
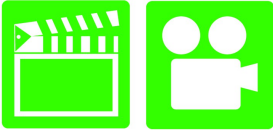


















Advanced Automotive Electricity & Electronics

Chapter 8 BATTERIES

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. <ol style="list-style-type: none">1. Describe how a battery works.2. Describe deep cycling.3. Discuss how charge indicators work.4. List battery ratings. 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 <i>WELCOME</i> , 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	Ch8 BATTERIES
        	<p>1. SLIDE 1 CH8 BATTERIES</p> <p>Check for ADDITIONAL VIDEOS & ANIMATIONS @ http://www.jameshalderman.com/ WEB SITE IS CONSTANTLY UPDATED</p> <p>2. SLIDE 2 EXPLAIN INTRODUCTION</p> <p>3. SLIDE 3 EXPLAIN: BATTERY CONSTRUCTION</p> <p>4. SLIDE 4 EXPLAIN Figure 8-1 Batteries are constructed of plates grouped into cells & installed in a plastic case</p> <p>00. SLIDE 00 EXPLAIN FREQUENTLY ASKED QUESTION</p> <p><u>SAFETY TIP: HAVE STUDENTS ACCESS MSDS FOR AN AUTOMOTIVE BATTERY TO FIND SAFE HANDLING INSTRUCTIONS, FIRST AID PROCEDURES, REACTIVITY DATA, AND SO FORTH. ASK STUDENTS TO WRITE A SUMMARY OF PROPERTIES AND PROCEDURES DETAILED IN MSDS AND SHARE THEIR WORK WITH CLASS.</u></p> <p>5. SLIDE 5 EXPLAIN Figure 8-2 grid from a battery used in both positive and negative plates.</p> <p>6. SLIDE 6 EXPLAIN FREQUENTLY ASKED QUESTION</p> <p>7. SLIDE 7 EXPLAIN BATTERY CONSTRUCTION</p> <p>8. SLIDE 8 EXPLAIN Figure 8-3 two groups of plates are combined to form a battery element.</p> <p><u>DISCUSSION: ASK STUDENTS TO TALK ABOUT RELEASE OF HYDROGEN & OXYGEN (GASSING) DURING CHARGING. WHY MIGHT GASSING BE DANGEROUS WHEN WORKING AROUND AN AUTOMOTIVE BATTERY?</u></p> <p><u>DEMONSTRATION: USE AA BATTERIES & VOLTMETER TO DEMONSTRATE BATTERY CONSTRUCTION. SHOW STUDENTS HOW VOLTAGE INCREASES WHEN BATTERIES ARE CONNECTED IN SERIES VERSUS PARALLEL.</u></p>

ICONS	Ch8 BATTERIES
	<p>9. SLIDE 9 EXPLAIN Figure 8-4 cutaway battery showing connection of cells to each other through partition</p>
	<p>10. SLIDE 10 EXPLAIN: HOW BATTERY WORKS</p> <p>11. SLIDE 11 EXPLAIN Figure 8-5 Chemical reaction for a lead-acid battery that is fully charged being discharged by the attached electrical load.</p>
	<p>12. SLIDE 12 EXPLAIN: HOW BATTERY WORKS</p> <p>13. SLIDE 13 EXPLAIN CAUTION</p> <p>14. SLIDE 14 EXPLAIN Figure 8-6 Chemical reaction for a lead-acid battery that is fully discharged being charged by the attached generator.</p>
	<p><u>DEMONSTRATION: LEMON BATTERY: USE A LEMON AND TWO DISSIMILAR METALS TO SHOW BATTERY CELL OPERATION. SEE HOW MANY CELLS IT TAKES TO LIGHT A BULB. DID YOU HAVE TO WIRE THE CELLS IN SERIES OR PARALLEL?</u></p>
	<p><u>ACADEMIC TASK: CROSS-CURRICULAR ACTIVITY: SCIENCE: HAVE STUDENTS RESEARCH CHEMICAL STRUCTURE OF A SULFURIC ACID MOLECULE. HAVE STUDENTS DISCUSS HOW THE ELECTROLYTE USED IN A BATTERY CHANGES AS THE BATTERY IS DISCHARGED AND CHARGED.</u></p>
	<p>15. SLIDE 15 EXPLAIN Valve-Regulated Lead-Acid Batteries</p> <p>16. SLIDE 16 EXPLAIN FIGURE 8-7 absorbed glass mat battery is totally sealed and is more vibration resistant than conventional lead-acid batteries</p>
	<p>17. SLIDE 17 EXPLAIN BATTERY RATINGS</p> <p>18. SLIDE 18 EXPLAIN FIGURE 8-8 This battery has a rating of 1,000 amperes using the cold cranking rating and 900 amperes using the CCA (cold-cranking method)</p>
	<p><u>DEMONSTRATION: SHOW STUDENTS DIFFERENT TYPES OF AUTOMOTIVE BATTERIES, FOCUSING ON CHARACTERISTICS THAT MAY BE USED TO DISTINGUISH ONE FROM ANOTHER.</u></p>
	<p>19. SLIDE 19 EXPLAIN REAL WORLD FIX</p>



20. SLIDE 20 **EXPLAIN** Battery Service Safety Precautions
21. SLIDE 21 **EXPLAIN** Battery Voltage Test
22. SLIDE 22 **EXPLAIN** FIGURE 8-9 (a) A voltage reading of 12.28 volts indicates that the battery is not fully charged and should be charged before testing. (b) A battery that measures 12.6 volts or higher after the surface charge has been removed is 100% charged.
23. SLIDE 23 **EXPLAIN** CHART 8-1 comparison showing relationship between battery voltage and state-of-charge
24. SLIDE 24 **EXPLAIN** NOTE
25. SLIDE 25 **EXPLAIN** BATTERY LOAD TESTING
26. SLIDE 26 **EXPLAIN** FIGURE 8-10 This battery has cold-cranking amperes (CCA) of 550 A, cranking amperes (CA) of 680 A, and load test amperes of 270 A listed on the top label. Not all batteries have this complete information



DISCUSSION: DISCUSS DIFFERENCE BETWEEN CCA & CA RATINGS. WHAT FACTORS AFFECT BATTERY'S CCA AND CA RATINGS? DISCUSS WHY NORMAL AUTOMOTIVE BATTERIES ARE NOT DESIGNED FOR REPEATED DEEP CYCLING. WHAT VEHICLES ARE LIKELY TO USE DEEP CYCLE BATTERIES?



HANDS-ON TASK: STUDENTS LOCATE AND READ THE CHARGE INDICATOR ON A BATTERY TO DETERMINE STATE-OF CHARGE. HAVE STUDENTS EXPLAIN THE VALIDITY OF CHARGE INDICATORS IN DETERMINING BATTERY STATE-OF-CHARGE.



DISCUSSION: DISCUSS WITH STUDENTS HOW SPECIFIC GRAVITY MEASUREMENT IS BASED ON A GRAVITY READING AT A SPECIFIC TEMPERATURE. HOW COULD CHANGES IN TEMPERATURE AFFECT A BATTERY'S SPECIFIC GRAVITY MEASUREMENT?



27. SLIDE 27 **EXPLAIN** FIGURE 8-11 An alternator regulator battery starter tester (ARBST) automatically loads the battery with a fixed load for 15 seconds to remove the surface charge, then removes the load for 30 seconds to allow the battery to recover, and then reapplies the load for another 15 seconds. The results of the test are then displayed



28. SLIDE 28 **EXPLAIN** Electronic Conductance Testing
29. SLIDE 29 **EXPLAIN** FIGURE 8-12 conductance tester is very easy to use and has proved to accurately



determine battery condition if the connections are properly made. Follow the instructions on the display exactly for best results.

30. SLIDE 30 EXPLAIN Electronic Conductance Testing
HANDS-ON TASK: HAVE STUDENTS LOCATE & RECORD DIFFERENT BATTERY RATINGS. DISCUSS HOW THOSE RATINGS CAN BE USED TO PROVIDE TESTING DATA, OR TO DETERMINE SPECIFICATIONS FOR REPLACEMENT BATTERIES.

31. SLIDE 31 EXPLAIN NOTE

32. SLIDE 32 EXPLAIN Battery Charging

33. SLIDE 33 EXPLAIN CHART 8-2 Battery charging guidelines based on the state-of-charge of the battery and the charging rate

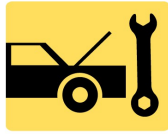
34. SLIDE 34 EXPLAIN FIGURE 8.13 A typical industrial battery charger. Be sure that the ignition switch is in the off position before connecting any battery charger. Connect the cables of the charger to the battery before plugging the charger into the outlet. This helps prevent a voltage spike and spark that could occur if the charger happened to be accidentally left on. Always follow the battery charger manufacturer's instructions

35. SLIDE 35 EXPLAIN Battery Electrical Drain Testing

36. SLIDE 36 EXPLAIN FIGURE 8-14 This mini clamp-on digital multimeter is being used to measure the amount of battery electrical drain that is present. In this case, a reading of 20 mA (displayed on the meter as 00.02 A) is within the normal range of 20 to 30 mA. Be sure to clamp around all of the positive battery cable or all of the negative battery cable, whichever is easiest to get the clamp around.

37. SLIDE 37 EXPLAIN FIGURE 8-15 After connecting the shut-off tool, start the engine and operate all accessories. Stop the engine and turn off everything. Connect the ammeter across the shut-off switch in parallel. Wait 20 minutes. This time allows all electronic circuits to "time out" or shut down. Open the switch—all current now will flow through the ammeter. A reading greater than specified (usually greater than 50 mA, or 0.05 A) indicates a problem that should be corrected.

38. SLIDE 38 EXPLAIN FIGURE 8-16 The battery was replaced in this Acura and the radio displayed "code" when the replacement battery was installed. Thankfully, the owner had five-digit code required to unlock radio



39. SLIDE 39 **EXPLAIN** Battery Electrical Drain Testing
NATEF TASK SHEET: RESEARCH APPLICABLE VEHICLE AND SERVICE INFORMATION, SUCH AS ELECTRICAL/ELECTRONIC SYSTEM OPERATION, SERVICE HISTORY, PRECAUTIONS, AND TECHNICAL SERVICE BULLETINS

40. SLIDE 40 **EXPLAIN NOTE**

41. SLIDE 41 **EXPLAIN** Battery Electrical Drain Testing

42. SLIDE 42 **EXPLAIN NOTE**

43. SLIDE 43 **EXPLAIN Hybrid Auxiliary Batteries**

44. SLIDE 44 **EXPLAIN CHART 8-3** summary chart showing where the 12-volt and high-voltage batteries and shut-off switch/plugs are located. Only the auxiliary 12-volt batteries can be serviced or charged.

45. SLIDE 45 **EXPLAIN CHART 8-3 CONTINUED**

46. SLIDE 46 **EXPLAIN** Jump Starting

47. SLIDE 47 **EXPLAIN FIGURE 8.17** Jump starting a 2001–2003 Toyota Prius using a 12-volt supply to boost the 12-volt auxiliary battery in the trunk.

48. SLIDE 48 **EXPLAIN** Hybrid and Electric Vehicle Batteries

49. SLIDE 49 **EXPLAIN FIGURE 8-18** NiMH cell. The unique element in a nickel metal hydride cell is the negative electrode. Note that electrolyte does not enter into chemical reaction and is able to maintain a constant conductivity regardless of state-of-charge of the cell

50. SLIDE 50 **EXPLAIN FREQUENTLY ASKED QUESTION**

51. SLIDE 51 **EXPLAIN** Hybrid and Electric Vehicle Batteries

52. SLIDE 52 **EXPLAIN FIGURE 8-19** One advantage of a lithium-ion cell is that it produces 3.6 volts, whereas an NiMH or Ni-Cd cell only produces 1.2 volts

53. SLIDE 53 **EXPLAIN FREQUENTLY ASKED QUESTION**

54. SLIDE 54 **EXPLAIN** Hybrid and Electric Vehicle Batteries

55. SLIDE 55 **EXPLAIN NOTE**

56. SLIDE 56 **EXPLAIN** Other High-Voltage Battery Types

57. SLIDE 57 **EXPLAIN FREQUENTLY ASKED QUESTION**



58. SLIDE 58 EXPLAIN Other High-Voltage Battery Types

59. SLIDE 59 EXPLAIN FIGURE 8-20 Zinc-air batteries are recharged by replacing the zinc anodes. These batteries are also considered to be a type of fuel cell, because the positive electrode is oxygen taken from atmospheric air.

60. SLIDE 60 EXPLAIN FIGURE 8-21 Sodium-metal-chloride batteries are also known as ZEBRA batteries. These batteries are lightweight (40% of the weight of lead-acid) and have a high energy density.

61. SLIDE 61 EXPLAIN Other High-Voltage Battery Types

62. SLIDE 62 EXPLAIN CHART 8.4 Secondary-type battery comparison showing specifications and limitations.