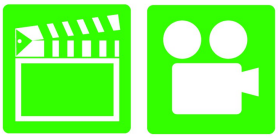
Automotive Maintenance and Light Repair, 1ST Edition

Chapter 28 Wiring Schematics and Circuit Testing

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers **Automotive Maintenance and Light Repair.** It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. ⁀ Interpret wiring schematics. ⁀ Locate shorts, grounds, opens, and resistance problems in electrical circuits, and determine necessary action. ⁀ Inspect and test switches, connectors, relays, solid state devices, and wires of electrical circuits, and perform necessary action. ⁀ This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronic System Diagnosis).
Establish the Mood or Climate	Provide a *WELCOME,* Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

ICONS	Ch28 Wiring Schematics & Circuit Testing
	**1. SLIDE 1 CH1 WIRING SCHEMATICS & CIRCUIT TESTING** 2. SLIDES 2-3 EXPLAIN OBJECTIVES **Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** 4. SLIDE 4 EXPLAIN WIRING SCHEMATICS & SYMBOLS
	
	
	**DISCUSSION: HAVE STUDENTS TALK ABOUT CIRCUIT INFORMATION ON A WIRING DIAGRAM. HOW IS A WIRING DIAGRAM SIMILAR TO A ROADMAP?**
	5. SLIDE 5 EXPLAIN Figure 28-1 The center wire is a solid color wire, meaning that the wire has no other identifying tracer or stripe color. The two end wires could be labeled "BRN/WHT," indicating a brown wire with a white tracer or stripe
	**DEMONSTRATION: PROCURE A WIRING HARNESS TO SHOW STUDENTS VARIOUS COLORS OF WIRES IN HARNESS**
	**DISCUSSION: DISCUSS VARIOUS COLORS OF THE WIRES IN A WIRING HARNESS. WHAT IS THE SIGNIFICANCE OF DIFFERENT COLORS?**
	6. SLIDE 6 EXPLAIN Figure 28-2 Typical section of a wiring diagram. Notice that 2 wire color changes at connection C210. 2 ".8" represents 2 metric wire size in square **millimeters**.
	7. SLIDE 7 EXPLAIN CHART 28-1 8. SLIDE 8 EXPLAIN Figure 28-3 Electrical/electronic symbols used in automotive wiring & circuit diagrams.
	**DISCUSSION: DISCUSS SYMBOLS USED TO INDICATE MALE & FEMALE CONNECTORS. WHY IS BATTERY SIDE OF CONNECTOR FEMALE & NOT MALE? STUDY CHART 28–3 TO BECOME FAMILIAR WITH SYMBOLS USED IN WIRING DIAGRAMS. WHAT DO SHORTER & LONGER LINES ON BATTERY SYMBOL MEAN? HOW IS WIRING SHOWN?**

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	9. **SLIDE 9 EXPLAIN FIGURE 28–4** In this typical connector, note that the positive terminal is usually a female connector 10. **SLIDE 10 EXPLAIN Schematic Symbols** 11. **SLIDE 11 EXPLAIN Figure 28-5** symbol for a battery. The positive plate of a battery is represented by the longer line and the negative plate by the shorter line. The voltage of the battery is usually stated next to the symbol. & **EXPLAIN Figure 28-6** ground symbol on the left represents earth ground. The ground symbol on the right represents a chassis ground
	**VIDEO: SHOW READING WIRING DIAGRAM VIDEO WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=READING%20A%20WIRING%20DIAGRAN&CLIP=PANDC/CHET/2012/AUTOMOTIVE/STARTING_CHARGING_ELECT/A6T2.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/STARTING_CHARGING_ELECT/XML/A6T2.XML
	12. **SLIDE 12 EXPLAIN Figure 28-7** Starting at top, wire from ignition switch is attached to terminal B of connector C2, wire is 0.5 mm^2 (20 gauge AWG), and yellow. Circuit number is 5. Wire enters connector C202 at terminal B3. 13. **SLIDE 13 EXPLAIN Figure 28-8** electrical terminals are usually labeled with a letter or number & **EXPLAIN Figure 28-9** Two wires that cross at the dot indicate that the two are electrically connected.
	**DEMONSTRATION: PROCURE A WIRING HARNESS WITH SPLICES. OPEN IT UP TO SHOW SPLICES IN HARNESS AND EXPLAIN NEED FOR SPLICES.**
	14. **SLIDE 14 EXPLAIN** Schematic Symbols 15. **SLIDE 15 EXPLAIN Figure 28-10** Wires that cross, but do not electrically contact each other, are shown with one wire bridging over the other. 16. **SLIDE 16 EXPLAIN Figure 28-11** Connectors (C), grounds (G), and splices (S) are followed by a number, generally indicating the location in vehicle. For example, G209 is a ground connection located under dash.
	**DISCUSSION: HAVE STUDENTS TALK ABOUT NUMBERS USED TO INDICATE GENERAL AREAS FOR CONNECTION LOCATIONS. WHY IS THERE NEED TO SEPARATE VEHICLE INTO DIFFERENT AREAS TO SIMPLIFY REPAIRS? WHAT IS DIFFERENCE BETWEEN EVEN & ODD NUMBERED**

ICONS	Ch28 Wiring Schematics & Circuit Testing
	CONNECTORS?
	17. **SLIDE 17 EXPLAIN Figure 28-12** ground for the battery is labeled G305 indicating the ground connector is located in the passenger compartment of the vehicle. The ground wire is black (BLK), the circuit number is 50, and the wire is 32 mm^2 (2 gauge AWG). 18. **SLIDE 18 EXPLAIN** SCHEMATIC SYMBOLS 19. **SLIDE 19 EXPLAIN Figure 28-13** The symbol for light bulbs shows the filament inside a circle, which represents the glass ampoule of the bulb. 20. **SLIDE 20 EXPLAIN Figure 28-14** An electric motor symbol shows a circle with the letter M in the center and two black sections that represent the brushes of the motor. This symbol is used even though the motor is a brushless design **& EXPLAIN Figure 28-15** Resistor symbols vary depending on the type of resistor.
	21. **SLIDE 21 EXPLAIN Figure 28-16** rheostat uses only two wires—one is connected to a voltage source and the other is attached to the movable arm. **EXPLAIN Figure 28-17** Symbols used to represent capacitors. If one of the lines is curved, this indicates that the capacitor being used has a polarity, while one without a curved line can be installed in the circuit without concern about polarity. 22. **SLIDE 22 EXPLAIN Figure 28-18** grid like symbol represents an electrically heated element. Symbol represents a cigarette lighter or heated rear window & **EXPLAIN Figure 28-19** Dashed outline represents a portion (part) of a component.
	**DISCUSSION: TALK ABOUT SYMBOLS USED TO REPRESENT CAPACITORS ON WIRING DIAGRAMS. WHY ARE 2 DIFFERENT SYMBOLS NEEDED FOR CAPACITORS?**
	23. **SLIDE 23 EXPLAIN** SCHEMATIC SYMBOLS 24. **SLIDE 24 EXPLAIN Figure 28-20** Solid box represents an entire component & **EXPLAIN Figure 28-21** Symbol represents a component that is case grounded
	**DEMONSTRATION: SHOW STUDENTS HOW TO USE A COPY OF A WIRING DIAGRAM AND HIGHLIGHTER TO TRACE CIRCUITS FOR TESTING OR REPAIR.**

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	**25. SLIDE 25 EXPLAIN Figure 28-22** (a) A symbol for a single-pole, single-throw (SPST) switch. This type of switch is normally open (N.O.) because nothing is connected to the terminal that the switch is contacting in its normal position. (b) A single-pole, double-throw (SPDT) switch has three terminals. (c) A double-pole, single-throw (DPST) switch has two positions (off and on) and can control two separate circuits. (d) A double-pole, double-throw (DPDT) switch has six terminals—three for each pole. Note: Both (c) and (d) also show a dotted line between the two arms indicating that they are mechanically connected, called a "ganged switch." **26. SLIDE 26 EXPLAIN Figure 28-23 (a)** symbol for a normally open (N.O.) momentary switch. **(b)** symbol for a normally closed (N.C.) momentary switch. **27. SLIDE 27 EXPLAIN FIGURE 28–24** Using a marker and color-coding the various parts of the circuit makes the circuit easier to understand and helps diagnosing electrical problems easier.
	**28. SLIDE 28 EXPLAIN RELAY TERMINAL ID** **29. SLIDE 29 EXPLAIN Figure 28-25** relay uses a movable arm to complete a circuit whenever there is a power at terminal 86 and a ground at terminal 85. A typical relay only requires about 1/10 ampere through the relay coil. The movable arm then closes the contacts (#30 to #87) and can relay 30 amperes or more. **30. SLIDE 30 EXPLAIN Figure 28-26** cross-sectional view of a typical 4-terminal relay. Current flowing through coil (terminals 86 and 85) causes movable arm (called armature) to be drawn toward coil magnet. Contact points complete electrical circuit connected to terminals 30 & 87. **31. SLIDE 31 EXPLAIN Figure 28-27** typical relay showing the schematic of the wiring in the relay. **32. SLIDE 32 EXPLAIN Figure 28-28** All schematics are shown in their normal, non-energized position.
	**DISCUSSION: HAVE STUDENTS TALK ABOUT OPERATION OF NORMALLY OPEN AND NORMALLY CLOSED RELAYS. WHAT ARE THE APPLICATIONS FOR NORMALLY OPEN RELAYS? WHAT ARE THE APPLICATIONS FOR NORMALLY CLOSED RELAYS?**

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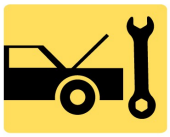
	33. **SLIDE 33 EXPLAIN Figure 28-29** typical horn circuit. Note that relay contacts supply the heavy current to operate horn when horn switch simply completes a low-current circuit to ground, causing relay contacts to close. 34. **SLIDE 34 EXPLAIN Figure 28-30** When relay or solenoid coil current is turned off, the stored energy in coil flows through clamping diode and effectively reduces voltage spike.
	**DISCUSSION: ASK STUDENTS TO TALK ABOUT CONTROLLING RELAY VOLTAGE SPIKES. HOW DOES DIODE USED IN A RELAY COIL CIRCUIT ELIMINATE VOLTAGE SPIKES?**
	35. **SLIDE 35 EXPLAIN Figure 28-31** resistor used in parallel with the coil windings is a common spike reduction method used in many relays.
	**AN INOPERATIVE CIRCUITINVOLVING A RELAY CAN BE DIVIDED IN ½ FOR TESTING. HIGH-CURRENT AND LOW-CURRENT SIDES CAN BE TESTED SEPARATELY TO DETERMINE WHICH SIDE OF CIRCUIT IS INOPERATIVE.**
	**LAB HANDS-ON TASK: STUDENTS COMPLETE THE WORKSHEET ON HIGHLIGHTING WIRING DIAGRAMS**
	**NATEF MLR TASK A6A3 USE WIRING DIAGRAMS TO TRACE ELECTRICAL/ELECTRONIC CIRCUITS**
	36. **SLIDE 36 EXPLAIN Figure 28-32** typical wiring diagram showing multiple switches & bulbs powered by one fuse.
	**DEMONSTRATION: USE TRAINER FOR AN OPEN CIRCUIT. HAVE STUDENTS WORK THROUGH CIRCUIT TROUBLESHOOTING PROCEDURE WITH YOU. EXPLAIN REASON FOR TESTING SIMPLE THINGS FIRST. TRY OUT THIS EXERCISE BEFORE CLASS TO MAKE SURE IT WORKS PROPERLY FOR DEMONSTRATING TO STUDENTS.**

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	37. **SLIDE 37 EXPLAIN Figure 28-33** To add additional lighting, simply tap into an existing light wire & connect a relay. Whenever the existing light is turned on, the coil of the relay is energized. The arm of the relay then connects power from another circuit (fuse) to auxiliary lights without overloading the existing light circuit. 38. **SLIDE 38 EXPLAIN** LOCATING OPEN CIRCUIT 39. **SLIDE 39-41 EXPLAIN Circuit Troubleshooting Procedure** 42. **SLIDES 42-43 EXPLAIN** LOCATING SHORT CIRCUIT 44. **SLIDE 44 EXPLAIN Figure 28-34** Always check simple things first. Check fuse for circuit you are testing. Maybe a fault in another circuit controlled by same fuse could have caused fuse to blow. Use a test light to check that both sides of fuse have voltage.
	**DISCUSSION: DISCUSS CIRCUIT BREAKER METHOD OF TESTING FOR A SHORT-TO-GROUND CIRCUIT. WHY IS THIS A BETTER ALTERNATIVE THAN FUSE REPLACEMENT METHOD?** 45. **SLIDE 45 EXPLAIN Figure 28-35** Gauss gauge can be used to determine the location of a short circuit even behind a metal panel
	**DEMONSTRATION: SHOW STUDENTS HOW A GAUSS GAUGE WORKS. HAVE THEM USE GAUSS GAUGE TO CHECK FOR A SHORTED WIRE.**
	46. **SLIDE 46 EXPLAIN Figure 28-36** tone generator-type tester used to locate open circuits and circuits that are shorted-to-ground. Included with this tester is a transmitter (tone generator), receiver probe, and headphones for use in noisy shops
	**DISCUSSION: HAVE STUDENTS DISCUSS FOUR METHODS OF TESTING FOR A SHORT-TO-GROUND CIRCUIT. WHICH METHOD WOULD BE EASIEST, & WHICH WOULD BE MOST DIFFICULT? WHY?**
	47. **SLIDE 47 EXPLAIN Figure 28-37** To check for a short-to-ground using a tone generator, connect black transmitter lead to a good chassis ground & red lead to load side of fuse terminal. Turn the transmitter on and check for tone signal with the receiver. Using a wiring diagram, follow strongest signal to short-to-ground. There will be no signal beyond the fault, either a short-to-

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  	ground as shown or an open circuit. **DEMONSTRATION: RAISE A VEHICLE ON A LIFT. HAVE STUDENTS INSPECT & LOCATE AREAS WHERE POTENTIAL ELECTRICAL OR ELECTRONIC PROBLEMS COULD OCCUR FROM HEAT OR MOVEMENT OF A WIRING HARNESS.** 48. SLIDE 48 EXPLAIN ELECTRICAL TROUBLESHOOTING 49. SLIDE 49 EXPLAIN FIGURE 28–39 Antistatic spray can be used by customers to prevent being shocked when they touch a metal object like the door handle **NATEF MLR TASK A6A5 DEMONSTRATE KNOWLEDGE OF THE CAUSES & EFFECTS FROM SHORTS, GROUNDS, OPENS, AND RESISTANCE PROBLEMS IN ELECTRICAL/ELECTRONIC CIRCUITS.**