*Career Technical Education Framework*

***Sheet Metalworking***

CIP Code 480506 | June 2014

# [Strand 2: Technical Knowledge and Skills](#_bookmark0)

###### Hand and Power Tool Safety

* + 1. Demonstrate safe methods of tool use following industry standards and OSHA guidelines.
       1. Describe and demonstrate safety rules regarding hand & power based tools.
       2. Perform a fabrication procedure using: hand and mechanical seamers, foot and mechanical shears, hand and mechanical brakes, bar folders and cheek benders.
       3. Demonstrate the use of material cutting shears, pipe crimper, nibbler, squaring shear hand turning machines and blind rivet gun.
       4. Smooth surfaces using: files, right angle grinders and air die grinders.
       5. Demonstrate how to use drill bits, taps and dies.
       6. Demonstrate how to punch holes using a hand punch.
       7. Demonstrate how to punch holes using a turret free-standing punch.
    2. Performance Examples:
       - Student will demonstrate safe techniques in using tools for laying out, cutting and fabricating fittings.
       - Student will perform a designated drilling exercise using 11 gauge steel, tap set, and tap drill chart.
    3. Demonstrate safety operation techniques with sheet metal equipment.
       1. Demonstrate knowledge from equipment technical safety manuals.
       2. Set up and safely operate hand and power brakes.
       3. Set up and safely operate foot and power shears.
       4. Set up and safely operate hand and power rolling equipment.
       5. Set up and safely operate a hand drill.
       6. Set up and safely operate hand turning machines.
       7. Set up and safely operate a drill press.
       8. Set up and safely operate an iron worker.
       9. Set up and safely operate a vertical band saw.
       10. Set up and safely operate a horizontal band saw.
       11. Set up and safely operate a chop or cold saw.
       12. Set up and safely operate a pedestal grinder.
       13. Set up and safely operate lock forming machines.
       14. Set up and safely operate a masonry rotary hammer drill.
       15. Set up and safely operate a reciprocating saw.
       16. Set up and safely operate a circle cutter.
       17. Set up and safely operate an angle grinder.
       18. Set up and safely operate an air die grinder.

2.A.02 Performance Example:

* Student will demonstrate their ability to safely set-up and operate shop equipment using equipment manuals, safety guidelines, operation procedures, and maintenance schedules.

##### Reading Technical Drawings and Blueprints

* + 1. Read and interpret prints.
       1. Define basic layouts and specifications of technical prints/ drawings.
       2. Identify basic print terms, abbreviations, line types, symbols and notes.
       3. Convert measurements from a print using an architect’s scale.
       4. Define and interpret floor plans, elevations, sections, details, ceiling plans, and finish schedules.
       5. Use estimating methods in pricing jobs from drawings/prints.
       6. Prepare material quantity takeoff sheets from technical prints.
       7. List state and/or local code requirements that apply to prints.
    2. Performance Examples:
       - Student will develop a material take-off list; indicating duct fittings and accessories using an authentic set of construction prints/drawings.
       - Student will complete a Sheet Metal permit application for work within the Commonwealth of Massachusetts.
    3. Draw and interpret specific prints.
       1. Define and interpret plan elevation sections, detail views and schedules.
       2. Identify and interpret the function of supply, return, fresh air supply, exhaust and ventilation air duct systems and their corresponding symbols.
       3. Sequence and describe methods of fabricating, assembling and installing sheet metal products, using blueprints, sketches, or product specifications.
       4. Draw a basic print of a layout of an air-duct system.
       5. Inspect assemblies and installations for conformance to specifications, using standard measurement instruments.
       6. Explain the importance of coordinating air duct systems with structural and architectural considerations.

2.B.02 Performance Example:

* Student will develop a basic print that includes return air, fresh air supply, exhaust and ventilation air duct systems and their corresponding symbols.
  + 1. Interpret and develop prints using current industry terminology.
       1. Use the appropriate terminology when producing drawings and technical writing, including reflections.
       2. Develop a basic drawing using line types, symbols and notes.

2.B.03 Performance Example:

* Student will develop a basic drawing/print using line types, symbols and notes.

##### Fundamentals of Sheet Metal Work.

* + 1. Define and apply specific uses of materials, hand tools, & charts.
       1. Perform: scratch, spark and magnetic tests to aid material identification.
       2. Describe and fabricate a project using non-ferrous sheet metal.
       3. Describe and fabricate a project using ferrous sheet metal.
       4. Describe and fabricate a project using galvanized sheet metal.
       5. Describe and fabricate a project using cold rolled sheet metal.
       6. Describe and fabricate a project using hot rolled sheet metal.
       7. Describe and fabricate a project using structural shaped metal.
       8. Describe and fabricate a project using alloys and the special materials.
       9. Use basic hand tools; aviation snips, bull dog snips, micrometer, dial calipers, hammers, mallets, punches, etc.
       10. Calculate the weight of ferrous and non-ferrous sheet metal by gauge.
       11. Use the following charts: fraction/decimal chart, tap and drill chart, circumference chart, power brake tonnage chart, hydraulic punch tonnage chart & circumference rule.
    2. Performance Example:
       - Student will identify and use basic hand tools used in the sheet metal trade on sheet metal projects according to current industry and OSHA standards.

##### Fabrication and Pattern Layouts

* + 1. Demonstrate skills in the selection and the use of layout and marking tools.
       1. Determine the thickness of ferrous and non-ferrous sheet metal with a sheet metal gauge and micrometer.
       2. Layout and mark dimensions on material using; scribes, awls, dividers, squares, protractors, trammel points, combination squares, steel rulers.
       3. Layout, cut, and use accurate templates using: drawing boards, tee squares, triangles, compass and dividers.
       4. Layout and fabrication using parallel line development.
       5. Layout and fabrication using triangulation.
       6. Layout and fabrication using radial line development.
    2. Performance Example:
       - Student will complete given sheet metal project, using layout techniques, cutting accurate templates, and using hand tools and devices according to current industry and OSHA standards.
    3. Create computer generated working drawings; AutoCAD, Inventor, etc.
       1. Create basic mechanical drawings with dimensions to manufacture templates and duct components.
       2. Convert and save drawings to DXF file format for use with CNC plasma cutting equipment.

2.D.02 Performance Example:

* Student will create basic mechanical drawing with given dimensions.
  + 1. Demonstrate the fabrication of sheet metal using seams, edges, notches, locks and clips.
       1. Identify hand forming stakes to shape sheet metal fittings.
       2. Fabricate hems, Pittsburg and pipe locks, slips and drives, standing seams, laps, elbow locks, beading, crimping etc.

2.D.03 Performance Example:

* Student will fabricated a designated project using the following types of connections; Pittsburg and pipe locks, slips and drives, standing seams, laps, elbow locks, beading, and crimping techniques.

##### Welding and Plasma Arc Cutting

* + 1. Demonstrate safe operation practices using gas metal arc welding (GMAW) equipment.
       1. Identify and maintain gas metal arc welding equipment.
       2. Identify and set up: gun, copper nozzle, cable and wire spool.
       3. Determine and set voltage and amperage for gauge thickness and position welding according to specifications.
       4. Identify shielding gases for welding types of metals.
       5. Identify potential hazards of fire, explosions and electrical shock.
       6. Identify and use personal protective equipment (PPE) for welding practices.
       7. Weld beads using filler in flat, horizontal and vertical positions.
       8. Prepare fittings, joints and seams for welding.
    2. Performance Examples:
       - Student will demonstrate how to set the wire feed and voltage, nozzle distance from the work piece and travel speed by completing a designated project.
       - Student will demonstrate how to use welding techniques i.e. oscillating, weaving and running bead by completing a designated project.
    3. Demonstrate safe operation practices using gas tungsten arc welding (GTAW) equipment.
       1. Identify and maintain GTAW welding equipment.
       2. Identify and set up gun, tungsten and ceramic nozzle.
       3. Identify and set controls for types of material to be welded for gauge thickness and position welding.
       4. Identify shielding gases for welding types of metals.
       5. Identify and define potential hazards of fire, explosions and electrical shock.
       6. Identify and use personal protective equipment (PPE) for welding practices.
       7. Weld beads in flat, horizontal and vertical positions.

2.E.02 Performance Examples:

* Student will demonstrate how to set the welding unit to accommodate AC and DC applications by completing a designated project.
* Students will practice welding in flat, horizontal, vertical positions using aluminum, stainless steel and cold roll steel by completing a designated project.
  + 1. Demonstrate safe operation practices using resistance welder.
       1. Identify and set up resistance welder for proper heat and cycle time to fuse metal type and thickness.
       2. Identify and use proper PPE for resistance welding practices.

2.E.03 Performance Example:

* Student will demonstrate the setting of heat and cycle time to spot weld various metal types and thickness by completing a designated project.
  + 1. Demonstrate safe operation practices using hand held plasma cutter.
       1. Identify and set up a Hand Held Plasma cutter with settings for metal type and thickness.
       2. Identify and use PPE for metal cutting practices.
       3. Identify potential hazards of fire, explosions and electrical shock.
       4. Identify and maintain cutting torch consumables i.e. swirl ring, electrode and torch tip.

2.E.04 Performance Example:

* Student will use a straight edge and cut lines between two, half inch diameter punched holes spaced four inches apart creating a slot by completing a designated project.

##### Soldering Metals.

* + 1. Demonstrate fundamentals of soldering.
       1. Identify and demonstrate different types of soft and hard solders.
       2. Identify and demonstrate different types and shapes of soldering coppers.
       3. Identify and demonstrate different liquid, paste and powder fluxes.
       4. Identify and demonstrate different composition of soft solders.
       5. Safely demonstrate the making of cut, killed or cured acid using zinc pieces and hydrochloric acid in a ventilated area.
       6. Demonstrate preparation of metal surface to be soldered.
       7. Demonstrate soldering techniques of sweating, skimming, tinning and tacking.
       8. Demonstrate soldering copper and brass using acetylene torch.
       9. Demonstrate forging techniques using a soldering copper / soldering iron.
    2. Performance Example:
       - Student will identity and demonstrate the different aspects of soldering, using given projects of different degrees of difficulty.

##### Design and Install Air Duct Systems.

* + 1. Design & install forced- air duct systems.
       1. Describe how static pressure applies to sizing duct.
       2. Demonstrate how to use and apply information from an air-duct calculator.
       3. Design & install forced–air rectangular duct systems.
       4. Design & install forced–air round duct systems.
       5. Identify the physical and thermal properties of moist air using a psychrometric chart and a psychrometer.
       6. Install air duct fasteners.
       7. Install sheet metal hangers and supports.
       8. Install sheet metal flex connections.
       9. Identify the different types of longitudinal standing seams, including applications and limitations.
       10. Seal a duct run according to industry standards.
       11. Explain the importance of coordinating air duct systems with structural and architectural considerations.
    2. Performance Example:
       - Using a furnace or air handling unit as a mock up, student will install rectangular and round duct systems that includes; a plenum, offsets, straight duct, round collar takeoffs, dampers, and headers.
    3. Identify and install forced -air ducts, equipment, and air duct accessories.
       1. Identify and install rectangular duct systems.
       2. Identify and install round air duct systems.
       3. Identify and install hangers and supports.
       4. Identify and install fire dampers.
       5. Identify and install access doors.
       6. Identify and install turning vanes.
       7. Identify and install smoke dampers.
       8. Identify and install flex connectors.
       9. Identify and install vibration eliminators.
       10. Identify control dampers.
       11. Identify and install outside air louvers.
       12. Identify and install diffusers, grilles and registers.
       13. Identify and install variable air volume boxes.
       14. Identify and install sound attenuation and sound traps.

2.G.02 Performance Examples:

* Student will identity and demonstrate the function of components used in a duct system.
* Student will identify and install duct accessories using authentic set of construction prints/drawings.

##### Architectural Sheet Metal

* + 1. Demonstrate fabrication techniques of architectural sheet metalworking.
       1. Identify various alloys and types of metal used in architectural sheet metal.
       2. Demonstrate positioning soldering techniques in flat, 45 and 90 degree angles.
       3. Fabricate gutter profiles of square, half round, and ogee shapes.
       4. Fabricate gutter hanging brackets, spacers and continuous bars.
       5. Demonstrate how to install copper line built-in gutters with expansion joints.
       6. Fabricate hanging gutters with expansion joints.
       7. Fabricate a conductor head.
       8. Identify types of architectural roofing including fabricating standing, flat and batten seams.
       9. Identify and fabricate wall cladding with flat and standing seams.

2.H.01.10 Fabricate a metal louver.

* + 1. Performance Example:
       - Student will layout and fabricate a given project to reflect knowledge of industry standards and proper installation of a pitched roof and wall mockup that include: gutters to the fascia - batten flat and standing seam panels on a pitched roof - wall cladding to be incorporated with roof edge - Louver through side wall of cladding.

# [Strand 3: Embedded Academics](#_bookmark0)

### Embedded English Language Arts and Literacy

|  |  |  |
| --- | --- | --- |
| CTE  Learning Standard Number | Strand Coding Designation Grades ELAs  Learning Standard Number | Text of English Language Arts Learning Standard |
| 2.B.01.06 | WHST.6-12.5-8  Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects | Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.  Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. Gather relevant information from multiple print and digital sources, assess  the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. |
| Performance Example: | * Student will identify, develop and complete material quantity takeoff sheet. |  |
| 2.B.01.07 | RI.6.3  Reading Standards for Informational Text | Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text |
| Performance Example: | * Student will read and discuss how state and/or local code requirements apply to prints. |  |
| 2.B.03.01 | SL.9-12.1-3  Speaking and Listening Standards | Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9–12 topics, texts, and issues, building on others’ ideas and expressing their own clearly and persuasively. Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data. Evaluate a speaker’s point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and  tone used. |
| Performance Example: | * Student will use appropriate terminology when discussing technical writing, drawings, discussions and reflections. |  |
| 2.G.01.11 | SL.9-12.4-6  Speaking and Listening Standards | Present information, findings, and supporting evidence, conveying a clear and distinct perspective, such that listeners can follow the line of reasoning, alternative or opposing perspectives are addressed, and the organization, development, substance, and style are appropriate to purpose, audience, and a range of formal and informal tasks. Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to  enhance understanding of findings, reasoning, and evidence |
|  |  | and to add interest.  Adapt speech to a variety of contexts and tasks, demonstrating a command of formal English when  indicated or appropriate. |
| Performance Example: | * Student will describe the importance of coordinating air duct systems with structural and architectural considerations. |  |
| 2.A.01.01 | L.6-12.4(c-d)  Language Standards | Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its’ part of speech, its etymology, or its standard usage. Verify the preliminary determination of the  meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary). |
| Performance Example: | * Student will read and articulate equipment technical manuals. |  |
| 2.H.01.08 | WHST.6-12.8  Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects | Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain  the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. |
| Performance Example: | * Through trade web-site resources, student will identify types of architectural roofing, including fabricating standing, flat and batten seams. |  |
| 2.H.01.01 | WHST.6-12.2(a-f),4  Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects | Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience’s knowledge of the topic. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic). Produce clear and coherent writing in which  the development, organization, and style are appropriate to |
|  |  | task, purpose, and audience. |
| Performance Example: | * Student will identify various alloys and types of metal used in architectural sheet metal. |  |
|  | and extend previous understandings of numbers to the system of rational numbers.  6.NS.6c  The Number System/ Apply and extend previous understandings of numbers  to the system of rational numbers. | axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates.  6.S.6c. - Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane. |
| Performance Example: | * Student will identify physical and thermal properties of moist air using a psychometric chart. |  |
| 2.B.01.05 | 7.EE.3  Expressions and Equations/ Analyze and solve linear equations and pairs of simultaneous linear equations. | Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *For example: If a woman making $25 an hour gets a 10% raise, she will make an additional* ***1****/****10*** *of her salary an hour, or*  *$2.50, for a new salary of $27.50. If you want to place a towel bar 93⁄4 inches long in the center of a door that is 271⁄2 inches wide, you will need to place the bar about 9 inches*  *from each edge; this estimate can be used as a check on the exact computation* |
| Performance Example: | * Student will estimate the cost of an installation from a given print/drawing. |  |
| 2.G.01.01 | 9-12.A.SSE.1  Seeing Structure in Expressions/  Interpret the structure of expressions.  9-12.A.CED.4  Creating Equations/ Create equations that describe numbers or  relationships. | 9-12.ASSe.1 - Interpret expressions that represent a quantity in terms of its context.\*   9-12.ACED.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.\** |
| Performance Example: | * Student will define concepts in calculating the ratio between pipe size and volume output. |  |
| 2.D.01.03 | 9-12.G.GPE.5  Expressing Geometric Properties with Equations | Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line  that passes through a given point |
| Performance Example: | * Student will create a layout and fabrication using triangulation methods. |  |
| 2.C.01.04 | 9-12.A.CED.3  Creating Equations/ Create equations that | 9-12.A.CED.3 - Represent constraints by equations or inequalities, and by systems of equations and/or  inequalities, and interpret solutions as viable or non-viable |

### [Embedded Mathematics](#_bookmark0)

|  |  |  |
| --- | --- | --- |
| CTE  Learning Standard Number | Math Content Conceptual Category and Domain Code Learning Standard Number | Text of Mathematics Learning Standard |
| 2.B.02.04 | 7.G.2  Geometry/Draw, construct, and describe geometrical figures and describe the relationships between them | 7.G.2 Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.  (MA 2011 specifies constructing triangles given measures of angles |
| Performance Example: | * Student will design and draw an air-duct system layout using different geometric shapes within the layout. |  |
| 2.G.01.03  2.G.01.04 | 8.EE.7  Expressions and Equations/ Analyze and solve linear equations and pairs of simultaneous linear equations.  8.EE.7a  Expressions and Equations/ Analyze and solve linear equations and pairs of simultaneous linear equations.  8.EE.7b  Expressions and Equations/ Analyze and solve linear equations and pairs of simultaneous linear equations.  7.RP.2  Ratios and Proportional Relationships/  Analyze proportional relationships and use them to solve real-world and  mathematical problems | 8.EE.7 - Solve linear equations in one variable.  8.EE.7a - Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form *x = a, a = a,* or *a = b* results (where *a* and *b* are different numbers).  8.EE.7b - Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.  7.RP.2 - Recognize and represent proportional relationships between quantities. |
| Performance Example: | * Student will solve a linear equation to identify missing dimensions on a given duct system project. |  |
| 2.G.01.05 | 6.NS.6  The Number System/ Apply | 6.NS.6 - Understand a rational number as a point on the number line. Extend number line diagrams and coordinate |
|  | describe numbers or relationships.  8.EE.8  Expressions and Equations/ Analyze and solve linear equations and pairs of  simultaneous linear equations. | options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.  8.EE.8 - Analyze and solve pairs of simultaneous linear equations. |
| Performance Example: | * Student will estimate the cost difference and effectiveness of using noncorrosive metals verses galvanized steel roofing material. |  |

### [Embedded Science and Technology/Engineering](#_bookmark0)

#### [Physical Science (Chemistry)](#_bookmark0)

|  |  |  |
| --- | --- | --- |
| CTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Chemistry Learning Standard |
| 2.C.01.02 | Properties of Matter 1.1 Periodicity 3.1 and 3.2 | * 1. Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.   2. Explain the relationship of an element’s position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.   3. Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids. |
| Performance Example: | * Student will identify the chemical and physical properties of non-ferrous metals. |  |
| 2.C01.03 | Properties of Matter 1.1 Periodicity 3.1 and 3.2 | * 1. Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.   2. Explain the relationship of an element’s position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.   3. Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids. |
| Performance Example: | * Student will identify the chemical and physical properties of ferrous metal. |  |
| 2.C.01.04 | Properties of Matter 1.1 and 1.2  Periodicity 3.1 and 3.2 | 1.1 Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new  substances). Distinguish between chemical and physical |
|  |  | changes.  1.2 Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.   * 1. Explain the relationship of an element’s position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.   2. Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids. |
| Performance Example: | * Student will identify the physical properties of a galvanized metal. |  |
| 2.C.01.05 | Properties of Matter 1.1 and 1.2  Periodicity 3.1 and 3.2 | * 1. Identify and explain physical properties (e.g., density, melting point, boiling point, conductivity, malleability) and chemical properties (e.g., the ability to form new substances). Distinguish between chemical and physical changes.   2. Explain the difference between pure substances (elements and compounds) and mixtures. Differentiate between heterogeneous and homogeneous mixtures.   3. Explain the relationship of an element’s position on the periodic table to its atomic number. Identify families (groups) and periods on the periodic table.   4. Use the periodic table to identify the three classes of elements: metals, nonmetals, and metalloids. |
| Performance Example: | * Student will identify physical properties of temperature on metals. |  |
| 2.F.01.05 | Acids and Bases 8.1 | 8.1 Define the Arrhenius theory of acids and bases in terms of the presence of hydronium and hydroxide ions in water and the Bronsted-Lowry theory of acids and bases in terms of proton  donors and acceptors. |
| Performance Example: | * Student will discuss safety precautions and equipment used when working with acid solutions. |  |

#### [Technology/Engineering](#_bookmark0)

|  |  |  |
| --- | --- | --- |
| CTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Technology/Engineering Learning Standard |
| 2.A.01.01 | Materials, Tools, and Machines 2.5 | 2.5 Identify and demonstrate the safe and proper use of common  hand tools, power tools, and measurement devices used in construction. |
| Performance Example: | * Student will demonstrate how to safely use power and hand tools. |  |
| 2.C.01.09 | Materials, Tools, and Machines 2.5 | 2.5 Identify and demonstrate the safe and proper use of common hand tools, power tools, and measurement devices used in construction. |
| Performance Example: | * Student will demonstrate how to measure sheet metal using a micrometer. |  |
| 2.B.01.03 | Engineering Design 1.4 | 1.4 Interpret and apply scale and proportion to orthographic projections and pictorial drawings (e.g., ¼" = 1'0", 1 cm = 1 m). |
| Performance Example: | * Student will create a scaled plan that includes measurements, and layout of project. |  |

[Industry Recognized Credentials](#_bookmark0) (Licenses and Certifications/Specialty Programs)

Occupational Safety and Health Administration (OSHA) 10 Hour Card – Construction

Hours credit toward Massachusetts Sheet Metal License requirements.

A student who successfully completes a CHAPTER 74 Sheet Metal program approved by the Board of State Examiners of Sheet Metal Workers may be granted a maximum of 150 hours of educational theory credit and 1,600 hours of experience credit from that program towards their journeyperson license.