

# Introduction to Automotive Service

## Chapter 33 Hybrid Electric Vehicles

### Opening Your Class

KEY ELEMENT	EXAMPLES
<b>Introduce Content</b>	This course or class serves as an introduction to the world of automotive service. It correlates material to task lists specified by ASE and NATEF.
<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 learning objectives to students.</p> <ol style="list-style-type: none"> <li>1. Describe the different types of hybrid electric vehicles.</li> <li>2. Explain how a hybrid vehicle is able to achieve an improvement in fuel economy compared to a conventional vehicle design.</li> <li>3. Discuss the advantages and disadvantages of the various hybrid designs.</li> <li>4. Describe HEV components, including motors, energy sources, and motor controllers.</li> <li>5. Discuss the operation of a typical hybrid electric vehicle.</li> </ol>
<b>Establish the Mood or Climate</b>	Provide a <b>WELCOME</b> , 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.

## ICONS



## Chapter 33 Hybrid Electric Vehicles

### 1. SLIDE 1 CH33 HYBRID ELECTRIC VEHICLES

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

### Show VIDEO: 2 MINUTES HEVS (Ch89) [www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_mylibs/akamai/template/video640x480.php?title=Hybrid%20Vehicle&clip=pandc/chet/2012/automotive/Auto\\_Shop\\_Safety/Clip39HybridVehic.mov&caption=chet/chet\\_mylibs/akamai/2012/automotive/Auto\\_Shop\\_Safety/xml/Clip39HybridVehic.xml](http://media.pearsoncmg.com/ph/chet/chet_mylibs/akamai/template/video640x480.php?title=Hybrid%20Vehicle&clip=pandc/chet/2012/automotive/Auto_Shop_Safety/Clip39HybridVehic.mov&caption=chet/chet_mylibs/akamai/2012/automotive/Auto_Shop_Safety/xml/Clip39HybridVehic.xml)

### 2. SLIDE 2 **EXPLAIN** Hybrid Electric Vehicles

3. SLIDE 3 **EXPLAIN** Figure 33-1 View of components of GM electric vehicle (EV1). Many of the 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 89-1**

### 4. SLIDE 4 **EXPLAIN** Common Features of Hybrid Electric Vehicles

### 5. SLIDE 5 **EXPLAIN** Levels of Hybrid Electric Vehicles

**DISCUSSION:** Review with students different methods of propulsion. What **two common combinations** are being used to classify vehicles as hybrids?

**DISCUSSION:** Review **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 resistance of circuit remains the same. How does Ohm's law apply to electric vehicles?

## ICONS



## Chapter 33 Hybrid Electric Vehicles

### Show ANIMATION: SERIES HEV OPERATION [www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_mylibs/akamai/template/video640x480.php?title=Comprehensive%20Components&clip=pandc/chet/2012/automotive/OBD2\\_Getting\\_On\\_Board/clip1.mov&caption=chet/chet\\_mylibs/akamai/2012/automotive/OBD2\\_Getting\\_On\\_Board/xml/clip1.xml](http://media.pearsoncmg.com/ph/chet/chet_mylibs/akamai/template/video640x480.php?title=Comprehensive%20Components&clip=pandc/chet/2012/automotive/OBD2_Getting_On_Board/clip1.mov&caption=chet/chet_mylibs/akamai/2012/automotive/OBD2_Getting_On_Board/xml/clip1.xml)

### Show ANIMATION: PARALLEL HEV OPERATION [www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_myautomotivelab\\_2/animations/AX\\_Animations/Chapter64\\_Fig\\_64\\_5/index.htm](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/AX_Animations/Chapter64_Fig_64_5/index.htm)

### Show ANIMATION: SERIES-PARALLEL HEV OPERATION [www.myautomotivelab.com](http://www.myautomotivelab.com)

[http://media.pearsoncmg.com/ph/chet/chet\\_myautomotivelab\\_2/animations/AX\\_Animations/Chapter64\\_Fig\\_64\\_7/index.htm](http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/AX_Animations/Chapter64_Fig_64_7/index.htm)

**DISCUSSION:** Gather information about newest **ZEV Vehicles** available. Ask students to identify current benefits, problems, and future of these vehicles.

**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?

6. **SLIDE 6 EXPLAIN** FIGURE 33-2 A full hybrid design allows the vehicle to operate in electric motor mode only or in combination with the internal combustion engine
7. **SLIDE 7 EXPLAIN** Working Around Hybrid Vehicles
8. **SLIDE 8 EXPLAIN** FIGURE 33-3 Look for an emblem that says “Hybrid” on the front, side, or rear of vehicle

**SAFETY INSULATED TOOLS MUST BE USED** when working on vehicles that use **HIGH VOLTAGE.**

**DEMONSTRATION:** Measure **amperage & voltage in series and parallel circuits** on vehicle. Call attention to the change in amperes and volts between series and parallel circuits.

## ICONS



QUESTION



QUESTION

## Chapter 33 Hybrid Electric Vehicles

**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.

**DEMONSTRATION:** While a hybrid engine is in idle stop mode, connect a five-gas analyzer. Have students take note of the CO<sub>2</sub> reading to confirm zero or low CO<sub>2</sub> levels in idle stop mode. Next, connect a five-gas analyzer to an ICE and compare CO<sub>2</sub> readings at idle. Discuss results.

9. **SLIDE 9 EXPLAIN FIGURE 33-4** Orange-colored cable under the hood means that the vehicle is a hybrid or an electric vehicle that uses high-voltage components and circuits
10. **SLIDE 10 EXPLAIN FIGURE 33-5** 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

**ON-VEHICLE NATEF TASK (A6-A-18)** Identify location of hybrid vehicle high-voltage circuit disconnect (service plug) location and safety precautions. **(P-3)**

11. **SLIDE 11 EXPLAIN FIGURE 33-6** If the “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

**DEMONSTRATION:** Start hybrid vehicle with students. Have them compare & contrast this start with a combustion engine vehicle start. Ask students to discuss differences between 2 starts.

**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.

## ICONS



## Chapter 33 Hybrid Electric Vehicles

**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**

12. **SLIDE 12 EXPLAIN** Jump Starting & Moving or Towing A Hybrid Vehicle
13. **SLIDE 13 EXPLAIN FIGURE 33-7** Jump-starting a 2001–2003 Toyota Prius using a 12-volt supply to boost the 12-volt auxiliary battery in the trunk

**DEMONSTRATION:** Show students **jump starting procedures** on HEV. Review safety procedures for connecting & disconnecting **jumper cables**. Can jump box or jumper cable from another vehicle be used on high-voltage HV battery pack?

**DISCUSSION:** Have students talk about importance of using leather gloves over insulated gloves. Gloves must be large enough to fit over insulated safety gloves. What should be done before each use of gloves?

14. **SLIDE 14 EXPLAIN** Hybrid Service Procedures
15. **SLIDE 15 EXPLAIN FIGURE 3388** The high-voltage wiring on this Honda hybrid is colored orange for easy identification

**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.

**DISCUSSION:** Discuss **auxiliary batteries**. Where are flood-type and AGM type batteries located? **CHART 90-1**

**DISCUSSION:** Discuss **CAT III-rated DMM**. Why is a CAT III-certified DMM required for taking measurements on HEVs? **FIGURES 90-4 & 5**

## ICONS



## Chapter 33 Hybrid Electric Vehicles

**DEMONSTRATION:** Using a CAT III DMM, show students how to check a floating ground to identify a high-voltage leak. FIGURES 90-4 & 5

**DISCUSSION:** Discuss identifying colors used for high voltage cables. What does blue or yellow plastic conduit mean? What does orange plastic conduit mean?

16. **SLIDE 16 EXPLAIN FIGURE 33-9** Always use the specified viscosity of oil in a hybrid electric vehicle not only for best fuel economy but also because of the need for fast lubrication due to the engine (idle) stop feature
17. **SLIDES 17-18 EXPLAIN** Hybrid Service Procedures
19. **SLIDE 19 EXPLAIN FIGURE 33-10** This 12-volt battery under the hood on a Ford Fusion hybrid is a flooded cell-type auxiliary battery
20. **SLIDE 20 EXPLAIN** Hybrid Service Procedures

**DISCUSSION:** discuss oil changes for HEVs. Why do most hybrid electric vehicles require either SAE 0W-20 or SAE 5W-20? FIGURE 90-14

**DISCUSSION:** Have students talk about cooling system service for HEVs. What considerations for servicing an HEV cooling system may differ from those for servicing ICE cooling system?

**DISCUSSION:** Have the students discuss servicing the air conditioning of an HEV. What does the service technician need to know about the air conditioning compressor on HEV

**DISCUSSION:** Have the students talk about the regenerative braking system and base brakes used on hybrid electric cars. Why do base brakes on HEVs often get stuck or function incorrectly?

**HANDS-ON TASK:** Have the students RESEARCH independent repair shops that work on hybrid electric vehicles. What types of repairs are they doing, and what safety precautions are being observed? Have students share their findings with class.

## ICONS



## Chapter 33 Hybrid Electric Vehicles

### ON-VEHICLE NATEF TASK (A8-A-4)

Locate and interpret HEV vehicle labels and calibration decals. (P-1)

**Homework:** complete Ch33 crossword puzzle:  
[http://www.jameshalderman.com/links/book\\_intro/cw/crossword\\_ch\\_33.pdf](http://www.jameshalderman.com/links/book_intro/cw/crossword_ch_33.pdf)