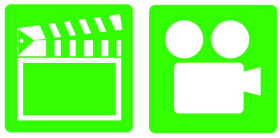
Advanced Automotive Electricity & Electronics

Chapter 1 Electrical Fundamentals

Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of **Advanced Automotive Electricity and Electronics Systems.** 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. 1. Describe electricity as it is used in automobiles. 2. Explain the units of electrical measurement, and discuss the relationship among volts, amperes, and ohms. 3. Explain how magnetism is used in automotive applications. **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	Ch01 ELECTRICAL FUNDAMENTALS
	**1. SLIDE 1 C1 ELECTRICAL FUNDAMENTALS**
	**Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/** **WEB SITE IS CONSTANTLY UPDATED**
	**2. SLIDE 2 EXPLAIN ELECTRICITY** **3. SLIDE 3 EXPLAIN Figure 1-1** In an atom (left), electrons orbit protons in the nucleus just as planets orbit the sun in our solar system (right) **4. SLIDE 4 EXPLAIN Figure 1-2** nucleus of an atom has a positive (+) charge and the surrounding electrons have a negative (-) charge. **5. SLIDE 5 EXPLAIN Figure 1-3** figure shows a balanced atom. The number of electrons is the same as the number of protons in the nucleus.
	**SHOW ANIMATION ON AN ATOM (FIGURE 1-3) WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A7_ANIMATION/CHAPTER31_FIG_31_2/INDEX.HTM
	**6. SLIDE 6 EXPLAIN Figure 1-4** Unlike charges attract and like charges repel.
	**ANIMATION ON AN LIKE & UNLIKE ATTRACTION (FIGURE 1-4) WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A7_ANIMATION/CHAPTER31_FIG_31_4/INDEX.HTM
	**DISCUSSION: DISCUSS FLOW OF ELECTRICAL CURRENT AND HOW THE CONSTANT FLOW, OR JUMPING OF ELECTRONS, CREATES CURRENT**
	**ELECTRON FLOW**
	**DEMONSTRATION: USE MAGNETS TO DEMONSTRATE HOW OPPOSITES FORCES ATTRACT AND LIKE FORCES REPEL. SHOW HOW MAGNETS ATTRACT AND REPEL EACH OTHER DEPENDING ON**

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	THE ORIENTATION OF THEIR POLES.
	**7. SLIDE 7 EXPLAIN Figure 1-5** unbalanced, positively charged atom (ion) will attract electrons from neighboring atoms. **8. SLIDE 8 EXPLAIN ELECTRICITY** **9. SLIDE 9 EXPLAIN NOTE** **10. SLIDE 10 EXPLAIN Figure 1-6** hydrogen atom is simplest atom, with only one proton, one neutron, and one electron. More complex elements contain higher numbers of protons, neutrons, and electrons.
	**ANIMATION: ELECTRON FLOW (FIGURE 1-5) WWW.MYAUTOMOTIVELAB.COM** http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A7_Animation/Chapter31_Fig_31_5/index.htm
	**11. SLIDES 11-13 EXPLAIN ELECTRICITY** **14. SLIDE 14 EXPLAIN Figure 1-7** As number of electrons increases, they occupy increasing energy levels that are farther from the center of the atom. **15. SLIDE 15 EXPLAIN Figure 1-8** Electrons in the outer orbit, or shell, can often be drawn away from the atom and become free electrons.
	**DISCUSSION: DISCUSS ELECTRON ORBIT AROUND NUCLEUS & SHELLS ELECTRONS ORBIT WITHIN. HOW MANY SHELLS FORM AROUND A NUCLEUS? DISCUSS VALENCE RING & HOW MOVEMENT OF ELECTRONS FROM THIS RING CREATES CURRENT. DESCRIBE DIFFERENCE BETWEEN FREE & BOUND ELECTRONS.**
	**16. SLIDE 16 EXPLAIN Figure 1-9** conductor is any element that has one to three electrons in its outer orbit. **17. SLIDE 17 EXPLAIN Figure 1-10** Copper is an excellent conductor of electricity because it has just one electron in its outer orbit, making it easy to be knocked out of its orbit and flow to other nearby atoms. This causes electron flow, which is definition of electricity. **18. SLIDE 18 EXPLAIN FREQUENTLY ASKED QUESTION**
	**DISCUSSION: HAVE STUDENTS DISCUSS DIFFERENT CONDUCTORS. WHY IS COPPER MOST COMMONLY USED CONDUCTOR IN ELECTRICAL SYSTEMS.**

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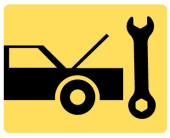
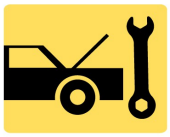
	**19. SLIDE 19 EXPLAIN Figure 1-11** Insulators are elements with five to eight electrons in the outer orbit. **20. SLIDE 20 EXPLAIN ELECTRICITY** **21. SLIDE 21 EXPLAIN Figure 1-12** Semiconductor elements contain exactly four electrons in the outer orbit
	**DISCUSSION: DISCUSS INSULATORS & REASON THEY MAKE POOR CONDUCTORS. WHAT IS RELATIONSHIP BETWEEN NUMBER OF ELECTRONS AN INSULATOR MATERIAL HAS & ITS ABILITY TO ACQUIRE & RELEASE ELECTRONS?**
	**COMPLETE TASK SHEET ON ELECTRICAL FUNDAMENTALS**
	**SEARCH INTERNET: RESEARCH AMPERAGE REQUIRED FOR VARIOUS APPLIANCES, SMALL ELECTRONIC DEVICES. DO THESE SAME DEVICES USE SAME NUMBER OF AMPERES AROUND WORLD? ASK STUDENTS TO RANK CURRENT DRAWN BY DIFFERENT AUTOMOBILE ACCESSORIES, I.E. HEADLIGHTS & IP PANEL LIGHTS.**
	**22. SLIDE 22 EXPLAIN How Electrons flow through a conductor** **23. SLIDE 23 EXPLAIN FIGURE 1-13** Current electricity is the movement of electrons through a conductor **24. SLIDE 24 EXPLAIN FIGURE 1-14** Conventional theory states that current flows through circuit from positive (+) to negative (–). Automotive electricity uses the conventional theory **25. SLIDE 25 EXPLAIN Units of Electricity** **26. SLIDE 26 EXPLAIN Figure 1-15** One ampere is the movement of 1 coulomb (6.28 billion billion electrons) past a point in 1 second. **27. SLIDE 27 EXPLAIN Figure 1-16** ammeter is installed in the path of the electrons similar to a water meter used to measure the flow of water in gallons per minute. **The ammeter displays current flow in amperes.**
	**28. SLIDE 28 EXPLAIN Figure 1-17** Voltage is electrical pressure that causes electrons to flow through a conductor

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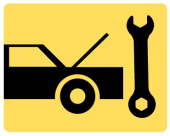
	**ANIMATION: VOLTAGE (FIGURE 1-17) WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A7_ANIMATION/CHAPTER31_FIG_31_17/INDEX.HTM
	29. **SLIDE 29** EXPLAIN **Figure 1-18** This digital multimeter set to read DC volts is being used to test the voltage of a vehicle battery. Most multimeters can also measure resistance (ohms) and current flow (amperes).
	**DEMONSTRATION: SHOW HOW DMM MEASURES VOLTAGE. USE TRAINER TO SHOW STUDENTS MEASURING VOLTAGE**
	30. **SLIDE 30** EXPLAIN **Figure 1-19** Resistance to flow of electrons through conductor measured in ohms
	**ANIMATION: RESISTANCE (FIGURE 1-19) WWW.MYAUTOMOTIVELAB.COM** HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/A7_ANIMATION/CHAPTER31_FIG_31_19/INDEX.HTM
	**DEMONSTRATION: SHOW HOW DMM MEASURES VOLTAGE. USE PROJECT BOARD TO SHOW STUDENTS MEASURING RESISTANCE**
	**DISCUSSION: HAVE STUDENTS TALK ABOUT RESISTANCE TO ELECTRON FLOW, OR OHMS. HOW DOES MATERIAL USED AS A CONDUCTOR AFFECT RESISTANCE?**
	31. **SLIDE 31** EXPLAIN **Figure 1-20** Display at Henry Ford Museum in Dearborn, Michigan, which includes a hand-cranked generator and a series of light bulbs. Figure shows a young man attempting to light as many bulbs as possible. Crank gets harder to turn as more bulbs light because it requires more power to produce necessary watts of electricity.
	**HANDS-ON TASK: HAVE BATTERY CABLES AND COMMON ELECTRICAL WIRING AVAILABLE TO PROVIDE STUDENTS A HANDS-ON EXPERIENCE WITH DIFFERENCES IN RESISTANCE THAT RESULT FROM CONDUCTORS OF DIFFERENT LENGTHS, DIAMETERS, AND MATERIALS.**

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	**32. SLIDE 32 EXPLAIN Sources of Electricity**
	**DEMONSTRATION: DEMONSTRATE FRICTION, OR STATIC ELECTRICITY, BY RUBBING A BALLOON ON VOLUNTEER STUDENT'S HAIR & STICKING BALLOON TO WALL. ASK STUDENTS TO NAME & EXPLAIN SOME COMMON EXAMPLES OF STATIC ELECTRICITY.**
	**33. SLIDE 33 EXPLAIN Figure 1-21** Electron flow is produced by heating the connection of 2 different metals.
	**ELECTRON TRAVEL, HEAT**
	**DISCUSSION: ASK STUDENTS TO DISCUSS HEAT, LIGHT, PRESSURE, CHEMICAL, & MAGNETIC MEANS OF PRODUCING ELECTRICAL CURRENT. WHICH PRINCIPLE IS BASIS OF AUTOMOTIVE BATTERY? WHICH PRINCIPLE IS BASIS FOR HOW AN ALTERNATOR WORKS?**
	**34. SLIDE 34 EXPLAIN Figure 1-22** Electron flow is produced by light striking a light-sensitive material
	**Electron Travel, Light** **Electron Travel, Magnet** **Electron Travel, Pressur**
	**35. SLIDE 35 EXPLAIN Figure 1-23** Electron flow is produced by pressure on certain crystals. **36. SLIDE 36 EXPLAIN** Sources of Electricity **37. SLIDE 37 EXPLAIN FREQUENTLY ASKED QUESTION** **38. SLIDES 38-39 EXPLAIN** Conductors and Resistance **40. SLIDE 40 EXPLAIN CHART 1.1** Conductor ratings (starting with the best).

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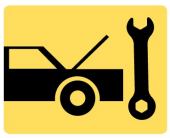
	41. SLIDE 41 EXPLAIN RESISTORS **42. SLIDE 42** EXPLAIN **Figure 1-24** This figure shows a resistor color-code interpretation
	**DISCUSSION: HAVE STUDENTS DISCUSS HOW WATTAGE RATING AFFECTS CURRENT. WHAT IS RELATIONSHIP BETWEEN WATTS & AMPERES?**
	**DISCUSSION: DISCUSS VARIOUS SIZES OF CONDUCTORS & REASONS DIFFERENT SIZES ARE USED FOR DIFFERENT CIRCUITS. WHAT HAPPENS WHEN CONDUCTOR LENGTH IS DOUBLED? WHAT HAPPENS WHEN CONDUCTOR DIAMETER IS INCREASED?**
	**SEARCH INTERNET AS CLASS TASK: HAVE STUDENTS WORK IN SMALL GROUPS AND USE INTERNET TO RESEARCH A SMALL ELECTROMAGNET. ASK THEM TO CONSTRUCT AN ELECTROMAGNET, BASED ON THEIR RESEARCH. AS A CLASS, HAVE STUDENTS THEORIZE HOW THEIR MAGNET'S STRENGTH COULD BE INCREASED.**
	**DEMONSTRATION: GATHER A SUPPLY OF RESISTORS IN VARIOUS SIZES. USE THEM TO SHOW COLOR BANDS, OR COLOR-CODED CONDUCTOR RATINGS. BASED ON YOUR DEMO ASK STUDENTS TO EXPLAIN MEANING AND IMPORTANCE OF BANDS**
	**43. SLIDE 43** EXPLAIN **Figure 1-25** typical carbon resistor.
	**DISCUSSION: HAVE STUDENTS DISCUSS EFFECT OF REPLACING RESISTOR WITH ONE OF LOWER OR HIGHER VALUE. HOW WOULD THIS CHANGE AFFECT OPERATION OF LOAD IN CIRCUIT?**
	**44. SLIDE 44** EXPLAIN **Figure 1-26 three-wire variable resistor called a potentiometer &** **45. SLIDE 45** EXPLAIN **Figure 3-27 two-wire variable resistor is called a rheostat.**
	**ASSESSMENT: HAVE STUDENTS CALCULATE VALUES OF SEVERAL DIFFERENT RESISTORS THAT YOU PROVIDE WITH THE USE OF A GUIDE SHEET.**

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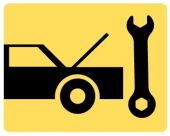	GRADE THEM ON THEIR ACCURACY IN DETERMINING THE VALUES. HOMEWORK: SEARCH INTERNET: HAVE STUDENTS USE INTERNET TO RESEARCH ELECTRICAL CURRENT. ASK THEM TO WORK IN GROUPS OF 3 OR 4 TO PREPARE SLIDE PRESENTATIONS FOR CLASS. HAVE CLASS DISCUSS INFORMATION PRESENTED IN EACH PRESENTATION.