable

A-REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

High School: Modeling

<sup>1</sup>*Torque/Lever Activity*

MP1: Make sense of problems and persevere in solving them.

MP4: Model with mathematics.

MP5: Use appropriate tools strategically.

MP6: Attend to precision.

A-REI.B Solve equations and inequalities in one variable

A-REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

High School: Modeling

Lesson 4

*Worksheets: BTU Conversions, Thermal Expansion, Pressure Calculations (see Addendum for Worksheets) and Suction Cup Activity (embedded in PowerPoint)*

MP5: Use appropriate tools strategically.

MP7: Look for and make use of structure.

MP8: Look for and express regularity in repeated reasoning.

N.Q.A Reason quantitatively and use units to solve problems.

N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

A.CED.A Create equations that describe numbers or relationships.

A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law  $V = IR$  to highlight resistance  $R$ .

A.REI.A Understand solving equations as a process of reasoning and explain the reasoning.

A.REI.B Solve equations and inequalities in one variable.

A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Lesson 5

<sup>1</sup>*Gas Law Calculations (Booklet)*

MP6: Attend to precision.

	<p>MP7: Look for and make use of structure.</p> <p>A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</p> <p><sup>1</sup><i>Conversions (Booklet)</i></p> <p>MP6: Attend to precision.</p> <p>MP7: Look for and make use of structure.</p> <p>N.Q.A Reason quantitatively and use units to solve problems.</p> <p>N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.</p> <p>Lesson 6</p> <p><sup>1</sup><i>Student Project: Laser Levels</i></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>N.Q.A Reason quantitatively and use units to solve problems.</p> <p>G-GMD.B Visualize relationships between two-dimensional and three-dimensional objects.</p> <p>G-MG.A Apply geometric concepts in modeling situations</p> <p>G-MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p>
--	--

## 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:

- <sup>1</sup>Online Work: [oli.cmu.edu](http://oli.cmu.edu) STEM Readiness, Module 8: Triangles
- <sup>1</sup>Lab Project: 'Designing a Footbridge with Trusses'.

Lesson 2:

- <sup>1</sup>Lab Project: 'Building a Footbridge with Trusses'.

Lesson 3:

- <sup>1</sup>Online Work: [oli.cmu.edu](http://oli.cmu.edu) STEM Readiness, Module 9: Cartesian Plane
- <sup>1</sup>Lab Project: Testing Your Footbridge

Lesson 4:



- 18 Tasks
- 16 Smarter Balanced Math Lesson Plans
- 1SBA Math Practice Assessment

**Leadership Alignment:** (Districts to complete for each unit)

*Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> 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.
- Represent a constraint by shading the correct side of the inequality line.
- Understand how combining inequalities affects a solution space.
- Interpret a situation and represent the constraints and variables mathematically.
- Select appropriate mathematical methods to use.
- Explore the effects of systematically varying the constraints.
- Interpret and evaluate generated data and identify the optimum case, checking it for confirmation.
- Communicate mathematical reasoning clearly.
- Find, based on equations, lines that are parallel and perpendicular.
- Identify and use intercepts.
- Understanding how the factored form of the function can identify a graph's roots.
- Understanding how the completed square form of the function can identify a graph's maximum or minimum point.
- Understanding how the standard form of the function can identify a graph's intercept.

- Articulate verbally the relationships between variables arising in everyday context.
- Translate between everyday situations and sketch graphs of relationships between variables.
- Interpret algebraic functions in terms of the contexts in which they arise.
- Reflect on the domains of everyday functions and in particular whether they should be discrete or continuous.

### Aligned Washington State Academic Standards

#### Math Practices and Standards

N-Q.A Reason quantitatively and use units to solve problems.  
 N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  
 N-Q.2A. Define appropriate quantities for the purpose of descriptive modeling.  
 A.REI.B Solve equations and inequalities in one variable.  
 A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.  
 G.CO.D Make geometric constructions  
 G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).  
 G.SRT.A Understand similarity in terms of similarity transformations  
 G.SRT.A.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.  
 G.SRT.C Define trigonometric ratios and solve problems involving right triangles.  
 G.SRT.C.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.  
 G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects.  
 G.MG.A Apply geometric concepts in modeling situations  
 G.MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).  
 N-Q.A Reason quantitatively and use units to solve problems.  
 G.CO.D Make geometric constructions  
 G.CO.D.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.).  
 G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects.  
 G.MG.A Apply geometric concepts in modeling situations  
 G.MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).  
 N-Q.A Reason quantitatively and use units to solve problems.

A.REI.B Solve equations and inequalities in one variable.

A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

F.IF.B Interpret functions that arise in applications in terms of the context.

F.IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F.IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.\*

F.LE.B Interpret expressions for functions in terms of the situation they model.

F.LE.B.5 Interpret the parameters in a linear or exponential function in terms of a context.

G.GPE.B Use coordinates to prove simple geometric theorems algebraically

G.GPE.B.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

S.ID.B Summarize, represent, and interpret data on two categorical and quantitative variables.

S.ID.B.6 Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

S.ID.B.6.a Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

S.ID.B.6.b Informally assess the fit of a function by plotting and analyzing residuals.

S.ID.B.6.c Fit a linear function for a scatter plot that suggests a linear association.

Interpret linear models

S.ID.C Interpret linear models.

S.ID.C.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

N.RN.A Extend the properties of exponents to rational exponents.

N.RN.A.1 Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define  $5^{\frac{1}{3}}$  to be the cube root of 5 because we want  $(5^{\frac{1}{3}})^3 = 5^1$  to hold, so  $(5^{\frac{1}{3}})^3$  must equal 5 .

N.RN.A.2 Rewrite expressions involving radicals and rational exponents using properties of exponents.

N-RN.B Use properties of rational and irrational numbers

A-SSE.A Interpret the structure of expressions.

A-SSE.A.2 Use the structure of an expression to identify ways to rewrite it. For example, see  $x^4 - y^4$  as  $(x^2)^2 - (y^2)^2$ , thus recognizing it as a difference of squares that can be factored as  $(x^2 - y^2)(x^2 + y^2)$ .

A-SSE.B Write expressions in equivalent forms to solve problems.

A-SSE.B.3 Choose and produce an equivalent form of an expression to reveal and explain

A-SSE.B.3.a Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-APR.A Perform arithmetic operations on polynomials.

A-APR.A.1 Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

A-APR.B Understand the relationship between zeros and factors of polynomials.

A-APR.B.2 Know and apply the Remainder Theorem: For a polynomial  $p(x)$  and a number  $a$ , the remainder on division by  $x - a$  is  $p(a)$ , so  $p(a) = 0$  if and only if  $(x - a)$  is a factor of  $p(x)$ .

A-APR.B.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-CED.A Create equations that describe numbers or relationships.

A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

A-REI.B Solve equations and inequalities in one variable.

A-REI.B.4 Solve equations and inequalities in one variable.

A-REI.C Solve systems of equations.

A-REI.C.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line  $y = -3x$  and the circle  $x^2 + y^2 = 3$ .

A-REI.D Represent and solve equations and inequalities graphically

A-REI.D.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

A-REI.D.11 Explain why the  $x$ -coordinates of the points where the graphs of the equations  $y = f(x)$  and  $y = g(x)$  intersect are the solutions of the equation  $f(x) = g(x)$ ; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where  $f(x)$  and/or  $g(x)$  are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.

F-IF.C Analyze functions using different representations.

F-IF.C.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.

F-IF.C.7.a Graph linear and quadratic functions and show intercepts, maxima, and minima.

	<p>F-IF.C.7.c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.</p> <p>F-LE.A Construct and compare linear, quadratic, and exponential models and solve problems.</p> <p>S.IC.B Make inferences and justify conclusions from sample surveys, experiments, and observational studies.</p> <p>S.IC.B.4 Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.</p>
<b>Mathematical Practices</b>	<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>MP5: Use appropriate tools strategically.</p> <p>MP7: Look for and make use of structure.</p> <p>MP8: Look for an express regularity in repeated reasoning.</p>

Unit 13: Rigging	Total Learning Hours for Unit: 30
<p><b>Performance Assessments:</b> (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li>Load Characterization Activity Worksheets: <ul style="list-style-type: none"> <li><sup>1</sup>Converting Dimensions</li> <li><sup>1</sup>Practicing Volume and Weight</li> <li><sup>1</sup>Center of Gravity</li> </ul> </li> <li>Practice Review/Quiz</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>Knowledge Assessment Quiz</li> </ul> <p>Lesson 3:</p> <ul style="list-style-type: none"> <li>Knowledge Assessment Quiz</li> </ul> <p><sup>1</sup>Activity: Practice lift and movement of a load</p>	
<p><b>Leadership Alignment:</b> (Districts to complete for each unit)</p> <p><i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i></p> <p><i>Example:</i></p> <ul style="list-style-type: none"> <li>Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.</li> <li>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.</li> </ul>	

- 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

#### Math Practices and Standards

##### Lesson 1

##### *<sup>1</sup>Worksheet: Converting Dimensions*

MP2: Reason abstractly and quantitatively.

MP6: Attend to precision.

N-Q.A Reason quantitatively and use units to solve problems.

N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

##### *<sup>1</sup>Worksheet: Practicing Volume and Weight*

MP1: Make sense of problems and persevere in solving them.

MP6: Attend to precision.

N-Q.A Reason quantitatively and use units to solve problems.

N-Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

G.GMD.A Explain volume formulas and use them to solve problems.

G.GMD.A.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects.

##### *<sup>1</sup>Worksheet: Center of Gravity*

MP1: Make sense of problems and persevere in solving them.

MP2: Reason abstractly and quantitatively.

MP4: Model with mathematics.

MP6: Attend to precision.

N-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.



	<p>G.GMD.B Visualize relationships between two-dimensional and three-dimensional objects.</p> <p>Lesson 2</p> <p>MP4: Model with mathematics.</p> <p>G-MG.A Apply geometric concepts in modeling situations.</p> <p>G-MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p> <p>Lesson 3</p> <p>MP1: Make sense of problems and persevere in solving them.</p> <p>MP6: Attend to precision.</p> <p>N-Q.A Reason quantitatively and use units to solve problems.</p> <p>G.GMD.A Explain volume formulas and use them to solve problems.</p> <p>G.GMD.A.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.</p> <p>G-MG.A Apply geometric concepts in modeling situations</p> <p>G-MG.A.3 Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).</p>
--	--

Unit 14: Hydraulics and Pneumatics	Total Learning Hours for Unit: 30
<p><b>Performance Assessments:</b> (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li>• Quiz: A hydraulics quiz is available (Addendum)</li> <li>• <sup>1</sup>Worksheet 1: Pascal's Law Calculations (Booklet)</li> <li>• <sup>1</sup>Worksheet 2: More Pascal's Law (Booklet)</li> <li>• <sup>1</sup>Worksheet 3: More Formulas, More Practice (Booklet)</li> <li>• Reading and Journaling: How Hydraulic Machines Work by Marshall Brain (Booklet)</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>• Activity: Have students take apart some cheap air compressors to see how they work.</li> <li>• <sup>1</sup>Activity: What Would It Cost to Set Up a Simple Pneumatic System?</li> <li>• Lab Activity: Tennis Balls Up in the Air</li> </ul>	
<p><b>Leadership Alignment:</b> (Districts to complete for each unit)</p> <p><i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i></p> <p><i>Example:</i></p> <ul style="list-style-type: none"> <li>• Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.</li> </ul>	

- 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 expect 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.
- Apply the knowledge of hydraulics with a hands-on project.

#### **Aligned Washington State Academic Standards**

<p><b>Math Practices and Standards</b></p>	<p>MP1: Make sense of problems and persevere in solving them.  MP2: Reason abstractly and quantitatively.  MP7: Look for and make use of structure.  N.Q.A Reason quantitatively and use units to solve problems.  N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  A.CED.A Create equations that describe numbers or relationships.  A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i>  MP4: Model with mathematics.  N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.  High School Modeling</p>
--	---

Unit 15: Electrical	Total Learning Hours for Unit: 35
<p><b>Performance Assessments:</b> (Districts to complete for each unit)  <i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li>Practice Review/Quiz</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>Practice Review/Quiz</li> <li>In-class activity: Visualizing a Magnetic Field</li> </ul> <p>Lesson 3:</p> <ul style="list-style-type: none"> <li>Practice Review/Quiz</li> </ul> <p>Lesson 4:</p> <ul style="list-style-type: none"> <li>Knowledge Assessment</li> <li>In-class activity: Creating a Basic Bread Board Electrical Circuit</li> <li>1Math Worksheet</li> <li>Student Handout</li> </ul> <p><b>Leadership Alignment:</b> (Districts to complete for each unit)  <i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i>  <i>Example:</i></p> <ul style="list-style-type: none"> <li>Students work collaboratively with others to complete assigned projects both in the classroom and lab setting.</li> <li>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.</li> <li>Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.</li> </ul>	

- 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

#### Math Practices and Standards

MP1: Make sense of problems and persevere in solving them.  
 MP7: Look for and make use of structure.  
 N.Q.A Reason quantitatively and use units to solve problems.  
 N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  
 A.CED.A Create equations that describe numbers or relationships.  
[A.CED.A.4](#) Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law  $V = IR$  to highlight resistance  $R$ .*

	<p>A.REI.A Understand solving equations as a process of reasoning and explain the reasoning.</p> <p>A.REI.A.1 Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.</p> <p>A.REI.A.2 Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p> <p>A.REI.B Solve equations and inequalities in one variable.</p> <p>A.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p>
--	--

Unit 16: Soldering	Total Learning Hours for Unit: 25
<p><b>Performance Assessments:</b> (Districts to complete for each unit)</p> <p><i>Example assessments for this unit include:</i></p> <p>Lesson 1:</p> <ul style="list-style-type: none"> <li>• <sup>1</sup>Worksheet: Eutectic Functions (Addendum)</li> <li>• Practice Review Assessment</li> </ul> <p>Lesson 2:</p> <ul style="list-style-type: none"> <li>• Practice Review/Quiz</li> <li>• In-class activity # 1: Hand soldering wires to terminals</li> </ul> <p>Lesson 3:</p> <ul style="list-style-type: none"> <li>• Practice Review/Quiz</li> <li>• In-class activity # 2: Sweating Plumbing Connections</li> </ul>	
<p><b>Leadership Alignment:</b> (Districts to complete for each unit)</p> <p><i>Leadership alignment must include a unit specific project/activity that aligns with the 21<sup>st</sup> Century Leadership Skills.</i></p> <p><i>Example:</i></p> <ul style="list-style-type: none"> <li>• Students collaboratively with others to complete assigned projects both in the classroom and lab setting.</li> <li>• 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.</li> <li>• Students are assigned rotating leadership roles in the group that will make them responsible for specific outcomes of the project.</li> <li>• Students reflect upon their own actions and decisions through self-evaluations on assigned projects.</li> <li>• Students consider their own knowledge, skills and abilities through self-evaluations.</li> <li>• Students demonstrate the ability to work independently and in small groups while engaging in research and data collection.</li> <li>• Students show up to class on time and prepared to work and except the same of their classmates.</li> <li>• Students demonstrate respect for themselves and others by maintaining a safe working environment in the lab.</li> </ul>	

**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

#### Math Practices and Standards

MP1: Make sense of problems and persevere in solving them.  
 MP2: Reason abstractly and quantitatively.  
 N.Q.A Reason quantitatively and use units to solve problems.  
 N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.  
 N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.  
 F.IF.A Understand the concept of a function and use function notation.  
 F.IF.A.1 Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If  $f$  is a function and  $x$  is an element of its domain, then  $f(x)$  denotes the output of  $f$  corresponding to the input  $x$ . The graph of  $f$  is the graph of the equation  $y = f(x)$ .  
 F.IF.B Interpret functions that arise in applications in terms of the context.  
 F.IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.\*  
 F.IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.\*

### 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)
- <sup>1</sup>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 21<sup>st</sup> 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.
- <sup>1</sup>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

#### Math Practices and Standards

MP1: Make sense of problems and persevere in solving them.  
 MP2: Reason abstractly and quantitatively.  
 MP3: Construct viable arguments and critique the reasoning of others.  
 S.ID.A Summarize, represent, and interpret data on a single count or measurement variable  
 S.ID.A.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).  
 S.ID.A.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.  
 S.ID.A.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).  
 MP2: Reason abstractly and quantitatively.  
 S-IC.B Making inference and justifying conclusions.  
 S-IC.B.3 Make inferences and justify conclusions from sample surveys, experiments, and observational studies: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

### 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
- <sup>1</sup>Designing and Making Whistles
- <sup>1</sup>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.
- <sup>1</sup>5S Game
- <sup>1</sup>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 21<sup>st</sup> 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

#### Math Practices and Standards

MP1 Make sense of problems and persevere in solving them.  
 MP2 Model with mathematics  
 Mathematical Modeling  
 N-Q.A: Reason quantitatively and use units to solve problems.  
 N-Q.A.1: Use units as a way to understand problems and to guide the solution of multi-step problems:  
     choose and interpret units consistently in formulas; choose and interpret the scale and the origin  
     in graphs and data displays.  
 MP1 Make sense of problems and persevere in solving them  
 MP4 Model with mathematics  
 Mathematical Modeling  
 F-IF.B.4 For a function that models a relationship between two quantities, interpret key features of graphs  
 and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of  
 the relationship.  
 F-IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship  
 it describes.