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CTE Standards Unpacking
Electrical/Electronic Systems and Heating Ventilation Air Conditioning (HVAC)

Course: Electrical/Electronic Systems and Heating Ventilation Air Conditioning (HVAC)
Course Description: Students in Electrical/Electronic Systems and Heating Ventilation Air Conditioning (HVAC) will learn theory and operation as well as diagnosis and repair of Electrical/Electronic and HVAC systems. Completion of this course will aid students as they continue their education at the post-secondary level or in the workforce and in the preparation for their ASE certification test. (The examples are NATEF (National Automobile Technician Education Foundation) tasks that the student may complete for ASE (Automotive Service Excellence) certification.)
Career Cluster: Transportation Distribution and Logistics
Prerequisites: Introduction to Vehicle Systems and Maintenance or Maintenance and Light Repair - Recommended
Program of Study Application: Electrical/Electronic Systems and Heating Ventilation Air Conditioning (HVAC) is an advanced pathway course in the transportation, distribution and logistics career cluster, automotive technology pathway.

INDICATOR #EEHVAC 1: **Students will demonstrate automotive technology safety practices, including Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) requirements, for an automotive repair facility.**		
SUB-INDICATOR 1.1 (Webb Level: 2 Skill/Concept): Demonstrate automotive technician safety practices		
Knowledge (Factual): -Protective clothing and safety equipment according to OSHA and EPA requirements. -Use of hand and power tools -Basic shop safety using OSHA standards -Safety data sheets. (SDS)	**Understand (Conceptual):** -The use of protective clothing and safety equipment according to OSHA and EPA requirements to protect technician's health. -Consequences of the improper use of hand and power tools	**Do (Application):** -Use protective clothing and safety equipment according to OSHA and EPA requirements. -Summarize the proper use of safety data sheet (SDS) -Demonstrate the proper use of hand and power tools -Examine basic shop safety using OSHA standards

		-Maintain a portfolio of successfully completed safety and equipment exams

Benchmarks:
Students will be assessed on their ability to:

- Create a safety poster the proper use of all safety equipment and protective clothing.
- Create a safety video for the proper use of hand and power tools.
- Maintian folder of SDS.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
SL2. Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.	Students will create a safety video.

INDICATOR #EEHVAC 2: **Students will perform maintenance, diagnostic and repair procedures of electrical/electronic systems.**

SUB-INDICATOR 2.1 (Webb Level: 3 Strategic Thinking): Demonstrate knowledge of the vehicle electrical system

SUB-INDICATOR 2.2 (Webb Level: 2 Skill/Concept): Test and repair electrical problems

Knowledge (Factual):	**Understand (Conceptual):**	**Do (Application):**
-Vehicle service information including vehicle service history, service precautions, and technical service bulletins. P-1	-Differences between electrical/electronic series, parallel, and series and parallel circuits using principles of electricity (Ohm's Law). P-1	-Research vehicle service information including vehicle service history, service precautions, and technical service bulletins. P-1 -Repair a vehicle electrical system.

-Electrical/electronic series, parallel, and series and parallel circuits using principles of electricity (Ohm's Law). P-1 -Digital multimeter (DMM) when measuring source voltage, voltage drop (including grounds), current flow, and resistance. P-1 - Shorts, grounds, opens, and resistance problems in electrical/electronic circuits. P-1 -Electrical/electronic system components and configuration. P-1 -Test light -Jumper wires -General circuit protection -Terminal ends and connector	-Causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits. P-1 -Electrical/electronic system components and configuration. P-1	-Identify electrical/electronic system components and configuration. P-1 -Use a test light to check operation of electrical circuits. P-2 -Use fused jumper wires to check operation of electrical circuits. P-2 -Measure key-off battery drain (parasitic draw). P-1 -Inspect and test fusible links, circuit breakers, and fuses; determine necessary action. P-1 -Repair and/or replace connectors, terminal ends, and wiring of electrical/electronic systems (including solder repair) P-1 -Use wiring diagrams to trace electrical/electronic circuits. P-1 -Generate a work order using a computer-based program.
Benchmarks:		

Students will be assessed on their ability to:

- Complete a work order.
- Identify electrical circuits using service manual.
- Measure a known voltage, amperage, and resistance circuit.
- Identify and repair an electrical circuit.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
HS-PS3-5 Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.	Students will model the circuits within the vehicle.
A-CED4. 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.	Students will calculate Ohm's Law problems that model the curcuits.

INDICATOR #EEHVAC 3: **Students will perform maintenance, diagnostic and repair procedures of the battery systems.**

SUB-INDICATOR 3.1 (Webb Level: 1 Recall): Identify battery requirements

SUB-INDICATOR 3.2 (Webb Level: 2 Skill/Concept): Service battery

Knowledge (Factual):	**Understand (Conceptual):**	**Do (Application):**
-High voltage systems on electric, hybrid electric, gasoline, and diesel vehicles.	-Hazards and consequences of high voltage systems. -Construction, maintenance, and testing, of a battery.	-Perform battery state-of-charge test. P-1 -Maintain or restore electronic memory functions. P-1 -Perform slow/fast battery charge according to manufacturer's recommendations. P-1

		-Jump-start vehicle using jumper cables and a booster battery or an auxiliary power supply. P-1

Benchmarks:
Students will be assessed on their ability to:

- Model testing a battery using proper test equipment.
- Properly jumpstart a vehicle.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
SL1 1. Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led)	Students will explain charge a battery according to manufacture specifications
HS-PS3-1 Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.	Students will create a mathematical model of the battery system

INDICATOR #EEHVAC 4: **Students will perform maintenance, diagnostic and repair procedures of starting systems.**

SUB-INDICATOR 4.1 (Webb Level: 1 Recall): Explain starting system operation

SUB-INDICATOR 4.2 (Webb Level: 2 Skill/Concept): Inspect and repair starting system

Knowledge (Factual):	**Understand (Conceptual):**	**Do (Application):**
-Components of starting system	-Starting system operation, maintenance and repair.	-Demonstrate knowledge of an automatic idle-stop/start-stop system. P-3

		-Perform starter current draw test; determine necessary action. P-1 -Perform starter circuit voltage drop tests; determine necessary action. P-1 -Inspect and test starter relays and solenoids; determine necessary action. P-2 -Remove and install starter in a vehicle. P-1 -Inspect and test switches, connectors, and wires of starter control circuits; determine necessary action. P-2

Benchmarks:
Students will be assessed on their ability to:

- Diagnose starter circuits, components, and motors using a test vehicle.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. A-CED Create equations and inequalities in one variable and use them to solve problems.	Students will create a repair estimate on test vehicle Students will create a formula representing the draw of a circuit

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INDICATOR #EEHVAC 5: **Students will perform maintenance, diagnostic and repair procedures of the charging system.**		
SUB-INDICATOR 5.1 (Webb Level: 2 Skill/Concept): Remove, inspect, and replace charging system components		
Knowledge (Factual): -Components of a charging system	**Understand (Conceptual):** -Charging system operation, repair, and maintenance.	**Do (Application):** -Perform charging system output test; determine necessary action. P-1 -Inspect, adjust, and/or replace generator (alternator) drive belts; check pulleys and tensioners for wear; check pulley and belt alignment. P-1 -Remove, inspect, and/or replace generator (alternator). P-2 -Perform charging circuit voltage drop tests; determine necessary action. P-2
Benchmarks: *Students will be assessed on their ability to:* • Diagnose charging system circuits, components, and alternators using a test vehicle.		
Academic Connections		
ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard): W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	**Sample Performance Task Aligned to the Academic Standard(s):** Students will create a repair estimate on test vehicle	

A-CED Create equations and inequalities in one variable and use them to solve problems.	Students will create a formula representing the draw of a circuit

INDICATOR #EEHVAC 6: **Students will identify and perform repair procedures of electrical systems.**		
SUB-INDICATOR 6.1 (Webb Level: 2 Skill/Concept): Identify and inspect lighting, instrument cluster, driver information, and body electrical systems and verify operation		
SUB-INDICATOR 6.2 (Webb Level: 2 Skill/Concept): Perform the following repair operations		
Knowledge (Factual): -Interior and exterior electrical systems.	**Understand (Conceptual):** -Ramifications of high intensity discharge headlights. -Importance of inspecting interior and exterior lamps. -Consequences of non-operational warning indicators. -Importance of windshield wiper system.	**Do (Application):** -Identify system voltage and safety precautions associated with high-intensity discharge headlights. P-2 -Inspect interior and exterior lamps and sockets including headlights and auxiliary lights (fog lights/driving lights); replace as needed. P-1 -Verify operation of instrument panel gauges and warning/indicator lights; reset maintenance indicators. P-1 -Verify windshield wiper and washer operation; replace wiper blades. P-1 -Describe the operation of keyless entry/remote-start systems. P-3

		-Aim headlights. P-2 -Disable and enable supplemental restraint system (SRS) and verify indicator lamp operation. P-1 -Remove and reinstall door panel. P-1

Benchmarks:
Students will be assessed on their ability to:

- Perform vehicle safety inspection.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	Students will create a vehicle safety report
N-VM2. Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.	Students will create a visual representation showing headlights as vectors

INDICATOR #EEHVAC 7: **Students will research and identify heating, ventilation, and air conditioning components.**

SUB-INDICATOR 7.1 (Webb Level: 1 Recall): Obtain vehicle service information on heating and air conditioning components

Knowledge (Factual):	**Understand (Conceptual):**	**Do (Application):**
-Vehicle service information including vehicle service history, service precautions, and	-Functions of the HVAC system and how they relate to a given vehicle.	-Research vehicle service information, including refrigerant/oil type, vehicle service history, service precautions, and

technical service bulletins. P-1		technical service bulletins. P-1 -Identify heating, ventilation and air conditioning (HVAC) components and configuration. P-1

Benchmarks:
Students will be assessed on their ability to:

- Complete checklist for identification of system components located on the vehicle.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	Students will create a repair estimate for HVAC systems
A-CED 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.	Students will create a model of the HVAC system using PV=nRT

INDICATOR #EEHVAC 8: **Students will perform repair procedures for the refrigeration system.**		
SUB-INDICATOR 8.1 (Webb Level: 2 Skill/Concept): Inspect and repair refrigeration system components		
Knowledge (Factual): -Air conditioner drive components.	**Understand (Conceptual):** -Importance of maintenance procedures.	**Do (Application):** -Inspect and replace A/C compressor drive belts, pulleys, and tensioners; visually inspect A/C

-Air conditioner maintenance.		components for signs of leaks; determine necessary action. P-1 -Identify hybrid vehicle A/C system electrical circuits and the service/safety precautions. P-2 -Inspect A/C condenser for airflow restrictions; determine necessary action. P-1

Benchmarks:
Students will be assessed on their ability to:

- Remove and install drive belt.
- Clean A/C condenser with appropriate equipment.

Academic Connections

ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard):	**Sample Performance Task Aligned to the Academic Standard(s):**
SL4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation	Students will explain A/C systems of hybrid and gas cars.
A-CED 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.	Students will create a model of the HVAC system using PV=nRT

INDICATOR #EEHVAC 9: **Students will perform repair procedures for the heating and cooling system.**		
SUB-INDICATOR 9.1 (Webb Level: 2 Skill/Concept): Analyze heating and engine cooling systems problem		
Knowledge (Factual): -Cooling and heating system operation.	**Understand (Conceptual):** -Importance of maintaining proper engine temperature.	**Do (Application):** -Inspect engine cooling and heater systems hoses and pipes; determine necessary action. P-1
Benchmarks: *Students will be assessed on their ability to:* • Completion of check list of cooling and heating system operation.		
Academic Connections		
ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard): W4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	**Sample Performance Task Aligned to the Academic Standard(s):** Students will create a written estimate of any engine repairs needed.	

INDICATOR #EEHVAC 10: **Students will perform inspection and identification procedures for the heating, ventilation and air conditioning (HVAC) system.**		
SUB-INDICATOR 10.1 (Webb Level: 2 Skill/Concept): Inspect and identify operating systems and related controls		
Knowledge (Factual): -HVAC operation.	**Understand (Conceptual):** -Consequences of correct and incorrect HVAC settings	**Do (Application):** -Inspect A/C-heater ducts, doors, hoses, cabin filters, and outlets; determine necessary action. P-1 -Identify the source of A/C system odors. P-2

Benchmarks:
Students will be assessed on their ability to:

- Complete inspection check list and report deficiencies.

Academic Connections	
ELA Literacy and/or Math Standard (if applicable, Science and/or Social Studies Standard): SL4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation	**Sample Performance Task Aligned to the Academic Standard(s):** Students will explain HVAC operations of hybrid and gas cars.

Additional Resources
Please list any resources (e.g., websites, teaching guides, etc.) that would help teachers as they plan to teach these new standards.