Automotive Technology 6th Edition
Chapter 44 Automotive Wiring & Wiring Repair
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. Explain automotive wiring and the wire gauge systems. 2. Explain the purpose of ground wires, battery cables, and jumper cables. 3. Describe the construction of fuses and explain how fuses protect circuits and wiring. 4. Discuss circuit breakers, PTC electronic circuit protection devices, and fusible links. 5. Discuss terminal and connectors, electrical conduits, and how to repair wires.
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 44 Chapter Images: From

http://www.jameshalderman.com/automotive_principles.html

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

ICONS	Chapter 44 Wiring Repair
	SLIDE 1: AUTOMOTIVE WIRING & WIRING REPAIR
	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**
	Some wire gauges have both AWG & Metric scales
	**DISCUSS FREQUENTLY ASKED QUESTION:** ***Why Is There a Ground Strap on My Exhaust System?*** **The ground strap is only there to dissipate static electricity. Static electricity is created when the flow of the exhaust gases travels through the system. Using a ground strap connected to the exhaust system helps prevent static charge from building up, which could cause a spark to jump to the body or frame of the vehicle. if a vehicle is equipped with a ground strap, be sure that it is connected at both ends to help ensure long exhaust system life. if static electricity is allowed to discharge from the exhaust system to the body or frame of the vehicle, the resulting arcing points can cause rust or corrosion,**

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shortening the life of the exhaust system. if a new exhaust system is installed, be sure to reattach the ground strap. Most vehicles also use a ground strap connected to the fuel filler tube for the same reason.

DISCUSS CHARTS 44-1 TO 44-4 on wiring

DEMONSTRATION: Show students how to use a standard wire gauge

DEMONSTRATION: Ask the students to discuss the Recommendations shown in Chart 44–4. What is relationship between length and resistance? What is the relationship between diameter & resistance?

2. **SLIDE 2 EXPLAIN Figure 44-1** All lights and accessories ground to the body of the vehicle. Body ground wires such as this one are needed to conduct all of the current from these components back to the negative terminal of the battery. Body ground wire connects body to engine. Most battery negative cables attach to engine.
3. **SLIDE 3 EXPLAIN Figure 44-2** Battery cables are designed to carry heavy starter current and are therefore usually 4 gauge or larger wire. Note that this battery has a thermal blanket covering to help protect the battery from high underhood temperatures. The wiring is also covered with plastic conduit called split-loom tubing.

DISCUSS FREQUENTLY ASKED QUESTION:

What Is a Twisted Pair? **A twisted pair is used to transmit low-voltage signals, using two wires that are twisted together. Electromagnetic interference can create a voltage in a wire and twisting the two signal wires cancels out the induced voltage. A twisted pair means that the two wires have at least nine turns per foot (turns per meter).**

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A rule of thumb is a twisted pair should have one twist per inch of length.

DEMONSTRATION: Demonstrate proper way to attach jumper cables and discuss need to check the wire gauge of jumper cables & not rely on outside diameter of the wire.

4. **SLIDE 4 EXPLAIN Figure 44-3** fuse panel.
5. **SLIDE 5 EXPLAIN Figure 44-4** Blade-type fuses can be tested through openings in plastic at the top of fuse.

DISCUSSION: Have the students talk about the different colors for amperage ratings. Why are colors a good idea?

6. **SLIDE 6 EXPLAIN Figure 44-5** 3 sizes of blade-type fuses: mini on left, standard or ATO type in center, & maxi on right.
7. **SLIDE 7 EXPLAIN Figure 44-6** comparison of the various types of protective devices used in most vehicles.

DISCUSS CHARTS 44-5-44-8 on circuit protectors

8. **SLIDE 8 EXPLAIN Figure 44-7** To test a fuse, use a test light to check for power at power side of fuse. The ignition switch and lights may have to be on before some fuses receive power. If fuse is good, test light should light on both sides (power side & load side) of fuse.
9. **SLIDE 9 EXPLAIN Figure 44-8** Typical blade circuit breaker fits into the same space as a blade fuse. If excessive current flows through the bimetallic strip, the strip bends and opens the contacts and stops current flow. When the circuit breaker cools, the contacts close again, completing the electrical circuit.
10. **SLIDE 10 EXPLAIN Figure 44-9** Electrical symbols used to represent circuit breakers.
11. **SLIDE 11 EXPLAIN Figure 44-10** (a) normal operation of a PTC circuit protector such as in a power window motor circuit showing the many conducting paths. With normal current flow, the temperature of the PTC circuit protector remains

normal.

12. **SLIDE 12 EXPLAIN Figure 44-10** (b) When current exceeds the amperage rating of PTC circuit protector, the polymer material that makes up electronic circuit protector increases in resistance. As shown, a high-resistance electrical path still exists even though motor will stop operating as a result of the very low current flow through very high resistance. Circuit protector will not reset/cool down until voltage removed from circuit.
13. **SLIDE 13 EXPLAIN Figure 44-11** PTC circuit protectors are used extensively in the power distribution center of this Chrysler vehicle.
14. **SLIDE 14 EXPLAIN Figure 44-12** Fusible links are usually located close to battery and are usually attached to a junction block. Notice that they are only 6 to 9 in. long and feed more than one fuse from each fusible link.
15. **SLIDE 15 EXPLAIN Figure 44-13** 125 ampere rated mega fuse used to control the current from alternator.

EXPLAIN TECH TIP: ***Find the Root Cause***

If a mega fuse or fusible link fails, find the root cause before replacing it. A mega fuse can fail due to vibration or physical damage as a result of a collision or corrosion. Check to see if the fuse itself is loose and can be moved by hand. If loose, simply replace the mega fuse. If a fusible link or mega fuse has failed due to excessive current, check for evidence of a collision or any other reason that could cause an excessive amount of current to flow. This inspection should include each electrical component being supplied current from fusible link. After being sure that the root cause has been found and corrected, replace the fusible link or mega fuse.

EXPLAIN TECH TIP: ***Look for the "Green Crud"***

Corroded connections are a major cause of intermittent electrical problems and open circuits. The usual sequence of conditions is as follows:

1. **Heat causes expansion. This heat can be**

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	from external sources, such as connectors being too close to the exhaust system. Another possible source of heat is a poor connection at the terminal, causing a voltage drop and heat due to the electrical resistance. 2. Condensation occurs when a connector cools. Moisture from condensation causes rust and corrosion. 1. 3. Water gets into connector. If corroded connectors are noticed, terminal should be cleaned and condition of electrical connection to wire terminal end(s) confirmed. Many OEMS recommend using a dielectric silicone or lithium-based grease inside connectors to prevent moisture from getting into and attacking the connector.
ASE Education Foundation	**ASEEDUCATION Task Sheet Inspect and test fusible links, circuit breakers, and fuses; determine needed action.**
ASE Education Foundation	**ASEEDUCATION Task Sheet Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; perform needed action.**
	HOMEWORK: Use information in Chart 44–4 to create a table in which you assign random circuit lengths and amperage loads. Have students select proper wire size to safely carry circuit load. Grade them on their understanding of relationship between wire size and load and their selection of size to use. **HOMEWORK** Have the students use Internet to research locations of fuse panels. Where panels are typically located? Have students write guidelines for locating fuse panels and share them with class.

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	16. **SLIDE 16** **EXPLAIN** **Figure 44-14** Some terminals have seals attached to help seal the electrical connections. 17. **SLIDE 17** **EXPLAIN** **Figure 44-15** Separate a connector by opening the lock and pulling the two apart. 18. **SLIDE 18** **EXPLAIN** **Figure 44-16** secondary locks help retain the terminals in the connector. 19. **SLIDE 19** **EXPLAIN** **Figure 44-17** Use small removal tool, sometimes called a pick, to release terminals from the connector. 20. **SLIDE 20** **EXPLAIN** **Figure 44-18** **Always** use rosin-core solder for electrical or electronic soldering. Also, use small-diameter solder for small soldering irons. Use large-diameter solder only for large-diameter (large-gauge) wire and higher-wattage soldering irons (guns). **DEMONSTRATION: Demonstrate several different types of connectors, including those with connector position assurance clips. Explain that it is especially necessary to guarantee that connectors will stay together in supplemental restraint systems. Demonstrate removal of terminals from several different types of connectors.** **Electrical Wire Repair (View) (Download)** **Make sure to have proper terminal removal tools available for teaching students about different connectors.** 21. **SLIDE 21** **EXPLAIN** **Figure 44-19** butane-powered soldering tool. The cap has a built-in striker to light a converter in the tip of the tool. This handy soldering tool produces the equivalent of 60 watts of heat. It operates for about 1/2 hour on one charge from a commonly available butane refill dispenser. **DISCUSSION: Have the students discuss process of soldering wires and the type of solder used. What do the percentages of each alloy in a solder determine?**

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22. **SLIDE 22 EXPLAIN Figure 44-20** Notice that to create a good crimp the open part of the terminal is placed in the jaws of the crimping tool toward the anvil or the W-shape part.
23. **SLIDE 23 EXPLAIN Figure 44-21** All hand-crimped splices or terminals should be soldered to be assured of a good electrical connection.

DEMONSTRATION: Demonstrate use of a soldering iron to connect wiring. Point out to the students that they should make sure that the solder joint is smooth; otherwise, a sharp point could puncture shrink wrap and cause a short circuit.

24. **SLIDE 24 EXPLAIN Figure 44-22** Butane torch especially designed for use on heat shrink applies heat without an open flame, which could cause damage.

25. **SLIDE 25 EXPLAIN Figure 44-23** typical crimp-and-seal connector. This type of connector is first lightly crimped to retain the ends of the wires and then it is heated. The tubing shrinks around the wire splice, and thermoplastic glue melts on the inside to provide an effective weather-resistant seal.
26. **SLIDE 26 EXPLAIN Figure 44-24** Heating crimp-and-seal connector melts the glue and forms an effective seal against moisture.
27. **SLIDE 27 EXPLAIN Figure 44-25** Conduit that has a paint strip is constructed of plastic that can withstand high underhood temperatures.
28. **SLIDE 28 EXPLAIN Figure 44-26 (a)** Blue conduit is used to cover circuits that carry up to 42 volts.
29. **SLIDE 29 EXPLAIN Figure 44-26 (b)** Yellow conduit can also be used to cover 42 volt wiring.
30. **SLIDE 30 EXPLAIN Figure 44-27** Always follow OEM instructions which include use of linesman's (high-voltage) gloves if working on circuits in orange conduit.

DISCUSS FREQUENTLY ASKED QUESTION:

What Method of Wire Repair Should I Use?

OEMS recommend all wire repairs performed under hood, or where repair could be

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exposed to elements, be weatherproof. Most commonly recommended methods include:

- **Crimp-and-seal connector. These Connectors are special and are not like low cost insulated-type crimp connectors. This type of connector is recommended by GM and others and is sealed using heat after mechanical crimp has secured the wire ends together.**
- **Solder and adhesive-lined heat shrink tubing. This method is recommended by Chrysler and it uses special heat shrink that has glue inside that melts when heated to form a sealed connection. Regular heat shrink tubing can be used inside a vehicle, but should not be used where it can be exposed to elements.**
- **Solder and electrical tape. This is acceptable to use inside vehicle where splice is not exposed to outside elements. It is best to use a crimp and seal, even on inside of vehicle, for best results.**

DISCUSS FREQUENTLY ASKED QUESTION:
What Is in Lead-Free Solder? **Lead is an environmental and health concern and all OEMS are switching to lead-free solder. Lead-free solder does not contain lead, but usually a very high percentage of tin. Several formulations of lead-free solder include:**

- **95% tin; 5% antimony (melting temperature 450°F (245°C))**
- **97% tin; 3% copper (melting temperature 441°F (227°C))**

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	• 96% tin; 4% silver (melting temperature 443°F (228°C))
Education Foundation	ASEEDUCATION Task Sheet Remove and replace terminal end from connector; replace connectors and terminal ends
Education Foundation	ASEEDUCATION Task Sheet Repair wiring harness (including CAN/BUS systems)
Education Foundation	ASEEDUCATION Task Sheet Perform solder repair of electrical wiring