Massachusetts Career Technical Education

Power Equipment Technology Framework

2014

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

###### Fundamentals of Work Area Safety

* + 1. Demonstrate safety precautions in the operation and service of power equipment according to current industry and OSHA standards.
       1. Identify safety checklists and procedures used while servicing and operating equipment.
       2. Identify and describe occupational safety precautions and procedures in fire safety and other emergency situations per Occupational Safety and Health Administration (OSHA) standards.
       3. Identify and demonstrate handling of chemicals and fuels that are commonly used in the servicing of power equipment.
       4. Demonstrate the use of Personal Protective Equipment (PPE).
       5. Identify and demonstrate safety procedures of lift equipment.
       6. Demonstrate use and storage of hydraulic floor jacks and safety stands.
       7. Explain hazards associated with the handling of batteries and follow electrical precautions.

1. A.01 Performance Examples:
   * Students will demonstrate safe practices while servicing equipment.
   * Students will demonstrate safe practices while handling batteries.

###### Fundamentals of Tools and Special Equipment

* + 1. Select and use appropriate tools and equipment to perform a given task.
       1. Identify basic hand tools.
       2. Demonstrate set-up/adjustment, maintenance, and storage of all basic hand tools.
       3. Identify basic power tools.
       4. Demonstrate set-up/adjustment, maintenance, and storage of all basic power tools.
       5. Demonstrate use and maintenance of grinding equipment.
       6. Demonstrate use and maintenance of soldering tools.
       7. Demonstrate use and maintenance of air impact tools.
       8. Demonstrate use and maintenance of tire changing equipment.
       9. Demonstrate use and maintenance of a hydraulic press or puller.

2.B.01.10 Use and maintain a torque wrench.

* + 1. Performance Examples:
       - Student will identify and demonstrate the use of different sized screwdrivers.
       - Student will identify and demonstrate the use of the different types of air impact equipment.
    2. Select and use appropriate measurement tools to perform a given task according to current industry and OSHA standards.
       1. Identify commonly used basic measuring tools.
       2. Demonstrate use of basic measuring tools.
       3. Identify precision measurement tools.
       4. Demonstrate use of precision tools.

2.B.02 Performance Examples:

* Student will demonstrate the use of a combination square.
* Student will demonstrate the use and maintenance of a micrometer.
  + 1. Select and use appropriate specialty tools and diagnostic/testing equipment according to current industry and OSHA standards.
       1. Identify specialty tools to service and repair Outdoor Power Equipment (OPE).
       2. Demonstrate maintenance and usage of all specialty tools.
       3. Identify diagnostic/testing equipment.
       4. Demonstrate maintenance and usage of all diagnostic/testing equipment.

2.B.03 Performance Examples:

* Student will demonstrate the use of an oil filter wrench.
* Student will demonstrate the use of a cylinder compression tester.
  + 1. Select and use diagnostics and troubleshooting techniques according to current industry and OSHA standards.
       1. Describe the principles of diagnostics and troubleshooting.
       2. Identify systems, their components and the sequence of events in a system.
       3. Remove, test and replace ignition armature module.
       4. Test capacitive discharge ignition system.
       5. Inspect ignition system and a perform three-point spark test.
       6. Demonstrate timing procedure.
       7. Measure primary and secondary resistance.
       8. Check safety interlock devices for proper operation; correct all problems and provide written documentation of repairs.
       9. Analyze and identify engine failures and document results.
       10. Inspect and test fuel system using pressure test.
       11. Inspect, bench and pressure test the carburetor.
       12. Inspect and perform fuel pump pressure test.
       13. Inspect and test exhaust system for restriction or leakage.
       14. Perform cylinder balance test and record results.
       15. Perform cylinder compression test and record results.
       16. Perform cylinder leak down test and record results.
       17. Inspect crankcase integrity with pressure/vacuum pump.
       18. Operate the engine to analyze starting, acceleration and power output under load.

2.B.04 Performance Examples:

* Student will be able to remove test and replace an ignition armature module.
* Student will identify a carburetor and its components.
* Student will perform a cylinder leak down test.
* Student will demonstrate the proper use of an oil filter wrench.
  + 1. Select and operate lifting equipment according to current industry and OSHA standards.
       1. Identify various types of lifting and hoisting equipment.
       2. Demonstrate usage of lifting and hoisting equipment according to current industry and OSHA standards and state laws/regulations.

2.B.05 Performance Examples:

* Student will identify a chain fall.
* Student will demonstrate the usage of a hydraulic lift.
  + 1. Select and demonstrate use of cleaning equipment according to current industry and OSHA standards.
       1. Identify basic cleaning equipment.
       2. Demonstrate usage of cleaning equipment such as a solvent tank, pressure washer and steam cleaner.
       3. Demonstrate disposal of cleaning materials based on the Environmental Protection Agency (EPA) and local regulations.

2.B.06 Performance Examples:

* Student will demonstrate handling of used anti-freeze.
* Student will demonstrate usage of a pressure washer.

###### Information/Communications

* + 1. Demonstrate customer service according to current industry standards.
       1. Interview the customer/operator and record comments and information on the work-order.
       2. Complete a thorough visual and physical examination; determine and classify all symptoms of a problem.
       3. Record the results of all testing on the work-order.
       4. Make all necessary repairs and retest to verify the repair is complete.
       5. Demonstrate customer service practices to communicate with the customer regarding the cause of the repair and prevention of future problems.
       6. Complete and interpret pre-delivery and delivery instructions.
    2. Performance Examples:
       - Student will demonstrate proper techniques to interview a customer.
       - Student will properly record data on a work-order.
       - Student will complete a pre-delivery check list.
    3. Demonstrate the use of technical data and records maintenance according to current industry standards.
       1. Identify manufacturer, model and serial number of engine.
       2. Identify manufacturer, model and serial number of equipment (not engine).
       3. Demonstrate the use of service and parts manual formats, such as paper, CD, DVD, web based and microfiche, to locate service, torque specifications, and procedures.
       4. Document service and/or repair work on a work-order.
       5. Document parts and shop supplies used on a work-order and shop inventory list.
       6. Complete various original equipment manufacturer (OEM) warranty forms.
       7. Identify, interpret and demonstrate recommended service operations and maintenance schedules from an operator’s manual.

2.C.02 Performance Examples:

* Student will demonstrate the use of a service manual.
* Student will demonstrate the ability to locate parts using various methods.
  + 1. Demonstrate industry expected workmanship according to current industry and OSHA standards.
       1. Demonstrate and maintain a neat and organized workspace.
       2. Demonstrate use of bins, paperwork and digital recordings of parts for projects.
       3. Perform tasks in a timely manner without sacrificing quality.

2.C.03 Performance Examples:

* Student will maintain an organized workspace.
* Student will operate a digital camera to record projects.

###### Fundamentals of Industry Practices on Outdoor Power Equipment (OPE)

* + 1. Identify and demonstrate use of industry fasteners.
       1. Identify fasteners used on small gas engines and OPE implements.
       2. Remove and install various fasteners and gaskets.
       3. Repair or produce internal and external threads.
    2. Performance Examples:
       - Student will identify metric bolts.
       - Students will differentiate between types of washers.
       - Student will demonstrate the proper repair of damaged threads.
    3. Identify and demonstrate the use of industry equipment and OPE according to current industry and OSHA standards.
       1. Identify safe tractor, machinery and equipment operation practices for consumer and commercial uses.
       2. Identify unsafe/dangerous conditions of equipment (e.g., cracked deck, split belt, etc.).
       3. Demonstrate methods of starting, stopping and operating outdoor power equipment (OPE).
       4. Select fuels, coolants, lubricants and hydraulic fluids for tractors, machinery and equipment.
       5. Identify the parts and functions of electrical, hydraulic, lubrication, cooling, exhaust, fuel, governor, induction and drive systems.
       6. Conduct a pre-operation inspection of a tractor and/or equipment.
       7. Establish ballast and tire pressure.
       8. Demonstrate mower deck service and blade sharpening techniques.
       9. Demonstrate saw sharpening techniques.
       10. Demonstrate service and maintenance of chainsaws and handheld equipment.
       11. Explain American National Standards Institute (ANSI) standards such as: kick back, operator presence etc.
       12. Adjust steering linkage, including tow-in.
       13. Inspect and adjust drive line components.
       14. Install, adjust and service belt and chain drives.
       15. Prepare tractor, machinery or equipment for storage.

2.D.02 Performance Examples:

* Student will demonstrate the safe starting of a chainsaw.
* Student will select proper fuel for a lawn mower.
* Student will explain ANSI standards of kick-back.
  + 1. Describe and demonstrate service and repair of drive trains and associated systems according to current industry and OSHA standards.
       1. Service and/or repair various drive systems.
       2. Service and/or repair various clutches.
       3. Service manual and hydrostatic transmissions.

2.D.03 Performance Examples:

* Student will identify a drive system.
* Student will demonstrate the service of a hydrostatic transmission.
  + 1. Diagnose and repair generator malfunctions in power equipment.
       1. Identify components of generators.
       2. Explain and demonstrate the repair of generator malfunctions in power equipment.
       3. Explain the operation of brush/slip-ring vs. brushless (induction) type generators.
       4. Diagnose and repair generator output problems.

2.D.04 Performance Example:

* Student will explain the operation of a brushless type generator.

###### Fundamentals of Service and Repair of Engines

* + 1. Identify and explain two and four stroke cycle engines.
       1. Explain two stroke cycle engine operation and theory.
       2. Explain the differences between piston ported, reed and rotary valve operations.
       3. Explain four stroke cycle engine operation and theory.
       4. Identify four stroke cycle engine components, parts and describe their purpose.
    2. Performance Examples:
       - Student will explain two stroke cycle engine operation.
       - Student will explain four stroke cycle engine operation.
    3. Identify and describe components of diesel engines.
       1. Explain diesel two and four stroke cycle engine operation and theory.
       2. Describe turbo charging vs. normal aspiration.
       3. Describe super charging vs. normal aspiration.
       4. Identify and select lubricants specified for diesel engine use.
       5. Diagnose common diesel operating issues.

2.E.02 Performance Examples:

* Student will describe turbo charging.
* Student will select proper lubricants for a diesel engine.
  + 1. Explain fundamentals of lubrication according to current industry and OSHA standards.
       1. Describe the theory of lubrication.
       2. Describe the American Petroleum Institute (API) oil ratings and the Society of Automotive Engineers (SAE) viscosity ratings.
       3. Describe the classification of two stroke engines and mix a given oil ratio for two cycle engine.
       4. Describe the functions of engine oil.
       5. Describe splash vs. pressure lubrication systems.
       6. Describe the two types of oil filtration systems.
       7. Demonstrate methods of checking oil level in an engine.
       8. Change engine oil and filter on a variety of equipment.

2.E.03 Performance Examples:

* Student will explain SAE viscosity ratings.
* Student will differentiate between oil ratings.
  + 1. Service cooling systems according to current industry and OSHA standards.
       1. Describe the major types of cooling systems used on power equipment and explain their purpose.
       2. Identify and repair the major causes of air-cooled engine overheating.
       3. Perform cooling system flush and cleaning of a liquid cooled engine.
       4. Inspect, remove and replace a water pump.
       5. Inspect, remove and replace a thermostat.

2.E.04 Performance Examples:

* Student will differentiate cooling systems.
* Student will flush a cooling system.
  + 1. Service fuel systems according to current industry and OSHA standards.
       1. Define the types and grades of fuels used in power equipment.
       2. Describe the use of a fuel additive for storage.
       3. Describe and perform the method of carburetor cleaning.
       4. Describe potential problems for oil/fuel mixtures.
       5. Identify common types and nomenclature of fuel pumps.
       6. Define accelerator pump nomenclature and function.
       7. Explain the theory and function of fuel injection.
       8. Inspect, remove and replace a carburetor on a small gasoline engine.
       9. Clean and install a repair kit in a carburetor.
       10. Inspect internal carburetor parts for wear.
       11. Inspect, remove and replace the fuel tank, filters, caps, hoses and lines.
       12. Adjust carburetor linkage.
       13. Adjust carburetor mixture screws per OEM specifications.
       14. Set and adjust carburetor float.

2.E.05 Performance Examples:

* Student will identify grades of fuels.
* Student will explain the function of fuel injection.
* Student will adjust the fuel mixture in a carburetor.
  + 1. Service exhaust systems and its components according to current industry and OSHA standards.
       1. Define and describe an air filter system nomenclature and explain its function.
       2. Demonstrate normal service procedures performed on each type of air filter system.
       3. Identify exhaust system types, nomenclature and describe their functions.
       4. Describe proper service cleaning procedures for exhaust ports and spark arrestor screens.

2.E.06 Performance Examples:

* Student will identify a muffler and explain its function.
* Student will identify and clean a spark arrestor.
  + 1. Service ignition, starting and electrical systems according to current industry and OSHA standards.
       1. Explain electrical/electronic terms that are common to the power equipment industry.
       2. Describe the purpose of an ignition system.
       3. Define engine starting systems nomenclature and function.
       4. Identify the components and function of a battery ignition system.
       5. Identify the components and function of a magneto ignition system.
       6. Identify the components and function of a recoil starting system.
       7. Test, remove and replace a starter motor.
       8. Test, remove and replace a starter relay (solenoid).
       9. Service three different styles of rewind starters.
       10. Replace a starter drive gear.
       11. Disassemble and reassemble a 12 volt DC-120 volt AC starter motor.
       12. Define charging system nomenclature and describe their functions.
       13. Describe and demonstrate an AC/DC volt test.
       14. Describe the function of diodes and rectifiers.
       15. Perform current drain and charging test using a DC shunt.
       16. Remove and replace a regulator/rectifier.
       17. Describe series and parallel circuits.
       18. Explain different types of circuit failures.
       19. Check continuity in circuits and electrical system components.
       20. Check current flow in electrical systems and components.
       21. Inspect, test and replace fusible links, fuses and circuit breakers.
       22. Identify and install terminals and connectors used in electrical systems.
       23. Calculate electrical wire sizes and selection based on anticipated current load.
       24. Identify sending units used in an electrical circuit and explain their function.
       25. Explain storage battery theory and operation.
       26. Clean, test, remove and replace a battery.

2.E.07 Performance Examples:

* Student will describe the purpose of an ignition system.
* Student will remove a starter motor.
  + 1. Service governor systems.
       1. Identify the purpose of a governor system.
       2. Describe governor system nomenclature and function.
       3. Adjust pneumatic and mechanical governor system settings.

2.E.08 Performance Examples:

* Student will describe the purpose of a governor.
* Student will adjust a governor system setting.
  + 1. Inspect, remove, rebuild and install engines.
       1. Inspect valve and seats, resurface or replace.
       2. Demonstrate and explain valve lapping operation.
       3. Remove ridge, de-glaze and clean cylinder bore using a rigid hone.
       4. Explain OEM cylinder reuse specification.
       5. Inspect and measure camshaft bearings for wear and damage.
       6. Inspect valve train including, valves, seats, valve guides, rocker arms, lifters, studs, and push rods.
       7. Inspect balance system.
       8. Inspect shafts and support bearings for damage and wear.
       9. Measure and determine values for engine bearings.
       10. Use a plasti-gauge to determine bearing clearances in an engine.
       11. Install all engine components, assembles and gaskets; torque according to manufacturer’s specifications and procedures.
       12. Install the crankshaft with its bearings.
       13. Measure crankshaft end play.
       14. Measure crankshaft run-out.
       15. Verify camshaft timing according to manufacturer’s specifications and procedure.
       16. Adjust values (mechanical and hydraulic).
       17. Assemble and test run engine.

2.E.09 Performance Examples:

* Student will resurface a valve.
* Student will measure crankshaft run-out.
* Student will determine bearing clearance.

***Advanced Technical Skills in Power Equipment***

*Students that wish to excel and broaden their knowledge may apply their Power Equipment skills in the following areas noted below. These technical competencies are not required, rather are supplemental/optional.*

###### Fundamentals of Motorcycles and ATV’s

2.F.01\* Identify and service motorcycles and all-terrain vehicles (ATV’s) according to current industry and OSHA standards.

2.F.01.01\* Service motorcycles and ATV’s.

* + - 1. \* Diagnose and repair common chassis and suspension problems.
      2. \* Examine and diagnose tire issues including repair, mounting and balancing.
      3. \* Differentiate between and service mechanical and hydraulic braking systems.

2.F.01\* Advanced Performance Examples:

* Student will mount and balance a tire.
* Student will repair leaking fork seals.

###### Fundamentals of Marine Equipment

2.G.01\* Diagnose and service Marine equipment according to current industry and OSHA standards.

2.G.01.01\* Service marine equipment.

2.G.01.02\* Diagnose and service an outboard drive assembly. 2.G.01.03\* Diagnose and service a stern-drive assembly.

2.G.01.04\* Assess and demonstrate propeller pitch and size for a given vessel. 2.G.01.05\* Demonstrate servicing of a personal water craft (PWC) according to the

manufacturer’s specifications.

2.G.01\* Advanced Performance Examples:

* Student will change the lower end lube of a given out-drive.
* Student will set the proper pitch of a propeller.

###### Fundamentals of Horse Power and Torque

2.H.01\* Measure and calculate horse power and torque. 2.H.01.01\* Explain and measure horsepower.

2.H.01.02\* Measure torque and revolutions per minute (RPM) to calculate horsepower. 2.H.01.03\* Compare values before and after engine alteration using a Dynamometer.

2.H.01\* Advanced Performance Examples:

* Student will demonstrate use of a dynamometer machine.
* Student will determine how to measure horsepower.

###### Fundamentals of Welding

2.I.01\* Identify and demonstrate welding and cutting techniques according to current industry and OSHA standards.

2.I.01.01\* Identify and demonstrate safe set-up of gas welding and cutting equipment. 2.I.01.02\* Identify and demonstrate safe set-up of electric welding equipment.

2.I.01.03\* Demonstrate safe welding and cutting techniques on given sample metal parts.

2.I.01\* Advanced Performance Examples:

* Student will demonstrate safe use of a gas welder.
* Student will perform cutting techniques on a given piece of metal.

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

Strand 3: Embedded Academics, a critical piece of a Vocational Technical Education Framework, are presented as Crosswalks between the Massachusetts Vocational Technical Education Frameworks and the Massachusetts Curriculum Frameworks. These Crosswalks are located in the Appendix of this Framework.

##### Academic Crosswalks

[Appendix A: English Language Arts](#_bookmark20) [Appendix B: Mathematics](#_bookmark20)

[Appendix C: Science and Technology/Engineering](#_bookmark22) Earth and Space Science

Life Science (Biology)

Physical Science (Chemistry and Physics) Technology/Engineering

# [Embedded Academic Crosswalks](#_bookmark0)

[Embedded English Language Arts and Literacy](#_bookmark0)

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| CVTE  Learning Standard Number | Strand Coding Designation Grades ELAs  Learning Standard Number | Text of English Language Arts Learning Standard |
| 2.B.04.01 | RST1 Grades 9-10 and | Cite specific textural evidence to support analysis of science and |
| 2.C.02.07 | Grades 11-12 | technical texts, attending to the precise details of explanations or |
| 2.E.05.03  2.E.05.05 |  | descriptions. |
| 2.E.05.06 | RST3 Grades 9-10 and | Follow precisely a complex multistep procedure when carrying out |
| 2.E.05.07 | Grades 11-12 | experiments, taking measurements, or performing technical tasks; |
| 2.E.06.01  2.E.07.17 |  | analyze the specific results based on explanations.  Performance Example:  Students will troubleshoot a technical problem using proper diagnostic principles. They will also be able to identify the system where the trouble is located, and explain the proper sequence of events in the system. |
| 2.E.07.25 |  |  |
| 2.B.04.02 |  |  |
| 2.C.02.07 |  |  |
| 2.C.01.01 | SL1 Grades 9-10 and | Initiate and participate effectively in a range of collaborative |
| 2.C.01.05 | Grades 11-12 | discussions (one-on-one, in groups, and teacher led) with diverse |
| 2.C.01.06 |  | partners on grades 9-12 topics, texts, and issues, building on other’s ideas and expressing their own clearly and persuasively.  Performance Example:   * Students will fill out a work order after/while interviewing a customer. They will show proper customer service practices to communicate effectively regarding repair, causes, prevention, and pre and post-   delivery instructions. |
| 2.C.04.01 | RST5 Grades 9-10 and Grades 11-12 | Analyze the structure of the relationships among concepts in a text,  including relationships among key terms (e.g., force, friction, reaction force, energy).  Performance Example:  Students will explain the operation of generators; comparing the brush/slip-ring versus the brushless (induction) type. |
| 2.E.05.01 | RST4 Grades 9-10 and | Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.  Performance Example:   * Students will define, describe, identify, and explain several terms and fundamentals of fuel, ignition, electrical, and governor systems. Not only will they use texts to find answers, they will also use a variety of research materials and fully explain one or more of the systems in writing of a technical nature. Students   will demonstrate proper methods for carrying our several tasks related to the systems they defined. |
| 2.E.05.03 | Grades 11-12 |
| 2.E.5.05 | WHST2 Grades 9-10 and |
| 2.E.05.06 | 11-12 |
| 2.E.05.07 | W7 Grades 9-10 and |
| 2.E.06.01 | Grades 11-12 |
| 2.E.07.17 |  |
| 2.E.07.25 |  |
| 2.E.05.03 |  |
| 2.E.05.05 |  |
| 2.E.05.06 |  |
| 2.E.05.01 |  | Conduct short as well as more sustained research projects to answer |
| 2.E.05.03 |  | a question (including a self-generated question) or solve a problem; |
| 2.E.05.05 |  | narrow or broaden the inquiry when appropriate; synthesize |
| 2.E.05.06 |  | multiple sources on the subject, demonstrating understanding of the |
| 2.E.05.07  2.E.06.01 |  | subject under investigation.  Performance Example:  Students will use manuals and other forms of media to identify and explain fundamentals of fuel, ignition, electrical, and governor systems. Students will demonstrate proper methods for carrying our several tasks related to the systems they defined. |

[Embedded Mathematics](#_bookmark0)

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| CVTE  Learning Standard Number | Math Content Conceptual Category and Domain Code Learning Standard Number | Text of Mathematics Learning Standard |
| 2.B.02.01 | G-CO-12 | Make geometric constructions with a variety of tools and methods |
| 2.B.02.02 | 5.MD.1 | (compass and straightedge, string, reflective devices, paper folding, |
| 2.B.02.03 | 7.G.1 | dynamic software, etc.). |
| 2.B.02.04 | 7.G.2 | Convert among different-sized standard measurement units within a |
|  |  | given measurement system and use these conversions in solving |
|  |  | multi-step, real-world problems. |
|  |  | Solve problems involving scale drawings of geometric figures, such |
|  |  | as computing actual lengths and areas from a scale drawing and |
|  |  | reproducing a scale drawing at a different scale. |
|  |  | Draw (freehand, with ruler and protractor, and with technology) |
|  |  | geometric shapes with given conditions.  Performance Examples:   * Student will demonstrate the proper use of a combination square.   Student will demonstrate the proper use and maintenance of a micrometer. |
| 2.E.09.09 | 5.MD.1 | Convert among different-sized standard measurement units within a |
| 2.E.09.16 | 7.RP.1  4.NF.7 | given measurement system and use these conversions in solving multi-step, real-world problems. |
|  | 4.MD.1 | Compute unit rates associated with ratios of fractions, including |
|  | 4.MD.2 | ratios of lengths, areas, and other quantities measured in like or different units. |
|  |  | Understand decimal notation for reactions, and compare decimal |
|  |  | fractions. |
|  |  | Know relative sizes of measurements units within one system of |
|  |  | units, including km, m, cm; kg, g; lb, oz; l ml; hr, min, sec. Within a |
|  |  | single system of measurements, express measurements in a larger unit in terms of a smaller unit.  Use the four operations to solve word problems involving simple fractions or decimals and problems that require expressing measurements given in a larger unit in terms of a smaller unit.  Represent measurement quantities using diagrams that feature a measurement scale.  Performance Examples:   * Student will properly measure crankshaft run-out.   Student will determine bearing clearance. |
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| 2.H.01.01 | 6.RP.1 | Understand the concept of a ratio and use ratio language to describe |
| 2.H.01.02 | 6.RP.3 | a ratio relationship between two quantities. |
| 2.H.01.03 | 6.RP.3b | Use ratio and rate reasoning to solve real-world and mathematical |
|  | 7.RP.1 | problems, e.g., by reasoning about tables of equivalent ratios, tape |
|  | 8.F.4 | diagrams, double number line diagrams, or equations. (Solve unit |
|  | 8.G.7 | rate problems involving constant speed.) |
|  | 8.G.8 | Compute unit rates associated with ratios of fractions, including |
|  |  | ratios of length, areas, and other quantities measured in like or |
|  |  | different units. |
|  |  | Use functions to model relationships between quantities. |
|  |  | Apply the Pythagorean Theorem to determine unknown side lengths |
|  |  | in right triangle in real-world and mathematical problems in two and |
|  |  | three dimensions. |
|  |  | Apply the Pythagorean Theorem to find the distance between two |
|  |  | points in a coordinate system.  Performance Examples:   * Student will demonstrate proper and safe use of a dynamometer machine.   Student will demonstrate the ability to measure horsepower. |

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

#### [Life Science (Biology)](#_bookmark0)

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| CVTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Biology Learning Standard |
| 2.E.05.01 | Energy Resources in the Earth System  2.1  2.2 | Recognize, describe, and compare renewable energy resources (e.g., solar, wind, water, biomass) and nonrenewable energy resources (e.g., fossil fuels, nuclear energy).  Describe the effects on the environment and on the carbon cycle of using both renewable and nonrenewable sources of energy.  Performance Examples:   * Student will identify grades of fuel. * Student will explain the function of fuel injection.   Student will adjust the fuel mixture in a carburetor. |

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

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| CVTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Chemistry Learning Standard |
| 2.B.04.10  2.B.04.15  2.D.02.06 | States of Matter, Kinetic Molecular Theory, and Thermochemistry  6.1  6.2 | Using the kinetic molecular theory, explain the behavior of gases and the relationship between pressure and volume (Boyle’s Law), volume and temperature (Charles’s Law), pressure and temperature (Gay-Lussac’s Law), and the number of particles in a gas sample (Avogadro’s hypothesis). Use combined gas law to determine changes in pressure, volume, and temperature.  Perform calculations using the ideal gas law. Understand the molar volume at 273 K and 1 atmosphere (STP).  Performance Examples:   * Student will be able to remove, test and replace an ignition armature module. * Student will identify a carburetor and its components. * Student will perform a cylinder leak down test. * Student will demonstrate safe starting of a chainsaw. * Student will select proper fuel for lawnmower.   Student will explain ANSI standards of kick-back. |
| 2.B.06.03 | Acids and Bases Oxidation- Reduction Reactions  8.1  8.2 | Define the Arrhenius theory of acids and bases in terms of the presence of hydronium and hydroxide ions in water and the Bronstad-Lowery theory of acids and bases in terms of proton donors and acceptors.  Relate hydrogen ion concentrations to the pH scale and to acidic, basic, and neutral solutions. Compare and contrast the strengths of  various common acids and bases (e.g., vinegar, baking soda, soap, citrus juice.)  Performance Examples:   * Student will demonstrate the safe handling of used anti-freeze.   Student will demonstrate safe usage of a pressure washer. |

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

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| CVTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Physics Learning Standard |
| 2.B.05.01  2.B.05.02 | Conservation of Energy and Momentum  2.2  2.3 | Interpret and provide examples of how energy can be converted from gravitational potential energy to kinetic energy and vice versa.  Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.  Performance Examples:   * Student will identify a chain fall.   Student will demonstrate the proper and safe usage of a hydraulic lift. |
| 2.D.02.13 | Conservation of Energy and Momentum  2.3  2.4 | Describe both qualitatively and quantitatively how work can be expressed as a change in mechanical energy.  Describe both qualitatively and quantitatively the concept of power as work done per unit time.  Performance Examples:   * Student will demonstrate safe starting of a chainsaw. * Student will select proper fuel for a lawnmower.   Student will explain ANSI standards of kick-back. |
| 2.E.03.01  2.E.03.02 | Motion and Forces 1.6 | Distinguish qualitatively between static and kinetic friction, and describe their effects on the motion of objects.  Performance Examples:   * Student will explain SAE viscosity ratings.   Student will differentiate between oil ratings. |
| 2.E.07.13 | Electromagnetism 5.1 | Recognize that an electric charge tends to be static on insulators and  can move on and in conductors. Explain that energy can produce a separation of charges.  Performance Examples:   * Student will describe the purpose of an ignition system.   Student will remove a starter motor. |
| 2.E.07.17  2.E.07.19 | Electromagnetism 5.2  5.3 | Develop qualitative and quantitative understandings of current, voltage, resistance, and the connections among them (Ohm’s law). Analyze simple arrangements of electrical components in both series and parallel circuits. Recognize symbols and understand the functions of common circuit elements (battery, connecting wire,  switch, fuse, resistance) in a schematic diagram.  Performance Examples:   * Student will describe the purpose of an ignition system.   Student will remove a starter motor. |

#### [Scientific Inquiry Skills Standards](#_bookmark0)

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| CVTE  Learning Standard Number | Subject Area, Topic Heading and  Learning Standard Number | Text of Scientific Inquiry Skills Learning Standard | |
| 2.B.04.01 | SIS1 | Make observations, raise questions, and formulate hypotheses. Observe the world from a scientific perspective.  Pose questions and form hypotheses based on personal observations, scientific articles, experiments, and knowledge.  Performance Examples:   * Student will be able to remove test and replace an ignition armature module. * Student will identify a carburetor and its components.   Student will perform a cylinder leak down test. | |
| 2.B.04.01 | SIS2 | | Design and conduct scientific investigations.  Articulate and explain the major concepts being investigated and the purpose of an investigation.  Select required materials, equipment, and conditions for conducting an experiment.  Identify independent and dependent variables. Write procedures that are clear and replicable.  Employ appropriate methods for accurately and consistently making observations  making and recording measurements at appropriate levels of precision  collecting data or evidence in an organized way Follow safety guidelines.  Performance Examples:   * Student will be able to remove test and replace an ignition armature module. * Student will identify a carburetor and its components.   Student will perform a cylinder leak down test. |
| 2.B.04.02 | SIS3 | | Analyze and interpret results of scientific investigations.  Present relationships between and among variables in appropriate forms.  Represent data and relationships between and among variables in charts and graphs.  Use appropriate technology (e.g., graphing software) and other tools.  Use mathematical operations to analyze and interpret data results. Assess the reliability of data and identify reasons for inconsistent results, such as sources of error or uncontrolled conditions.  Use results of an experiment to develop a conclusion to an investigation that addresses the initial questions and supports or refutes the stated hypothesis.  State questions raised by an experiment that may require further investigation.  Performance Examples:   * Student will be able to remove test and replace an ignition armature module. * Student will identify a carburetor and its components.   Student will perform a cylinder leak down test. |
| 2.B.04.02 | SIS4 | | Communicate and apply the results of scientific investigations. Develop descriptions of and explanations for scientific concepts that were a focus of one or more investigations.  Review information, explain statistical analysis, and summarize data collected and analyzed as the result of an investigation.  Explain diagrams and charts that represent relationships of variables.  Construct a reasoned argument and respond appropriately to critical comments and questions.  Use language and vocabulary appropriately, speak clearly and logically, and use appropriate technology (e.g., presentation software) and other tools to present findings.  Use and refine scientific models that simulate physical processes or phenomena.  Performance Examples:   * Student will be able to remove test and replace an ignition armature module. * Student will identify a carburetor and its components.   Student will perform a cylinder leak down test. |

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

* The Equipment and Engine Training Council (EETC) offers certification as Master Technician of Power Equipment in the areas noted below. This certification is currently available for all eligible recipients at Baypath Regional Vocational Technical High School in Charlton, MA:

Four Stroke Gasoline Engines Two Stroke Gasoline Engines Electrical

Compact Diesel Generator Driveline/Hydro Reel Technology

* Occupational Safety and Health Administration (OSHA) General Certification (10 hour classroom/online program