Automotive Electrical & Engine Performance 8/E

Chapter 4 Electrical Circuits & Ohm's Law

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Electrical & Engine Performance 8th edition provides complete coverage of automotive areas pertaining vehicle electrical systems and engine performance. It correlates material to task lists specified by ASE and ASEEducation (NATEF) and emphasizes a problem-solving approach. Chapter features include Tech Tips, Frequently Asked Questions, Case Studies, Videos, and Animations that are listed in this Lesson Plan. This Lesson Plan also references ASEEducation (NATEF) Task Sheets available from Jim's web site.
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. 1. Identify the parts of a complete circuit. 2. Describe the characteristics of different types of circuits. 3. Explain Ohm's law as it applies to automotive circuits. 4. Explain Watt's law as it applies to automotive circuits. **This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area "A" (General Electrical/Electronic**
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.

NOTE: This lesson plan is based on Automotive Electrical & Engine Performance 8th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

DOWNLOAD Chapter 04 Chapter Images: From

http://www.jameshalderman.com/books_a8.html#anchor2

ICONS	Ch04 ELECTRICAL CIRCUITS/OHM'S LAW
	**1. SLIDE 1 CH4 ELECTRICAL CIRCUITS/OHM'S LAW**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	**Videos**
	**At the beginning of this class, you can download the crossword puzzle & Word Search from Jim's web site to familiarize your class with terms in this chapter & then discuss them, see below:** **HTTP://WWW.JAMESHALDERMAN.COM/BOOKS_A8.HTML#ANCHOR2** **DOWNLOAD** **CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)** **WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF**
	
	**2. SLIDE 2 EXPLAIN Figure 4-1** All complete circuits must have a power source, a power path, protection (fuse), an electrical load (light bulb in this case), and a return path back to the power source.
	**DEMONSTRATION: DEMO BASIC ELECTRICAL CIRCUIT ON TRAINER. SHOW (FIGURE 4-1)WHAT HAPPENS WHEN CIRCUIT IS SHORTED TO GROUND**
	**TRAINER TASK: ALLOW STUDENTS TO BLOW FUSE BY CREATING A SHORT CIRCUIT, OBSERVING WHAT IT TAKES TO CREATE SHORT CIRCUIT**
	**3. SLIDE 3 EXPLAIN Figure 4-2** return path back to the battery can be any electrical conductor, such as a copper wire or the metal frame or body of the vehicle. **4. SLIDE 4 EXPLAIN Figure 4-3** electrical switch opens the circuit and no current flows. The switch could also be on the return (ground) path wire. **5. SLIDE 5 EXPLAIN Figure 4-4** Examples of common causes of open circuits. Some are often difficult to find.

ICONS	Ch04 ELECTRICAL CIRCUITS/OHM'S LAW
	6. **SLIDE 6 EXPLAIN Figure 4-5** short circuit permits electrical current to bypass some or all of resistance in circuit. **DISCUSSION: Ask students to discuss ground path. Why doesn't a separate ground wire have to be run from the battery to each electrical load?** **Ask students to discuss how and why a short-to-voltage occurs. What is the reason that a short-to-voltage may or may not blow a fuse?**
	**EXPLAIN TECH TIP: *Open" Is a Four-Letter Word*** **An open in a circuit breaks the path of current flow. The open can be any break in the power side, load, or ground side of a circuit. A switch is often used to close and open a circuit to turn it on and off. Just remember,** **Open = no current flow** **Closed = current flow** **Trying to locate an open circuit in a vehicle is often difficult and may cause you to use other four-letter words, such as "HELP"!**
	7. **SLIDE 7 EXPLAIN Figure 4-6** A fuse or circuit breaker opens the circuit to prevent possible overheating damage in the event of a short circuit. 8. **SLIDE 8 EXPLAIN Figure 4-7** short-to-ground affects power side of circuit. Current flows directly to ground return, bypassing some or all of electrical loads in the circuit. There is no current in circuit past the short. A short-to ground will also cause fuse to blow
	**DISCUSS CASE STUDY: *THE SHORT-TO-VOLTAGE STORY:* a technician was working on a Chevrolet pickup truck with the following unusual electrical problems.** 1. **When brake pedal was depressed, dash light and side marker lights would light.** 2. **Turn signals caused all lights to blink and the fuel gauge needle to bounce up and down.** 3. **When brake lights were on, the front parking lights also came on.** **Note: using a single-filament bulb (such as a**

#1156) in the place of a dual-filament bulb (such as a #1157) could also cause many of these same problems. Because most of the trouble occurred when the brake pedal was depressed, the technician decided to trace all the wires in the brake light circuit. The technician discovered the problem near the exhaust system. Small hole in tailpipe (after the muffler) directed hot exhaust gases to wiring harness containing all of wires for circuits at rear of the truck. The heat had melted the insulation and caused most of the wires to touch. Whenever one circuit was activated (such as when the brake pedal was applied), the current had a complete path to several other circuits. A fuse did not blow because there was enough resistance in the circuits being energized, so the current (in amperes) was too low to blow any fuses.

Summary:

- Complaint—customer stated that the truck lights were doing strange things when the brake pedal was depressed.
- Cause—melted wires caused by a small hole in the exhaust was found during a visual inspection.
- Correction—performing a wire repair and fixing the exhaust leak corrected the customer concern.

DISCUSSION: Ask students to discuss effects of higher than-normal resistance on various components in an automotive electrical system. What can cause high resistance?

HOMEWORK: Research on Internet opportunities for technicians who specialize in electrical systems in your area. Ask them to focus on following questions: What types of work are available? What are the training and job qualification requirements?

ICONS	Ch04 ELECTRICAL CIRCUITS/OHM'S LAW
  	**What is salary range for technician who is trained in automotive electrical systems?** **DEMONSTRATION: Use an inductive ammeter or charging system tester to show that *amount of current leaving battery on positive is returned on negative side.*** **EXPLAIN TECH TIP: *Think of a Waterwheel*** **A beginner technician cleaned the positive terminal of the battery when the starter was cranking the engine slowly. When questioned by the shop foreman as to why only the positive post had been cleaned, the technician responded that the negative terminal was "only a ground." The foreman reminded technician that current, in amperes, is constant throughout a series circuit (such as the cranking motor circuit). If 200 amperes leave the positive post of the battery, then 200 amperes must return to the battery through negative post. The technician could not understand how electricity can do work (crank an engine), yet return same amount of current, in amperes, as left the battery. The shop foreman explained that even though the current is constant throughout the circuit, the voltage (electrical pressure or potential) drops to zero in the circuit. Foreman drew a waterwheel. • SEE FIGURE 4–8. As water drops from a higher level to a lower level, high potential energy (or voltage) is used to turn waterwheel and results in low potential energy (or lower voltage). The same amount of water (or amperes) reaches the pond under waterwheel as started in the fall above the waterwheel. As current (amperes) flows through a conductor, it performs work in the circuit (turns the waterwheel) while its voltage (potential) drops.** **9. SLIDE 9 EXPLAIN FIGURE 4-8** Electrical flow through a circuit is similar to water flowing over a waterwheel. **10. SLIDE 10 EXPLAIN Figure 4-9** To calculate one unit of electricity when the other two are known, simply use your finger and cover the unit you do not know. For example, if both voltage (E) and resistance (R) are known, cover the letter I (amperes). Notice that the letter

E is above the letter R, so divide the resistor's value into the voltage to determine the current in the circuit.

DISCUSSION: Ask students to talk about Ohm's law. What is application of Ohm's law in automotive wiring circuits?

Ohm's Law, Current (View) (Download)

Ohm's Law, Resistance (View) (Download)

Ohm's Law, Volt (View) (Download)

Complete Task Sheet on Electrical Circuits

STUDENTS COMPLETE ASEEDUCATION TASK SHEET ON OHM'S LAW: A2. DEMONSTRATE KNOWLEDGE OF ELECTRICAL/ELECTRONIC SERIES, PARALLEL, AND SERIES-PARALLEL CIRCUITS USING PRINCIPLES OF ELECTRICITY (OHM'S LAW).

Students can complete NATEF Task Sheet on Ohm's Law: Diagnose electrical/electronic integrity of series, parallel & series-parallel circuits using principles of electricity (Ohm's Law). (P-1)

11. **SLIDE 11 EXPLAIN Figure 4-10** This closed circuit includes a power source, power-side wire, circuit protection (fuse), resistance (bulb), and return path wire. In this circuit, if battery has 12 volts & electrical load has 4 ohms, then current through circuit is 4 amperes.

DISCUSS CHART 4-1 OHM'S LAW RELATIONSHIP WITH 3 UNITS OF ELECTRICITY.

DISCUSSION: Ask students to compare Ohm's & Watt's laws. Which law can be used to determine the diameter of wire needed for a circuit?

12. **SLIDE 12 EXPLAIN Figure 4-11** Calculate 1 unit when other 2 are known, cover unknown unit to see what unit needs to be divided or multiplied to arrive at solution.
13. **SLIDE 13 EXPLAIN Figure 4-12** "Magic circle" of most formulas for problems involving Ohm's law. Each quarter of "pie" has formulas used to solve for a particular unknown value: current (amperes), in upper right segment; resistance (ohms), in lower right; voltage (E), in lower left; and power (watts), in upper left.

ICONS	Ch04 ELECTRICAL CIRCUITS/OHM'S LAW
	**EXPLAIN TECH TIP:** ***Wattage Increases by the Square of the Voltage:*** **The brightness of a lightbulb, such as an automotive headlight or courtesy light, depends on the number of watts available. The watt is the unit by which electrical power is measured. If the battery voltage drops, even slightly, the light becomes noticeably dimmer. The formula for calculating power (P) in watts is P = IE. This can also be expressed as Watts = Amps * Volts. According to Ohm's law, I = E/R. Therefore, E/R can be substituted for I in the previous formula, resulting in I=E/R. A small change in the voltage (E) has a big effect on the total brightness of the bulb. (Remember, household lightbulbs are sold according to their wattage.) Therefore, if the voltage to an automotive bulb is reduced, such as by a poor electrical Connection, brightness of the bulb is greatly affected. A poor electrical ground causes a voltage drop. The voltage at the bulb is reduced and the bulb's brightness is reduced.**
	**DISCUSSION: ASK STUDENTS TO DISCUSS GROUND PATH. WHY DOESN'T A SEPARATE GROUND WIRE HAVE TO BE RUN FROM THE BATTERY TO EACH ELECTRICAL LOAD?** **ASK STUDENTS TO DISCUSS HOW AND WHY A SHORT-TO-VOLTAGE OCCURS. WHAT IS THE REASON THAT A SHORT-TO-VOLTAGE MAY OR MAY NOT BLOW A FUSE?**
	**DEMONSTRATION: USE AN INDUCTIVE AMMETER OR CHARGING SYSTEM TESTER TO SHOW THAT *AMOUNT OF CURRENT LEAVING BATTERY ON POSITIVE IS RETURNED ON NEGATIVE SIDE.***
	**DISCUSSION: ASK STUDENTS TO TALK ABOUT OHM'S LAW. WHAT IS APPLICATION OF OHM'S LAW IN AUTOMOTIVE WIRING CIRCUITS?**