Automotive Technology 6th Edition
Chapter 40 ELECTRICAL CIRCUITS & OHM'S LAW
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This Automotive Technology 6th text provides complete coverage of automotive components, operation, design, and troubleshooting. 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, Animations, and ASEEducation (NATEF) Task Sheets.
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 as listed: 1. Identify the parts of a complete circuit. 2. Describe the characteristics of different types of circuit faults. 3. Explain Ohm's law as it applies to automotive circuits. 4. Explain Watt's law as it applies to automotive circuits..
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 the 6th Edition Chapter Images found on Jim's web site @
www.jameshalderman.com

DOWNLOAD Chapter 40 Chapter Images: From
http://www.jameshalderman.com/automotive_principles.html

NOTE: You can use Chapter Images or possibly Power Point files:

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	**1 SLIDE 1 ELECTRICAL CIRCUITS & OHM'S LAW** **Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED** **http://www.jameshalderman.com/automotive_principles.html** **DOWNLOAD** **Crossword Puzzle (Microsoft Word) (PDF)** **Word Search Puzzle (Microsoft Word) (PDF** **Videos** 2. **SLIDE 2 FIGURE 40.1 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.** **TRAINER TASK: Use an electrical trainer & have students to blow fuse by creating a short circuit, observing what it takes to create short circuit and what results are found**
	**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"!** 3. **SLIDE 3 EXPLAIN Figure 40-2** 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 40-3** electrical switch opens the circuit and no current flows. The switch could also be on the return (ground) path wire.

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	5. **SLIDE 5 EXPLAIN Figure 40-4** Examples of common causes of open circuits. Some of these causes are often difficult to find. 6. **SLIDE 6 EXPLAIN Figure 40-5** 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?** 7. **SLIDE 7 EXPLAIN Figure 40-6** 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 40-7** 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**

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	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? What is salary range for technician who is trained in automotive electrical systems? Have students write a summary of their findings and share it with class.** **DEMONSTRATION: Use an inductive ammeter or charging system tester to show that *amount of current leaving battery on positive is returned on negative side.***

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	**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 40–8. 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 40-8** Electrical flow through a circuit is similar to water flowing over a waterwheel. 10. **SLIDE 10 EXPLAIN Figure 40-9** 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?**

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	Ohm's Law, Current (View) (Download) **Ohm's Law, Resistance (View) (Download)** **Ohm's Law, Volt (View) (Download)** **Complete Task Sheet on Electrical Circuits**
	**DISCUSS CHART 40-1 Ohm's law relationship with the three units of electricity.** **Students can complete ASEEDUCATION Task Sheet A6A5 on Ohm's Law: Diagnose electrical/electronic integrity of series, parallel & series-parallel circuits using principles of electricity (Ohm's Law). (P-1)**
Education Foundation	**11. SLIDE 11 EXPLAIN Figure 40-10** 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. **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 40-11** 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 40-12** "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.
	**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**

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	= 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.