Appendix Q

TRANSPORTATION, DISTRIBUTION AND LOGISTICS YOUTH APPRENTICESHIP

AUTO TECHNICIAN PATHWAY ELECTRICAL/ELECTRONICS (UNIT 9)

Unit 9: Auto Technician Pathway
Electrical/Electronics

Competency

1. Assist to diagnose electrical/electronic integrity of series, parallel, and series-parallel circuits using principles of electricity (Ohm's Law)

Performance Standard Condition

Competence will be demonstrated

- at the worksite
- while assisting a worksite professional

Performance Standard Criteria

Performance will be successful when learners:

- Locate the wiring diagram for the component of concern
- Determine the circuit characteristic pattern
- Given 2 of 3 measured values, calculate the remaining value (voltage, current, resistance)
- Verify calculations with worksite professional
- Given measured and calculated values throughout a given circuit, identify some common cause that could result in the vehicle concern
- Determine additional testing or repairs required with worksite professional

Learning Objectives

- Explain the principles of electricity
- Describe the action of basic electric circuits
- Compare voltage, current, and resistance
- Describe the principles of magnetism and magnetic fields
- Identify basic electric and electronic terms and components
- Describe fundamental electrical tests
- Identify factors that will determine how much current will flow in a circuit
- Define Ohm's Law and how to determine circuit resistance, current flow and voltage drop
- State the relationships between voltage, current & resistance in a simple circuit
- Identify sources of AC/DC voltages & their automotive applications
- Explain how to use the following testing instruments: Voltmeter, Test Light, Ammeter, & Ohmmeter
- Identify series & parallel circuits as they apply to typical lighting circuits
- Describe characteristics of a series circuit
- Describe characteristics of a parallel circuit
- Describe characteristics of a series/parallel circuit
- Identify common causes of electrical circuit or component failures
- List electrical systems in a vehicle

Comments:

Unit 9: Auto Technician Pathway
Electrical/Electronics

Competency

2. Demonstrate proper use of a digital multimeter (DMM) during diagnosis of electrical circuit problems, including source voltage, voltage drop, current flow, and resistance

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety procedures
- Set the DMM to the correct voltage scale
- Connect the red lead to the appropriate point in the circuit to be measured
- Connect the black lead to the appropriate position on the circuit depending on the function to be measured
- Measure voltage, voltage drop, current flow and resistance
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Explain the function of the DMM
- Define voltage, voltage drop, current flow and resistance & their common units of measurement
- Describe how the DMM works to measure voltage, voltage drop, current flow & resistance
- Describe the purpose of the ground lead in using the DMM

Comments:

Unit 9: Auto Technician Pathway
Electrical/Electronics

Competency

3. Locate shorts, grounds, opens, and resistance problems in electrical/electronic circuits

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Locate & read the circuit system outline to see how circuit is supposed to operate using the wiring diagram
- Determine if the problem affects all or part of the circuit by testing at various points in the circuit
- Line Out parts of the circuit on the diagram that are working as each point is tested
- Identify all components, connectors, wires, related to that component
- Trace the circuit to verify how it works
- From the lined out circuit trace, narrow down possible causes
- Perform tests to quickly identify or rule out the possibilities
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Define an open circuit, short circuit, & high resistance in a circuit
- Describe what an intermittent problem in a circuit is
- Identify the effect of an open circuited component on voltage & amperage measured at various points in the circuit
- Identify the effect of a short circuited component on voltage & amperage measured at various points in the circuit
- Identify common electrical schematic symbols
- Identify electrical components on schematic drawings
- Read & interpret electrical schematic drawings
- Identify the differences between electrical and electronic components
- Identify common electronic components such as transistors, diodes, & integrated circuits

Comments:

Unit 9: Auto Technician Pathway
Electrical/Electronics

Competency

4. Inspect, test fusible links, circuit breakers, & fuses

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety procedures
- Inspect the fuses, breakers & links for tripping or breaks
- Reset the breaker or replace the fuse as needed
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify types of circuit protection devices used in an electrical circuit
- Define the functions of a fuse, fuse box, fusible link, circuit breaker
- Compare circuit breakers to fuses
- Explain the common functions & locations of fuses & breakers in a vehicle
- Describe types of circuit faults

Comments:

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Electrical/Electronics

Competency

5. Inspect, test switches, connectors, relays, solenoid devices, & wires of electrical/electronic circuits

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety procedures
- Inspect the switches, connectors, relays, solenoid devices for proper connection and wearing, burning or pitting
- Inspect the wires for proper connection and wearing, rubbing or fraying
- Test devices & wires for voltage, voltage drop, current flow, and resistance
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify safety precautions when performing wire repair
- Define the functions of a switch, connector, relay, solenoid device, & wire
- List common methods of wire repair
- Describe wire size and wire gauge
- Compare & contrast types of automotive wiring

Comments:

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Electrical/Electronics

Competency

6. Remove/replace terminal end from connector; replace connectors & terminal ends

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety procedures
- Unscrew/unplug the wire with terminal end
- Remove terminal end
- Replace new terminal end onto end of wire by soldering or crimping into place

Learning Objectives

- List types of common automotive wiring
- Explain common causes of wire damage
- Identify types of wire damage
- Describe wire repair procedures
- List common types of insulation damage
- List common types of wiring connectors used in vehicles
- Explain how to terminate primary wires

Comments:

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Electrical/Electronics

Competency

7. Perform battery state-of-charge test

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures

NON-SLA

- On NON-SLA (sealed lead acid) batteries, perform a hydrometer state of charge test
- If specific gravity is at or above acceptable level, do capacity test
- If specific gravity for all cells is below acceptable level, charge & retest battery
- If specific gravity between cells varies by more than acceptable amount, replace the battery

SLA

- Remove surface charge
- Perform open circuit voltage test
- Measure the open circuit voltage
- Refer to voltage chart to determine state of charge on battery
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify safety precautions when performing battery service
- Explain the operating principles of a lead-acid battery
- Compare conventional & maintenance-free batteries
- Explain how to remove surface charge from a battery
- Define specific gravity and how it indicates battery charge
- Describe how to do the hydrometer test
- Describe how to do the capacity test
- Describe how to do the open circuit voltage test
- Explain how to use the voltage chart to determine charge
- List levels which require a new battery vs. re-charging

Comments:

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Competency

8. Perform battery load (capacity) test

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Ensure battery is charged
- Select the appropriate load (capacity) tester
- Calculate the load (capacity) rating, how much current draw should be applied to the battery
- Remove surface charge from the battery
- Connect the 2 large positive and negative clamps to the battery positive and negative terminals
- Connect the induction clamp around the negative tester lead if applicable
- Apply the calculated battery load for 15 seconds
- Turn off the load
- Compare reading to service information
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify safety precautions when performing battery service
- Compare inductive and non-inductive capacity testers
- Explain how to calculate battery load values
- Describe the purpose of the battery load test

Comments:

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Competency

9. Inspect, clean, fill, &/or replace battery, battery cables, connectors, clamps, & hold-downs

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Inspect the condition of the support tray, hold-down, posts, cables and clamps

TOP

- If the battery top is dirty, test the top of the battery with a voltmeter; if leaking voltage then clean
- Clean top with baking soda & water

TERMINALS

- Perform a battery terminal test with a voltmeter with the ignition disabled
- If disconnecting battery, use a memory saver to keep programmable information intact
- Clean battery terminals by removing the cables and cleaning with baking soda & water
- Coat terminals with white grease
- Tighten fasteners to secure cable

ELECTROLYTE LEVEL

- In older NON maintenance free batteries, check electrolyte level
- Remove vent cap
- Check electrolyte level
- Fill cells to correct level with distilled water if needed

REMOVE/INSTALL

- Disconnect the cables
- Loosen the battery hold-down
- Carefully lift the battery out using a battery strap
- Gently place the battery into its try or box
- Ensure the battery fits properly
- Tighten the hold-down and reconnect the cables
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify safety precautions when performing battery service
- Describe the basic parts of an automotive battery
- Explain how temperature & other factors affect battery performance
- Describe the function of the baking soda mixture for cleaning
- Explain how to clean a battery top on a NON maintenance free battery
- Explain how to perform a battery terminal test

- Discuss when to use pliers to remove battery cables
- Discuss precautions to take around battery fill openings
- Explain why only distilled water can be used in batteries
- Explain why over-tightening terminals is a problem
- Discuss how size of battery relates to motor performance & battery service life

Comments:

Unit 9: Auto Technician Pathway
Electrical/Electronics

Competency

10. Perform battery charge

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Install the battery terminal adapters if required
- Connect charger according to manufacturer instructions
- Connect the red charger lead to the positive terminal
- Connect the black charger lead to the negative terminal
- Set the charger to the appropriate current for the type of charging
- Turn charger on
- Turn charger off when charging is complete
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe how a battery charger works to charge a battery
- List battery charging precautions to prevent damage
- Compare advantages & disadvantages for slow & fast battery charging
- Describe the temperature and charging rates for slow & fast charging
- Discuss what would happen if a charger was on when it is connected to the battery

Comments:

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Electrical/Electronics

Competency

11. Start a vehicle using jumper cables or auxiliary power supply

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Connect one end of the red jumper cable to the positive terminal on the dead battery
- Connect the other end of the red jumper cable to the positive terminal of the power source or good battery
- Connect the other end of the black jumper cable to negative terminal of the power source or good battery
- Connect other end of the black jumper cable to a good ground away from the dead battery
- Run the engine or activate the power source while starting the vehicle with the dead battery
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe problems that can occur if jumper cables are not connected properly

Comments:

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Electrical/Electronics

Competency

12. Perform starter current draw tests

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Determine starter type & main starter components
- Disable the ignition system to prevent the vehicle from starting
- Connect a DMM across the battery
- Measure battery voltage
- Crank the engine for no more than 15-30 seconds
- Note the voltage & current readings
- If values are not within specifications, further tests are needed
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe common starting system troubles
- Explain the purpose of the current draw test on a starter
- Define the order for starting system tests
- Explain typical procedures for a starting motor rebuild
- Adjust a neutral safety switch
- Describe the safety practices that should be followed when testing or repairing a starting system
- Describe the function of major ignition system components
- Explain vacuum, centrifugal, and electronic ignition timing advance
- Sketch the primary and secondary sections of an ignition system

Comments:

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Competency

13. Perform starter circuit voltage drop tests

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Determine starter type & main starter components
- Disable the ignition system to prevent the vehicle from starting
- Connect the DMM leads correctly
- Check voltage drop across different parts of the starter control circuit using the wiring diagram
- Note voltage drop readings
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Explain the purpose of the voltage drop test
- Define the order for doing voltage drop testing using a wiring diagram
- Cite the safety practices for testing and repairing a starter system

Comments:

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Electrical/Electronics

Competency

14. Remove, install starter in a vehicle

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures

REMOVAL

- Disconnect the battery
- Remove any shielding that covers the starter or its bolts
- Disconnect any accessible wires on the starter
- If needed, lower exhaust pipes by carefully loosening the bolt/studs
- Support the starter & remove the starter retaining bolts
- Check for shims
- Lower the starter & disconnect any wiring not yet removed
- Inspect the flywheel teeth for chipping & breakage

TO INSTALL:

- Reverse the steps taken to remove the starter; return shims to the same place if applicable
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Explain the principles of an electric motor
- Describe the construction and operation of a starting motor
- Sketch a simple starting system circuit
- Explain the operation of solenoids
- List the functions of the main starter drive parts
- Describe starter drive operation
- Compare different types of starting motors
- Describe starting system safety features
- Explain when it is best to repair vs. replace a starter motor

Comments:

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Competency

15. Perform charging system output test

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Connect the load tester leads as required for inductive or non-inductive testers
- Set load tester controls to proper positions
- Start the engine
- Adjust idle to speed to test specifications
- Adjust the load control on the tester until the ammeter displays the maximum current output without letting the voltage drop (about 12 v)
- Compare the readings to specifications
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- List the basic parts of a charging system
- Explain charging system operation
- Describe the construction of major charging system components
- Compare alternator and voltage regulator design differences
- Explain charging system indicators
- Describe safety practices to follow when working with charging systems
- List charging system tests and their purpose
- Describe the causes of charging system noises

Comments:

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Competency

16. Remove, inspect, install generator (alternator)

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Disconnect the battery

REMOVE

- Loosen the bolts and remove the fan belt
- Remove the wires from the generator, note their location
- Remove the generator

INSPECT

- Check for battery problems
- Check the condition of the generator belt. Replace if needed

INSTALL

- Connect the wires back on the generator in the proper locations with insulating washers, if applicable
- Hand screw in the bolts without tightening
- Slip the belt over the engine and generator pulley
- Align belt properly
- Adjust belt tension correctly
- Tighten the bolts
- Reconnect the battery
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- List common problems with charging systems
- Describe the importance of proper belt tightening
- Describe common wear that require belt replacement

Comments:

Unit 9: Auto Technician Pathway
Electrical/Electronics

Competency

17. Inspect, replace, aim headlights & bulbs

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures

INSPECT

- Test the power at the bulb socket
- Check the ground circuit
- Look for any shorted or open circuits
- Check for corrosion of the connector terminals
- Check the fuse
- Check the switch

REPLACE

- Remove the bulb assembly
- Remove small rings or screws
- Remove the lens
- Replace with new bulb
- Reinstall lens, screw, rings, and bulb assembly

AIM HEADLIGHTS

- Use headlight aimers, aiming screen or bubble levelers according to equipment specification
- Adjust headlights using the vertical & horizontal adjusting screws
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Explain the operating principles of automotive light, wiper, and horn systems
- Discuss the diagnostic questions to determine problems in light, wiper, and horn systems
- Summarize automatic light and wiper systems
- Explain how to aim headlights
- Describe the safety practices to follow when working with light, wiper, and horn systems
- Explain both analog and digital instrumentation
- Summarize how to remove and service an instrument cluster
- Identify safety precautions when handling halogen bulbs
- Describe how to load a vehicle prior to aiming headlights
- Explain the purpose of the bubble level

Comments:

Unit 9: Auto Technician Pathway
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Competency

18. Inspect, test gauges & gauge sending units for cause of abnormal gauge readings

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- If one gauge is not functioning, check the sending unit

ONE WIRE SENDING UNITS

- Disconnect the wire
- Ground the wire ONLY if required
- Check the gauge with the ignition ON
- If gauge moves, replace sending unit
- If gauge doesn't work, check wiring between instrument & sending unit
- If wiring is good, replace gauge or instrument cluster

TWO WIRE SENDING UNITS (TEMPERATURE SENSORS)

- Use scan tool or thermometer/ohmmeter
- Replace bulbs, inoperative gauges or sending units
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe the different types of gauges and sending units
- Explain how different types of gauges and sending units work
- Compare & contrast warning lights, sending units, switches, & basic display systems
- Explain both analog and digital instrumentation

Comments:

Unit 9: Auto Technician Pathway
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Competency

19. Remove, reinstall door panel

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Remove all screws that hold the door panel to the frame
- Unscrew & remove the door lock button
- Remove the inner door handle and window crank, if applicable
- Pop out the spring clips around the outside of the door panel
- After servicing, verify service and make adjustments as needed, cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Describe the importance of proper door removal
- Describe the parts of the door panel

Comments:

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Competency

20. Check for module communication (including CAN/BUS systems) errors using scan tool

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Turn the vehicle ON but do not start the engine
- Connect the scan tool cable to the vehicle's data link connector
- Ensure the pins match up
- If needed, power the scan tool to the cigarette lighter adapter
- Follow the onscreen instructions to check for trouble codes
- Use scan tool snapshot and data-stream values to find problems not tripping trouble codes
- Record codes
- Use codes with worksite professional to determine testing or servicing required
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Summarize where computers, control modules, sensors, and actuators are typically located
- Summarize the flow of data through a computer
- Explain how a computer uses sensor inputs to determine correct outputs
- Discuss the purpose & operation of on-board diagnostic systems
- Compare & contrast OBD I & OBD II diagnostic systems
- Describe what could happen if the scan tool is forced into a connector or connected to the wrong connector
- Distinguish between computer system failure types
- Explain the importance of checking the ECM for stored diagnostic codes first
- Describe common locations of data link connectors
- Discuss precautions for scan tool program cartridges
- Identify the instrumentation used to monitor engine operating condition and fluid levels
- Explain the operation of components required to monitor engine operating conditions

Comments:

Unit 9: Auto Technician Pathway
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Competency

21. Diagnose electronic transmission control systems using a scan tool

Performance Standard Condition

Competence will be demonstrated

- at the worksite

Performance Standard Criteria

Performance will be successful when learners:

- Obtain equipment & materials needed
- Review safety & service procedures
- Turn the vehicle ON but do not start the engine
- Connect the scan tool cable to the vehicle's data link connector
- Ensure the pins match up
- If needed, power the scan tool to the cigarette lighter adapter
- Follow the onscreen instructions to check for trouble codes
- Use scan tool snapshot and data-stream values to find problems not tripping trouble codes
- Record codes
- Use codes with worksite professional to determine testing or servicing required
- After testing, prepare for service or cleanup work area, return tools to proper location, complete appropriate documentation

Learning Objectives

- Identify the basic components of an automatic transmission
- Describe the function and operation of the major parts of an automatic transmission
- Trace the flow of power through an automatic transmission
- Explain how an automatic transmission shifts gears
- Define the functions of the transmission control unit

Comments: