

# Automotive Electrical & Engine Performance 8/E












## Chapter 16 Battery Testing & Service









### Opening Your Class





KEY ELEMENT	EXAMPLES
<b>Introduce Content</b>	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.
<b>Motivate Learners</b>	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.
<b>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.</b>	<p>Explain the chapter learning objectives to the students.</p> <ol style="list-style-type: none"> <li>1. List the precautions necessary when working with batteries.</li> <li>2. Describe how to inspect and clean battery cables, connectors, clamps, and hold-downs.</li> <li>3. Discuss how to test batteries for open-circuit voltage and specific gravity.</li> <li>4. Describe how to perform a battery load test and a conductance test.</li> <li>5. Explain how to safely charge or jump start a battery.</li> <li>6. Discuss how to perform a battery drain test.</li> </ol> <p><b>This chapter will help you prepare for the ASE Electrical/Electronic Systems (A6) certification test content area “B” (Battery Diagnosis and Service).</b></p>
<b>Establish the Mood or Climate</b>	Provide a <i>WELCOME</i> , Avoid put downs and bad jokes.
<b>Complete Essentials</b>	Restrooms, breaks, registration, tests, etc.
<b>Clarify and Establish Knowledge Base</b>	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** 8<sup>th</sup> Edition Chapter Images found on Jim's web site @ [www.jameshalderman.com](http://www.jameshalderman.com)







**DOWNLOAD Chapter 16 Chapter Images: From**  
[http://www.jameshalderman.com/books\\_a8.html#anchor2](http://www.jameshalderman.com/books_a8.html#anchor2)






ICONS	Ch16 Battery Testing & Service
	<p><b>1. SLIDE 1 CH16 Battery Testing &amp; Service</b></p>
 	<p>Check for <b>ADDITIONAL VIDEOS &amp; ANIMATIONS</b>  @ <a href="http://www.jameshalderman.com/">http://www.jameshalderman.com/</a>  <b>WEB SITE IS CONSTANTLY UPDATED</b></p>
	<p><u><b>Videos</b></u></p>
 	<p>At the beginning of this class, you can download the crossword puzzle &amp; Word Search from Jim's web site to familiarize your class with terms in this chapter &amp; then discuss them, see below:</p>
	<p><a href="http://www.jameshalderman.com/books_a8.html#anchor2">HTTP://WWW.JAMESHALDERMAN.COM/BOOKS_A8.HTML#ANCHOR2</a></p>
	<p><b>DOWNLOAD</b>  <b>CROSSWORD PUZZLE (MICROSOFT WORD) (PDF)</b>  <b>WORD SEARCH PUZZLE (MICROSOFT WORD) (PDF)</b>  <a href="#">Jump Box Usage (View) (Download)</a>  <a href="#">Jump Starting Hybrids (View) (Download)</a>  <a href="#">Jumper Cable Usage (View) (Download)</a>  <a href="#">Measure Battery Voltage Drop (View) (Download)</a>  <a href="#">Meter Usage Battery Volt Check (View) (Download)</a></p>
	<p>2. SLIDE 1 <b>EXPLAIN</b> Figure 16-1 visual inspection on this battery shows the electrolyte level was below the plates in all cells.</p>
	<p>3. SLIDE 1 <b>EXPLAIN</b> Figure 16-2 Corrosion on a battery cable could be an indication that the battery itself is either being overcharged or is sulfated, creating a lot of gassing of the electrolyte.</p>
	<p><b><u>EXPLAIN TECH TIP:</u> <i>Dynamic versus Open Circuit Voltage:</i> Open circuit voltage is the voltage (usually of a battery) that exists without a load being applied. Dynamic voltage is voltage of power source (battery) with the circuit in operation. A vehicle battery, for example, may indicate that it has 12.6 volts or more, but that voltage drops when battery is put under a load, such as cranking engine. If battery voltage drops too much, starter motor rotates more slowly and the engine may not</b></p>

ICONS	Ch16 Battery Testing & Service
       	<p>start. If the dynamic voltage is lower than specified, the battery may be weak or defective or the circuit may be defective.</p> <p><b><u>DEMONSTRATION:</u> Show using a DMM to perform a voltage drop test to find corroded and/or poor battery cable connections.</b></p> <p>4. SLIDE 4 <b><u>EXPLAIN</u></b> Figure 16-3 Besides baking soda and water, a sugar-free diet soft drink can also be used to neutralize the battery acid</p> <p><b><u>DEMONSTRATION:</u> Show students proper procedure for removing a surface charge. Load battery with fixed load for 15 sec. to remove surface charge, using AVR.</b></p> <p><b><u>DEMO</u> Open Circuit Voltage (OCV) Test</b></p> <p>5. SLIDE 5 <b><u>EXPLAIN</u></b> Figure 16-4 (a) A voltage reading of 12.28 volts indicates that the battery is not fully charged and should be charged before testing.</p> <p>6. SLIDE 6 <b><u>EXPLAIN</u></b> Figure 16-4 (b) A battery that measures 12.6 volts or higher after the surface charge has been removed is 100% charged.</p> <p><b><u>DISCUSS CHART 16-1</u> estimated state of charge of a 12-volt battery after the surface charge has been removed.</b></p> <p><a href="#">Measure Battery Voltage Drop (View) (Download)</a>  <a href="#">Meter Usage Battery Volt Check (View) (Download)</a></p> <p><b><u>DISCUSS CHART 16-2</u> Measuring specific gravity can detect a defective battery. A battery should be at least 75% charged before being load tested.</b></p> <p><b><u>DISCUSS FREQUENTLY ASKED QUESTION:</u> What Is Three-Minute Charge Test? A 3-minute charge test is used to check if a battery is sulfated and is performed as follows:</b></p> <ul style="list-style-type: none"> <li>• <b>Connect a battery charger and voltmeter to battery terminals.</b></li> </ul>

ICONS	Ch16 Battery Testing & Service
   	<ul style="list-style-type: none"> <li>• Charge battery at a rate of 40 amperes for 3 minutes.</li> <li>• At the end of 3 minutes, read voltmeter.</li> </ul> <p><b>Results:</b> If the voltage is above 15.5 volts, replace the battery. If the voltage is below 15.5 volts, the battery is not sulfated and should be charged and retested. This is not a valid test for many maintenance-free batteries. Due to the high internal resistance, a discharged <b>Delphi Freedom Battery</b> may not start to accept a charge for several hours. Always use another alternative battery test before discarding a battery based on the results of the three-minute charge test.</p> <p><b>DISCUSSION:</b> Have students discuss correlation between specific gravity, open-circuit voltage, &amp; battery state of charge. How do you detect defective battery? Talk about differences between open-circuit voltage and specific gravity when determining battery state of charge. Why might a technician prefer one or the other?</p> <p>8. SLIDE 8 <b>EXPLAIN</b> Figure 16-6 This battery has cold-cranking amperes (CCA) of 550 Amperes, 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.</p> <p><b>DEMONSTRATION:</b> Show students how to load test battery. Typically done at 1/2 CCR.</p> <p>9. SLIDE 9 <b>EXPLAIN</b> FIGURE 16-7 Snap-on battery tester that is capable of performing a battery load test, as well as starter and alternator amperage tests. <b>This tester loads battery with a fixed load for 15 sec. to remove surface charge, then removes load for 30 sec. to allow battery to recover, and then reapplies load for another 15 sec. Results of test are displayed.</b></p>

ICONS	Ch16 Battery Testing & Service
                       	<p><b>DISCUSS FREQUENTLY ASKED QUESTION:</b>  <i>How Should You Test a Vehicle Equipped with Two Batteries?</i> Many vehicles equipped with a diesel engine use two batteries. These batteries are usually electrically connected in parallel to provide additional current (amperes) at the same voltage. • <b>SEE FIGURE 16-8.</b> Some heavy-duty trucks and buses connect two batteries in series to provide about the same current as one battery, but with twice the voltage, as shown in • <b>FIGURE 16-9.</b> To successfully test the batteries, they should be disconnected and tested separately. If just one battery is found to be defective, most experts recommend that both be replaced to help prevent future problems. Because the two batteries are electrically connected, a fault in one battery can cause the good battery to discharge into the defective battery, thereby affecting both, even if just one battery is defective.</p> <ol style="list-style-type: none"> <li>10. SLIDE 10 <b>EXPLAIN FIGURE 16-8</b> Most light-duty vehicles equipped with two batteries are connected in parallel as shown. Two 500 A, 12 volt batteries are capable of supplying 1,000 A at 12 volts, which is needed to start many diesel engines.</li> <li>11. SLIDE 11 <b>EXPLAIN FIGURE 16-9</b> Many heavy-duty trucks and buses use two 12 volt batteries connected in series to provide 24 volts.</li> <li>12. SLIDE 12 <b>EXPLAIN Figure 16-10 Conductance Tester</b> is very easy to use and has proved to accurately determine battery condition if connections are properly made. <b>Follow instructions on display exactly for best results</b></li> <li>13. SLIDE 13 <b>EXPLAIN FIGURE 16-11 Midtronics Conductance</b> tester that can not only test battery but can also detect faults with the starter and alternator.</li> </ol>

ICONS	Ch16 Battery Testing & Service
             	<p><b><u>WARNING:</u> Never Charge or Jump Start a Frozen Battery:</b> A discharged battery can freeze because the electrolyte becomes mostly water. Never attempt to charge or jump start a vehicle that has a frozen battery. When battery freezes, it often bulges at sides because water expands about 9% when it freezes, forming ice crystals that occupy more space than water. The crystals can trap bubbles of hydrogen and oxygen that are created during the chemical processes in a battery. When attempting to charge or jump start frozen battery, these pockets of gases can explode. Because electrolyte expands, freezing action usually destroys the plates and can loosen the active material from the grids. It is rare for a frozen battery to be restored to useful service.</p> <p><b><u>DISCUSSION:</u></b> Have students discuss difference between battery load testing and conductance testing. What are pros &amp; cons of each?</p> <p><b><u>DEMONSTRATION:</u></b> Show how to properly test a battery using Conductance Tester</p> <p>14. SLIDE 14 <b><u>EXPLAIN</u></b> Figure 16-12 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.</p> <p><b><u>DISCUSS CHART 16-3</u></b> Battery charging guideline showing the charging times that vary according to state of charge, temperature, and</p>

ICONS	Ch16 Battery Testing & Service
	<p>charging rate. It may take 8 hours or more to charge a fully discharged battery.</p> <p><b>DEMONSTRATION:</b> Show how to properly disable high-voltage battery to decrease risk of Injury/death when working around high voltage systems.</p>
	<p><b>EXPLAIN TECH TIP:</b> <i>Charge Batteries at 1% of Their CCA Rating</i> Many batteries are damaged due to overcharging. To help prevent damages, such as warped plates and excessive release of sulfur smell gases, charge batteries at a rate equal to 1% of the battery's CCA rating. For example, a battery with a 700 CCA rating should be charged at 7 amperes (<math>700 * 0.01 = 7</math> amperes). No harm occurs to the battery at this charge rate, even though it may take longer to achieve a full charge. This means that a battery may require eight or more hours to become fully charged, depending on the battery capacity and state of charge (SOC).</p>
	<p><b>EXPLAIN TECH TIP:</b> <i>Always Use Adapters on Side-Post Batteries:</i> Side-post batteries require that an adapter be used when charging the battery, if it is removed from the vehicle. Do not use steel bolts. If a bolt is threaded into the terminal, only the parts of the threads that contact the battery terminal are conducting all of the charging current. An adapter or a bolt with a nut attached is needed to achieve full contact with the battery terminals. • <b>SEE FIGURE 16-13.</b></p>
	<p>15. SLIDE 15 <b>EXPLAIN FIGURE 16-13</b> Adapters should be used on side terminal batteries whenever charging.</p> <p>16. SLIDE 16 <b>EXPLAIN</b> Figure 16-14 typical battery jump box used to jump start vehicles. These hand-portable units have almost made jumper cables obsolete.</p>
	<p><b>DISCUSS FREQUENTLY ASKED QUESTION:</b> <i>Should Batteries Be Kept Off of Concrete Floors?</i> All batteries should be stored in a cool, dry place when not in use. Many</p>



ICONS	Ch16 Battery Testing & Service
-------	--------------------------------



technicians have been warned not to store or place a battery on concrete. According to battery experts, it is the temperature difference between the top and bottom of battery that causes a difference in voltage potential between top (warmer section) and bottom (colder section). It is this *difference in temperature that causes self-discharge to occur*. In fact, submarines cycle seawater around their batteries to keep all sections of the battery at the same temperature to help prevent self-discharge. So, always store or place batteries up off the floor and in a location where the entire battery can be kept at the same temperature, avoiding extreme heat and freezing temperatures. Concrete cannot drain the battery directly because the case of the battery is a very good electrical insulator.

**EXPLAIN TECH TIP:** *Look at the Battery Date Code*

All major battery manufacturers' stamp codes on battery case give date of manufacture and other information about battery. Most battery manufacturers use a number to indicate year of manufacture and a letter to indicate month of manufacture, except letter I, because it can be confused with number 1. For example:

- A = January G = July
- B = February H = August
- C = March J = September
- D = April K = October
- E = May L = November
- F = June M = December

The shipping date from the manufacturing plant is usually indicated by a sticker on the body of the battery. Almost every battery manufacturer uses just one letter and one number to indicate the month and year. • SEE FIGURE 16-15.

## ICONS

## Ch16 Battery Testing & Service



17. **SLIDE 17 EXPLAIN FIGURE 16–15** The sticker on this battery indicates that it was shipped from the factory January, 2015.
18. **SLIDE 18 EXPLAIN FIGURE 16–16** This mini clamp-on digital multimeter is being used to measure amount of battery electrical drain that is present. In this case, a reading of 20 milliamperes (displayed on meter as 00.02 ampere) is within normal range of 20 to 30 milliamperes. Be sure to clamp around all of positive battery cables or all of negative battery cables, whichever is easiest to get clamp around.
19. **SLIDE 19 EXPLAIN FIGURE 16–17** After Connecting shut-off tool, start the engine and operate all accessories. Stop the engine and turn off everything. Connect ammeter across shut-off switch in parallel. Wait 20 minutes. This time allows all electronic circuits to “time out” or shut down. Open switch—all; current now flows through ammeter. A reading greater than specified (usually > 50 milliamperes, or 0.05 ampere) indicates a problem that should be corrected.









[Jump Box Usage \(View\) \(Download\)](#)

[Jump Starting Hybrids \(View\) \(Download\)](#)

[Jumper Cable Usage \(View\) \(Download\)](#)

**DISCUSS CASE STUDY: *Chevrolet Battery Story***  
**2011 Chevrolet Impala was being diagnosed for dead battery. Testing for battery drain (parasitic draw) showed 2.25 amperes, which was clearly over acceptable value of 0.050 or less. At suggestion of shop foreman, technician used Tech 2 scan tool to check if all of computers and modules went to sleep after ignition was turned off. Scan tool display indicated that instrument panel (IP) showed that it remained awake after all of others had gone into sleep mode. The IP cluster was unplugged and vehicle was tested for an electrical drain again. This time, it was only 32 milliamperes (0.032 ampere), well within**

ICONS	Ch16 Battery Testing & Service
     	<p>normal range. Replacing IP cluster solved excessive battery drain.</p> <p><b>Summary:</b></p> <ul style="list-style-type: none"> <li>• <b>Complaint—Battery was dead.</b></li> <li>• <b>Cause—Excessive battery drain (parasitic draw) was found. Using scan tool to test modules, it was discovered that instrument panel cluster (IPC) remained awake &amp; never powered down when ignition was turned off.</b></li> <li>• <b>Correction—IPC was replaced, which fixes excessive battery drain problem.</b></li> </ul> <p>20. <b>SLIDE 20 EXPLAIN FIGURE 16–18</b> battery was replaced in this Ford Focus and the radio displayed “enter code” when the replacement battery was installed. Thankfully, owner had the code required to unlock the radio.</p> <p><b><u>DEMONSTRATION:</u> Show students how to perform a parasitic draw test using an ammeter with an inductive lead.</b></p> <p><b><u>DEMONSTRATION:</u> Show the students how to perform a parasitic draw test using an ammeter hooked up in series.</b></p> <p>21. <b>SLIDE 21 EXPLAIN FIGURE 16–19</b> A special tool that includes a lighter plug what can be plugged into a jump-start battery unit and the other end connected to the data link connector (DLC) of the vehicle to maintain the memory functions.</p> <p><b><u>DISCUSSION:</u> Have the students discuss why vehicle manufacturers use radios that require codes after the battery has been disconnected. What should be checked before disconnecting battery?</b></p> <p>22. <b>SLIDE 22 EXPLAIN FIGURE 16–20</b> A memory saver tool that uses a 12-volt battery to connect to the power (terminal 16) and ground (terminals 4 and 5) of the DLC.</p> <p>23. <b>SLIDE 23 EXPLAIN FIGURE 16–21</b> (a) Memory saver. The part numbers represent components from RadioShack. (b) A schematic drawing of the same memory saver. Some experts recommend using a 12-volt</p>

**ICONS** **Ch16 Battery Testing & Service**



lantern battery, instead of a small 9-volt battery, to help ensure there is enough voltage in the event that a door is opened while the vehicle battery is disconnected. Interior lights could quickly drain a small 9-volt battery.















**DEMONSTRATION: Show how to use a memory saver to retain radio memory.**

**EXPLAIN TECH TIP: Dead Batteries Can Freeze**  
If a battery becomes discharged, the electrolyte can freeze. This can occur because, when a battery is discharged, the “acid” (PbSO4) leaves the electrolyte and is deposited on both the negative and positive plates, leaving just water. Never attempt to charge or place into service a battery that is frozen. Often the case is split, requiring the battery to be replaced. If a battery is found to be frozen, place the battery into a warm room with good ventilation and allow to thaw. If the case is not cracked, then it may be able to be restored to useful service, if charged at a low rate for several hours. Connect the load tester to.

**DISCUSS FREQUENTLY ASKED QUESTION:**  
*Where Is the Battery?* Many OEMS place battery under backseat, under front fender, or in trunk. • **SEE FIGURE 16-22.** Often, the battery is not visible, even if it is located under the hood. When testing or jump starting a vehicle, look for a battery access point.

24. SLIDE 24 **EXPLAIN FIGURE 16-22** Many newer vehicles have batteries that are sometimes difficult to find. Some are located under plastic panels under the hood, under the front fender, or even under the rear seat, as shown here.

**Complete ASE EDUCATION Task Sheet, A8: Measure and diagnose the cause (s) of excessive parasitic draw; determine needed action.**

ICONS	Ch16 Battery Testing & Service
 	<p><b>Complete ASEEDUCATION Task B3: Maintain or restore electronic memory functions.</b></p>
 	<p><b>Complete ASEEDUCATION Task B2. Confirm proper battery capacity for vehicle application; perform battery capacity and load test; determine needed action.</b></p>
 	<p><b>Complete ASEEDUCATION Task B4: Inspect, clean, fill, and/or replace battery, battery cables, connectors, clamps, and hold-downs</b></p>
 	<p><b>Complete ASEEDUCATION Task B5. Perform slow/fast battery charge according to manufacturer's recommendations.</b></p>
 	<p><b>Complete ASEEDUCATION Task B6: Start a vehicle using jumper cables or an auxiliary power supply</b></p>
 	<p><b>Complete ASEEDUCATION Task B8. Identify electrical/electronic modules, security systems, radios, and other accessories that require reinitialization or code entry after reconnecting vehicle battery.</b></p>
 	<p><b>Complete ASEEDUCATION Task B9: Identify hybrid vehicle auxiliary (12v) battery service, repair and test procedures</b></p>