

# Automotive Maintenance and Light Repair, 1<sup>ST</sup> Edition

## Chapter 43 Hybrid Electric Vehicles

### Opening Your Class

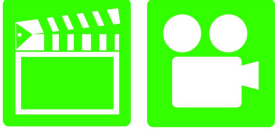
KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers <b>Automotive Maintenance and Light Repair</b> . It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to 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. <ul style="list-style-type: none"><li>⤵ Describe the different types of hybrid electric vehicles.</li><li>⤵ Explain how a hybrid vehicle is able to achieve an improvement in fuel economy compared to a conventional vehicle design.</li><li>⤵ Discuss the advantages and disadvantages of the various hybrid designs.</li><li>⤵ Describe HEV components, including motors, energy sources, and motor controllers.</li><li>⤵ Discuss the operation of a typical hybrid electric vehicle.</li></ul>
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

## Ch43 Hybrid Electric Vehicles



1. SLIDE 1 CH43 Hybrid Electric Vehicles
2. SLIDES 2-3 EXPLAIN OBJECTIVES



Check for **ADDITIONAL VIDEOS & ANIMATIONS**  
@ <http://www.jameshalderman.com/>  
**WEB SITE REGULARLY UPDATED**



**VIDEO:HEVS**  
**WWW.MYAUTOMOTIVELAB.COM**

[HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET\\_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=HYBRID%20VEHICLE&CLIP=PANDC/CHET/2012/AUTOMOTIVE/AUTO\\_SHOP\\_SAFETY/CLIP39HYBRIDVEHIC.MOV&CAPTION=CHET/CHET\\_MYLABS/AKAMAI/2012/AUTOMOTIVE/AUTO\\_SHOP\\_SAFETY/XML/CLIP39HYBRIDVEHIC.XML](http://media.pearsoncmg.com/ph/chet/chet_myLABS/akamai/template/VIDEO640X480.PHP?TITLE=HYBRID%20VEHICLE&CLIP=PANDC/CHET/2012/AUTOMOTIVE/AUTO_SHOP_SAFETY/CLIP39HYBRIDVEHIC.MOV&CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/AUTO_SHOP_SAFETY/XML/CLIP39HYBRIDVEHIC.XML)



4. SLIDE 4 EXPLAIN Hybrid Vehicle

5. SLIDE 5 EXPLAIN Figure 43-1 View of components of GM electric vehicle (EV1). Many of features of this vehicle, such as regenerative braking, currently used on hybrid vehicles were first put into production on this vehicle

















**DISCUSSION: ASK THE STUDENTS TO DISCUSS EVOLUTION OF AUTOMOBILES. HAVE THEM SHARE HOW AUTOMOBILES HAVE CHANGED OVER TIME. WHAT ADVANCES WILL FUTURE VEHICLES HAVE? FIGURE 43-1**

















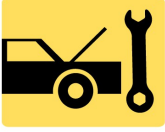










**DISCUSSION: REVIEW WITH STUDENTS DIFFERENT METHODS OF PROPULSION. WHAT TWO COMMON COMBINATIONS ARE BEING USED TO CLASSIFY VEHICLES AS HYBRIDS?**





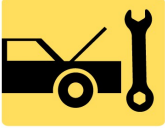
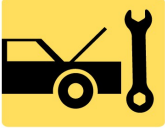









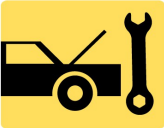


**DISCUSSION: OHM'S LAW: 1 VOLT IS REQUIRED TO PUSH 1 AMPERE THROUGH 1 OHM OF RESISTANCE; THEREFORE, IF VOLTAGE IS DOUBLED, THEN NUMBER OF AMPERES OF CURRENT FLOWING THROUGH CIRCUIT WILL ALSO DOUBLE IF THE RESISTANCE OF CIRCUIT REMAINS THE SAME. HOW DOES OHM'S LAW APPLY TO ELECTRIC VEHICLES?**

ICONS	Ch43 Hybrid Electric Vehicles
	<p><b><u>SAFETY</u> REMIND STUDENTS TO USE <u>INSULATED TOOLS</u> WHEN WORKING ON VEHICLES THAT USE <u>HIGH VOLTAGE.</u></b></p>
	
  <p>QUESTION</p>	<p><b>DISCUSSION: GATHER INFORMATION ABOUT NEWEST ZEV VEHICLES AVAILABLE. ASK STUDENTS TO IDENTIFY CURRENT BENEFITS, PROBLEMS, AND FUTURE OF THESE VEHICLES.</b></p>
  <p>QUESTION</p>	<p><b>DISCUSSION: HAVE THE STUDENTS CONSIDER THE BENEFITS OR DRAWBACKS CONCERNING COST OF A VEHICLE VS. FUEL SAVINGS. HOW LONG WILL YOU NEED TO DRIVE A VEHICLE WITH FUEL SAVINGS IN ORDER TO OFFSET ITS EXTRA COST AS COMPARED TO DRIVING AN INTERNAL COMBUSTION ENGINE VEHICLE?</b></p>
 	<p><b><u>DEMONSTRATION: MEASURE AMPERAGE &amp; VOLTAGE IN SERIES AND PARALLEL CIRCUITS ON VEHICLE.</u> CALL ATTENTION TO THE CHANGE IN AMPERES AND VOLTS BETWEEN SERIES AND PARALLEL CIRCUITS.</b></p>
	<p>6. SLIDE 6 EXPLAIN Common Features of Hybrid Electric Vehicles</p> <p>7. SLIDE 7 EXPLAIN Levels of Hybrid Electric Vehicles</p>
 	<p><b><u>DEMONSTRATION: START HYBRID VEHICLE WITH STUDENTS. HAVE THEM COMPARE &amp; CONTRAST THIS START WITH A COMBUSTION ENGINE VEHICLE START. ASK STUDENTS TO DISCUSS DIFFERENCES BETWEEN 2 STARTS.</u></b></p>
  <p>QUESTION</p>	<p><b>DISCUSSION: SHOW THE STUDENTS CHARGE PORT FOR A HYBRID ELECTRIC VEHICLE. DISCUSS THE PROCEDURES INVOLVED WITH RECHARGING ALONG WITH ELECTRICAL REQUIREMENTS OF A CHARGING FACILITY.</b></p>
	<p>8. SLIDE 8 EXPLAIN FIGURE 43-2 full hybrid design allows the vehicle to operate in electric motor mode only or in combination with the internal combustion engine.</p>

ICONS	Ch43 Hybrid Electric Vehicles
	<p><b>ANIMATION: SERIES HEV OPERATION</b>  <a href="http://www.myautomotivelab.com">WWW.MYAUTOMOTIVELAB.COM</a>  <small>HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYLABS/AKAMAI/TEMPLATE/VIDEO640X480.PHP?TITLE=COMPREHENSIVE%20COMPONENTS&amp;CLIP=PANDC/CHET/2012/AUTOMOTIVE/OBD2_GETTING_ON_BOARD/CLIP1.MOV&amp;CAPTION=CHET/CHET_MYLABS/AKAMAI/2012/AUTOMOTIVE/OBD2_GETTING_ON_BOARD/XML/CLIP1.XML</small></p>
	<p><b>ANIMATION: PARALLEL HEV OPERATION</b>  <a href="http://www.myautomotivelab.com">WWW.MYAUTOMOTIVELAB.COM</a>  <small>HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/AX_ANIMATIONS/CHAPTER64_FIG_64_5/INDEX.HTM</small></p>
	<p><b>ANIMATION: SERIES-PARALLEL HEV OP</b>  <a href="http://www.myautomotivelab.com">WWW.MYAUTOMOTIVELAB.COM</a>  <small>HTTP://MEDIA.PEARSONCMG.COM/PH/CHET/CHET_MYAUTOMOTIVELAB_2/ANIMATIONS/AX_ANIMATIONS/CHAPTER64_FIG_64_7/INDEX.HTM</small></p>
  <p>QUESTION</p>	<p><b>DISCUSSION: HAVE STUDENTS COMPARE &amp; CONTRAST COMPONENTS OF SERIES AND PARALLEL HYBRID VEHICLES, REFERRING TO. ASK STUDENTS TO IDENTIFY PROS/CONS OF COMPONENTS.</b></p>
  <p>QUESTION</p>	<p><b>DISCUSSION: REVIEW IDLE STOP MODE WITH THE STUDENTS AND HIGHLIGHT THE DIFFERENCE BETWEEN A CONVENTIONAL STARTER &amp; VOLTAGE MOTOR GENERATOR.</b></p>
	<p>9. SLIDE 9 EXPLAIN Working Around Hybrid Vehicles</p>
 	<p><b>DEMONSTRATION: WHILE A HYBRID ENGINE IS IN IDLE STOP MODE, CONNECT A 5-GAS ANALYZER. HAVE STUDENTS TAKE NOTE OF THE CO2 READING TO CONFIRM ZERO OR LOW CO2 LEVELS IN IDLE STOP MODE. NEXT, CONNECT A FIVE-GAS ANALYZER TO AN ICE AND COMPARE CO2 READINGS AT IDLE. DISCUSS RESULTS.</b></p>
  <p>QUESTION</p>	<p><b>DISCUSSION: WHAT ARE COMMON VOLTAGE RATINGS FOR MILD, MEDIUM, AND FULL HYBRID VEHICLES? REMIND STUDENTS OF SAFETY PRECAUTIONS REQUIRED FOR WORKING ON HYBRID ELECTRIC VEHICLES</b></p>
  <p>QUESTION</p>	<p><b>DISCUSSION: HAVE STUDENTS DISCUSS EFFICIENCIES OF ELECTRIC MOTORS AND INTERNAL COMBUSTION ENGINES. WHICH IS MORE EFFICIENT OVERALL—ELECTRIC MOTOR OR</b></p>

ICONS	Ch43 Hybrid Electric Vehicles
	<p><b>ICE?</b></p> <p><b>HANDS-ON TASK: HAVE THE STUDENTS RESEARCH <u>INDEPENDENT REPAIR SHOPS THAT WORK ON HYBRID ELECTRIC VEHICLES</u>. WHAT TYPES OF REPAIRS ARE THEY DOING, &amp; WHAT SAFETY PRECAUTIONS ARE BEING OBSERVED?</b></p>
	<p>10. SLIDE 10 EXPLAIN FIGURE 43-3 Look for an emblem that says “Hybrid” on the front, side, or rear of the vehicle.</p>
	<p>11. SLIDE 11 EXPLAIN FIGURE 43-4 Orange-colored cable under hood means that the vehicle is a hybrid or an electric vehicle that uses high-voltage components and circuits.</p>
	<p><b><u>DISCUSSION: DISCUSS IDENTIFYING COLORS USED FOR HIGH VOLTAGE CABLES. WHAT DOES BLUE OR YELLOW PLASTIC CONDUIT MEAN? WHAT DOES ORANGE PLASTIC CONDUIT MEAN?</u></b></p>
	<p>12. SLIDE 12 EXPLAIN FIGURE 43-5 service plug on a Toyota Prius, which is located in the trunk and is orange in color. Toyota recommends that the technician wear high-voltage gloves when removing the disconnect plug.</p>
	<p><b><u>DEMONSTRATION: SHOW STUDENTS MATERIALS NECESSARY TO CREATE A “HIGH VOLTAGE: DO NOT TOUCH” SIGN THAT CAN BE PLACED ON ROOF OF HEV THAT IS BEING STORED.</u></b></p>
	<p>13. SLIDE 13 EXPLAIN FIGURE 43-6 If “Ready” light is on, then the gasoline engine can start at any time and the vehicle can be driven in electric mode for a short distance and limited speed.</p>
	<p>14. SLIDE 14 EXPLAIN Jump Starting &amp; Moving or Towing a Hybrid Vehicle</p>
	<p>15. SLIDE 15 EXPLAIN FIGURE 43-7 Jump-starting a 2001–2003 Toyota Prius using a 12-volt supply to boost the 12-volt auxiliary battery in the trunk.</p>
 	<p><b><u>DEMONSTRATION: SHOW STUDENTS JUMP STARTING PROCEDURES ON HEV. REVIEW SAFETY PROCEDURES FOR CONNECTING &amp; DISCONNECTING JUMPER CABLES. CAN JUMP BOX OR JUMPER CABLE FROM ANOTHER VEHICLE</u></b></p>

ICONS	Ch43 Hybrid Electric Vehicles
	<p><b>BE USED ON HIGH-VOLTAGE HV BATTERY PACK? FIGURES 43-7</b></p> <p><b><u>DEMONSTRATION: DEMO DE-POWERING PROCEDURE ON A HYBRID ELECTRIC VEHICLE</u></b></p>
	<p><b>USE A COOKING TIMER WITH A BELL ALARM OR SOME OTHER AUDIBLE SIGNAL AS A WAY TO KNOW WHEN 10-MINUTE WAITING PERIOD FOR HV BATTERY SHUTDOWN HAS PASSED.</b></p>
	<p><b><u>DISCUSSION: HAVE STUDENTS TALK ABOUT WHEN HIGH VOLTAGE SYSTEM NEEDS TO BE DE-POWERED &amp; WHEN IT DOESN'T. WHEN SERVICING A SYSTEM THAT MAY CONTAIN HIGH VOLTAGE, HOW CAN YOU BE SURE OF WHETHER OR NOT IT NEEDS TO BE DE-POWERED?</u></b></p>
	<p><b><u>DEMONSTRATION: SHOW PROCEDURE FOR MOVING &amp; STORING HEV WAITING FOR PARTS TO ARRIVE.</u></b></p>
	<p><b><u>HANDS-ON TASK: HAVE THE STUDENTS DESCRIBE SAFETY PRECAUTIONS THAT SHOULD BE TAKEN TO WORK ON HEVS. GRADE THEM ON THOROUGHNESS AND A CLEAR UNDERSTANDING OF DANGERS THAT HEVS PRESENT AND HOW THOSE DANGERS CAN BE ADDRESSED.</u></b></p>
	<p><b><u>HANDS-ON TASK: REVIEW IMPORTANCE OF SEPARATING THE KEYS FROM A HYBRID VEHICLE TO PREVENT AN ACCIDENTAL START-UP THAT COULD LEAD TO PERSONAL INJURY. HAVE STUDENTS CREATE A METAL LOCK BOX OR RESEARCH THE COST OF PURCHASING ONE.</u></b></p>
	<ol style="list-style-type: none"> <li>16. SLIDE 16 EXPLAIN Hybrid Service Procedures</li> <li>17. SLIDE 17 EXPLAIN FIGURE 43-8 high-voltage wiring on this Honda hybrid is colored orange for easy identification.</li> <li>18. SLIDE 18 EXPLAIN FIGURE 43-9 Always use the specified viscosity of oil in a hybrid electric vehicle not</li> </ol>

ICONS	Ch43 Hybrid Electric Vehicles
	<p>only for best fuel economy but also because of the need for fast lubrication due to the engine (idle) stop feature.</p> <p><b>DISCUSSION: HAVE STUDENTS TALK ABOUT IMPORTANCE OF USING LEATHER GLOVES OVER INSULATED GLOVES. REMIND THEM THAT WHEN PURCHASING LEATHER GLOVES, THEY MUST BE LARGE ENOUGH TO FIT OVER INSULATED SAFETY GLOVES. WHAT SHOULD BE DONE BEFORE EACH USE OF GLOVES?</b></p>
 	<p><b><u>SAFETY HAVE STUDENTS TALK ABOUT NEED FOR SAFETY PRECAUTIONS WHEN WORKING AROUND &amp; WITH HYBRID ELECTRIC VEHICLES. BOTH HYBRID ELECTRIC VEHICLES &amp; ALL-ELECTRIC VEHICLES USE HIGH-VOLTAGE CIRCUITS THAT CANNOT BE TOUCHED WITHOUT PROTECTION.</u></b></p>
	<p>19. SLIDES 19-20 EXPLAIN Hybrid Service Procedures</p> <p>21. SLIDE 21 EXPLAIN FIGURE 43-10 12-volt battery under the hood on a Ford Fusion hybrid is a flooded cell-type auxiliary battery.</p>
	<p>22. SLIDE 22 EXPLAIN Hybrid Service Procedures</p> <p><b>DISCUSSION: DISCUSS <u>CAT III-RATED DMM.</u> WHY IS A CAT III-CERTIFIED DMM REQUIRED FOR TAKING MEASUREMENTS ON HEVS?</b></p>
 	<p><b><u>NATEF MLR TASK A6B7 IDENTIFY HIGH-VOLTAGE CIRCUITS OF ELECTRIC OR HYBRID ELECTRIC VEHICLE AND RELATED SAFETY PRECAUTIONS.</u></b></p>
 	<p><b><u>NATEF MLR TASK A6B9 IDENTIFY HYBRID VEHICLE AUXILIARY (12V) BATTERY SERVICE, REPAIR, AND TEST PROCEDURES.</u></b></p>