TEST INFORMATION
FOR THE
LIGHT DUTY HYBRID/ELECTRIC VEHICLE SPECIALIST TEST (L3)

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Light Duty Hybrid/Electric Vehicle Specialist Test

Overview

Introduction

The *Light Duty Hybrid/Electric Vehicle Specialist (L3) Test* is the first advanced level test offered by ASE for light duty hybrid/electric vehicle technicians. It is designed to measure a technician's knowledge of the skills needed to diagnose both high and low voltage electrical/electronic problems, as well as other supporting system problems, on hybrid/electric vehicles. It is an extension of the repair and diagnostic skills tested by the Automobile Electrical/Electronic Systems (A6) and Engine Performance (A8) tests. To register to take the L3 certification test, you must have passed both the Automobile Electrical/Electronic Systems (A6) and Engine Performance (A8) tests.

The L3 test consists of 45 scored multiple choice questions. The questions require your familiarity with the supplied reference materials, as this information is used to bridge gaps in your familiarization with technology and terminology among various hybrid/electric vehicle platforms.

Registration information is available on the ASE website at **www.ase.com**. On the ASE website, you can also create your own myASE account, giving you direct access to your personal ASE certification information and more.

Who Writes the Questions?

Each question has its roots in an ASE "question-writing" workshop, where service representatives from automobile manufacturers, aftermarket trainers, working technicians, and vocational educators meet to share ideas and translate them into test questions. Each test question written by these experts must survive review by all members of the group. The questions deal with practical problems experienced by technicians in their daily work. Naturally, the failures described in the advanced level questions are more complex and challenging.

From there, all questions are pre-tested and quality-checked on a national sample of technicians. Those questions that meet ASE standards of quality and accuracy are included in the scored sections of future tests; the "rejects" are sent back to the drawing board or are discarded altogether.

How Do I Prepare for the ASE L3 Test?

To prepare for the test, **you need this book which includes the *Hybrid Specialist Certification Test Reference*** (print version or online at www.ase.com). We suggest that you follow these steps:

Step 1. Study the content areas listed in the Test Specifications, noting what percentage of the test each covers.
Step 2. Carefully read the Task List, noting the areas in which your skills are strong or weak. Do this by checking off each task that you do not perform often or do not understand completely.
Step 3. Practice on the sample questions that follow. Although the sample questions will not appear in the test, they are similar in style and difficulty to the actual test questions.
Step 4. Use steps 1 through 3 to identify any skill areas where you need additional study or training. Then refer to the Industry Training reference section to locate the training sources that are right for you.

What is the ASE Light Duty Hybrid/Electric Vehicle Specialist Certification Test Reference?

The *ASE Light Duty Hybrid/Electric Vehicle Specialist Certification Test Reference* (starting on page 7 in this book) is a resource that identifies concepts for the hybrid/electric vehicle technology that will be included in the ASE test. The reference is included in this study guide and will also be available as a pop-up document during the Certification Test. The first page outlines the concepts for the common technical constructs for all hybrid/electric vehicle drive systems included in the test. All test questions will follow this outline to ensure that the test content remains consistent and is understandable to candidates regardless of their area of hybrid/electric vehicle specialty. The block diagrams illustrate systems similar to those used in many hybrid/electric vehicles. These diagrams will serve as a visual reference and identify a vehicle classification for each of the platforms based on technical characteristics. Vehicle classifications will be used in some test questions to define the specific hybrid/electric vehicle type referenced in the scenario. The “Glossary of Terms” can be used as a reference to clarify differences in how a term is used by various hybrid/electric vehicle manufacturers.

The majority of the test questions will be generic, meaning the concept identified should be applicable to most of today’s hybrid/electric vehicles. There will be some questions that will apply only to the Type-1, Type-2 or Type-3 vehicle platforms identified in the block diagrams. You should become familiar with the technology associated with all of these vehicle platforms, since questions about each may be included. Please take the time to review all of the information contained in the Certification Test Reference before your test appointment.

Before the Test

Try to be well rested for the test so you will be alert and efficient. Be sure to bring along your test center admission ticket and some form of current (unexpired) government-issued photo identification, like a driver’s license. You do not need to bring this book. The *Hybrid Specialist Certification Test Reference* will be provided as an electronic pop-up document during your test session.

How Long Are the Tests?

Test	Name	# of Questions	Testing Time
L3	Light Duty Hybrid/Electric Vehicle Specialist	45*	2 hrs

***Note:** The test will include 10 additional questions that are for statistical research purposes only. Your answers to tthese questions will not affect your score, but since you do not know which ones they are, you should answer all questions in the test.

At the Test Center

Lockers will be available for you to store your personal items, including cell phones. Pencils and scratch paper will be provided for you in the test room.

Once the test begins, be sure to read each question carefully and thoroughly so that you understand exactly what is being asked. There are no “trick” questions. Each question tests a specific diagnostic skill and has a single correct answer.

If you are unsure of an answer, don’t get stuck. Mark the answer that you think is correct and flag the question using the on-screen button. Then go on to the next question. If you finish before the allotted time is up, you can go back to the flagged questions. It is to your advantage to answer every question. **Do not leave any answers blank. Your score is based on the total number of correct answers that you give.**

TEST SPECIFICATIONS FOR THE LIGHT DUTY HYBRID/ELECTRIC VEHICLE SPECIALIST TEST (L3)

Content Area	Questions in Test	Percentage of Test
A. Battery System	11	25%
B. Internal Combustion Engine	6	13%
C. Drive Systems	9	20%
D. Power Electronics	13	29%
E. Hybrid Supporting Systems	6	13%
Total:	45*	100%

***Note:** The L3 Certification test will include 10 additional questions that are for statistical research purposes only. Your answers to these questions will not affect your score, but since you do not know which ones they are, you should answer all questions in the test.

LIGHT DUTY HYBRID/ELECTRIC VEHICLE SPECIALIST TEST TASK LIST

A. Battery System (11 questions)

1. Perform high voltage disconnect procedure; reconnect/enable high voltage system.
2. Select, test and use proper safety gloves.
3. Select, qualify and use proper electrical testing equipment and leads.
4. Retrieve and diagnose DTCs; determine needed repairs.
5. Diagnose problems caused by damaged or failed harnesses, connectors, terminals and fuses.
6. Diagnose high voltage (HV) battery pack malfunctions.
7. Remove and install high voltage battery pack.
8. Test, diagnose and repair high voltage leaks/loss of isolation.
9. Test, diagnose and repair high voltage battery pack heating and cooling systems.
10. Test, diagnose, repair or replace high voltage battery pack internal components.
11. Test and diagnose charging problems when using electric vehicle supply equipment (EVSE).

B. Internal Combustion Engine (6 questions)

1. Retrieve and diagnose DTCs; determine needed repairs
2. Determine if the internal combustion engine (ICE) is in CRANK mode or RUN mode.
3. Differentiate between driveability problems caused by the internal combustion engine and/or hybrid drive system.
4. Perform internal combustion engine cranking compression test.
5. Keep the internal combustion engine running during service.
6. Diagnose internal combustion engine no-crank condition.
7. Diagnose internal combustion engine cranks/no-start condition.
8. Interpret vacuum and compression readings on Atkinson cycle engines.
9. Identify engine start/stop strategy; diagnose malfunctions.
10. Service engine cooling system.

C. Drive Systems (9 questions)

1. Perform high voltage disconnect procedure; reconnect/enable high voltage system.
2. Select, test and use proper safety gloves.
3. Select, qualify and use proper electrical testing equipment and leads.
4. Retrieve and diagnose driveline DTCs; determine needed repairs.
5. Diagnose problems caused by damaged or failed harnesses, connectors, and terminals.
6. Test, diagnose and repair high voltage leaks/loss of isolation.
7. Remove and install rotor from stator.
8. Diagnose motor-rotor position sensor (Resolver or Encoder type).
9. Diagnose drive/traction motor-generator assembly for improper operation (such as an inoperative condition, noise, shudder, overheating, etc.).
10. Diagnose improper electrically actuated parking pawl operation; determine needed repair.
11. Identify transmission fluid and coolant fluid requirements; verify fluid levels.

D. Power Electronics (13 questions)

1. Perform high voltage disconnect procedure; reconnect/enable high voltage system.
2. Select, test and use proper safety gloves.
3. Select, qualify and use proper electrical testing equipment and leads.
4. Retrieve and diagnose DTCs; determine needed repairs.
5. Diagnose problems caused by damaged or failed harnesses, connectors, and terminals.
6. Identify procedures necessary to establish the proper vehicle operational power mode during service (OFF, ACCESSORY, POWER ON, READY TO DRIVE).
7. Diagnose the cause of a hybrid system warning displayed on the instrument panel and/or a driveability complaint.
8. Diagnose impact sensor problems; determine needed repair.
9. Diagnose AC/DC inverter overheating; determine needed repair.
10. Diagnose AC/DC inverter failure; determine needed repair.
11. Replace AC/DC inverter cooling pump.
12. Remove and install AC/DC inverter.
13. Diagnose failures in the data communications bus network; determine needed repair.
14. Locate and test the voltage level of capacitors.
15. Diagnose, locate and safely disable/enable safety interlocks.
16. Diagnose failed DC/DC converter; determine needed repair.
17. Remove and install DC/DC converter.
18. Test high voltage cable integrity and loss of isolation.
19. Perform 12-volt battery testing.
20. Diagnose system main relay (SMR)/contactor malfunctions; determine needed repairs.

E. Hybrid Supporting Systems (6 questions)

1. Perform high voltage disconnect procedure; reconnect/enable high voltage system.
2. Select, test and use proper safety gloves.
3. Select, qualify and use proper electrical testing equipment and leads.
4. Diagnose problems caused by damaged or failed harnesses, connectors, and terminals.
5. Retrieve and diagnose DTCs; determine needed repairs.
6. Inspect, test and diagnose EVAP emission system components; determine needed repairs.
7. Observe and interpret driver indicators, power flow display and energy monitor; determine necessary action.
8. Test and diagnose high voltage air conditioning compressor malfunctions; diagnose system problems; determine needed repairs.
9. Remove and install high voltage air conditioning compressor; identify and select proper system oil.
10. Diagnose cabin heating system performance problems; determine needed repairs.
11. Diagnose and repair electric/electronic steering systems.
12. Diagnose brake system performance problems; differentiate between braking problems caused by hydraulic system and regenerative system malfunctions; determine needed repairs.
13. Deactivate brake system self-test prior to service.
14. Service liquid cooling system(s).

ASE LIGHT DUTY HYBRID/ELECTRIC VEHICLE SPECIALIST CERTIFICATION TEST REFERENCE

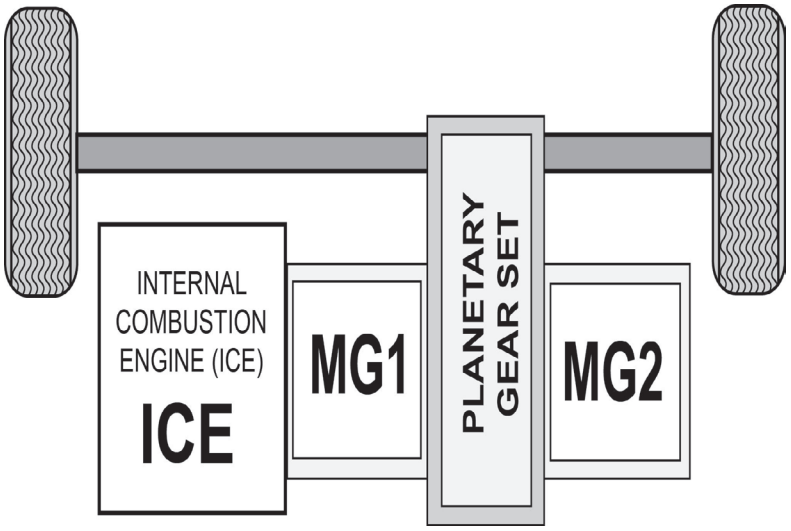
The block diagrams included in this document represent the power flow strategies used by the hybrid-drive systems included in the ASE Light Duty Hybrid/Electric Vehicle Specialist test. Although additional details may be provided in individual test questions, the following information should be considered common to each of these systems.

- All represented hybrid-systems are high-voltage. These systems typically exceed 100 volts, but systems greater than 60 volts DC or AC RMS should be considered high-voltage.
- All motor/generators (MG) are high-voltage three-phase AC electric motor/generators.
- Each vehicle type is equipped with a high-voltage (HV) battery pack. Neither battery chemistry nor total battery pack voltage is defined in this general description document.
- Each system uses a DC/AC bi-directional inverter to provide AC current to and from the motor/generator(s).
- Each system uses a DC/DC converter. This converter supplies stepped-down voltage to the vehicle's 12 V system and replaces the traditional generator (alternator).
- All systems are equipped with a 12 V battery.
- Failures affecting the vehicle's electric drive system may result in the display of a "Hybrid System Warning" on the instrument panel.
- The terms Encoder and Resolver may be used interchangeably.
- Because of the variation in terminology used by different manufacturers when referring to the hybrid system's readiness state, ASE test questions will use the following to indicate the operational power modes.

OFF	All systems OFF. The engine and electric drive system are powered OFF.
ACCESSORY	Same as ACC on a conventional vehicle.
POWER ON	Equivalent to KOEO – Key ON/Engine OFF. In this mode, the engine will not run, nor will the vehicle move under electric power.
READY TO DRIVE	Equivalent to KOER – Key On/Engine Running. In this mode, the vehicle is ready to drive. The engine is running, or is OFF and ready to run if so commanded. The electric drive system is also ready for a drive command.

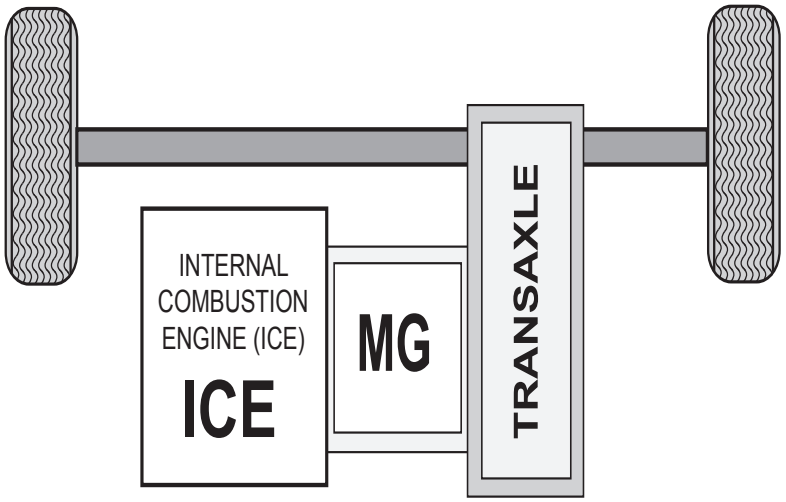
Type-1

The Type-1 hybrid-drive system uses power from the internal combustion engine (ICE) and/or motor/generator(s) to propel the vehicle. Power flow to the drive-wheels is blended as needed through a planetary gear set, with motor/generator 1 (MG1) serving as a reaction unit to control the effective ratio and direction of the gears. MG1 is used as the starter motor for the ICE, and conversely, it can be driven by the ICE to act as a generator. MG2 also serves as a generator during regenerative braking.



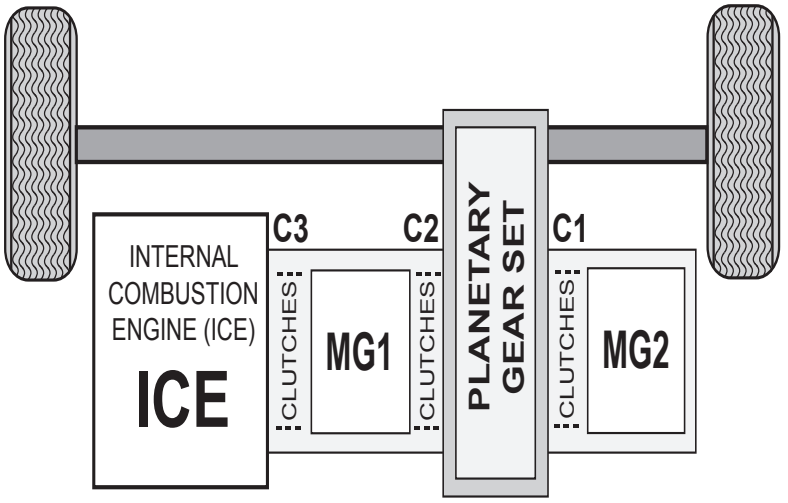
Type-2

The Type-2 hybrid-drive system uses a single motor/generator (MG) integrally mounted between the internal combustion engine (ICE) and the transmission. The ICE and MG are used together to maximize vehicle propulsion. During regenerative braking, the MG acts as a generator. Under most conditions, the MG serves as the starter motor for the ICE. Some Type-2 vehicles may be equipped with an auxiliary 12 V starter motor. Power flow to the drive wheels can be provided by a split-pulley/steel belt continuously variable transmission, a conventional automatic transmission, or a standard transmission.



Type-3

The Type-3 hybrid-drive system is regarded as an extended range electric vehicle. MG2 provides vehicle propulsion and electrical regeneration while braking. In certain situations, MG1 assists MG2 by combining power flow through a planetary gear set to reduce the speed of MG2. When the high-voltage (HV) battery pack falls to a predetermined state-of-charge (SOC), the internal combustion engine (ICE) is started with MG1. The ICE then drives MG1 to generate sufficient current to power MG2 and maintain the HV battery pack.



Light Duty Hybrid/Electric Vehicle Specialist Test Glossary of Terms

The reference materials and questions for this test use electronic and emission terms and acronyms that are consistent with the industry-wide SAE standards J1715, J1930, and J2012. Some of these terms are listed below.

Auto Stop - In the READY TO DRIVE (KOER) operational power mode, the internal combustion engine is automatically turned off when power demand is zero or negative, such as during vehicle stop, and then restarted automatically.

Battery Cell - An assembly of a positive electrode, a negative electrode, and other necessary electrochemical and structural components. A cell is a self-contained energy conversion device whose function is to deliver electrical energy to an external circuit via an internal chemical process.

Battery Module - A grouping of interconnected cells in a single mechanical and electrical unit.

Battery Pack/Traction Battery - Interconnected battery modules that have been configured for a specific energy storage application.

Battery System - Completely functional energy storage system consisting of the pack(s) and necessary ancillary subsystems for physical support, thermal management, and electronic control.

DC/DC Converter - A power converter that produces an output voltage greater than (boost) or less than (buck) the input voltage.

Energy Monitor - A display that indicates the charge/discharge status of the high voltage battery.

Hybrid System Warning - A display on the instrument panel that is activated when failures affecting the vehicle's electric drive system are detected. This display is the same as a "Master Warning Light," "Service Hybrid System" message, "IMA Warning Light," etc.

ICE - Internal Combustion Engine

IGBT - Insulated Gate Bipolar Transistor

Motor/Generator - An electromechanical device that can operate in two modes without changing rotational direction. As a motor, it consumes electricity to produce mechanical power. As a generator, it consumes mechanical power to produce electricity**.**

Power Flow Display - An animated graphic indicating the direction of the flow of energy.

Service Life (years or cycles) - A general term that describes the length of time a battery can remain in service. Service life can be specified in terms of either time or duty cycles.

Service Plug - A high-voltage electrical disconnect device that is used when performing repairs on the high voltage hybrid/electric vehicle circuits.

Light Duty Hybrid/Electric Vehicle Specialist Test Sample Questions

NOTE: The ASE Light Duty Hybrid/Electric Certification Test Reference (pages 7-9 in this study guide) will be available to you as a pop-up document on the computer screen while you are taking the L3 test, but you should become familiar with it before that time. It may be helpful to review those pages before you attempt the following questions.

1. A hybrid vehicle equipped with push button start will enter the POWER ON (KOEO) mode, but will not enter the READY TO DRIVE (KOER) mode. No diagnostic trouble codes (DTCs) are stored. This could be caused by:

   (A) the high voltage safety plug is removed.
   (B) a failed brake on/off switch.
   (C) an empty fuel tank.
   (D) a disconnected 12 V battery.

Question #1 Explanation:

Answer (A) is wrong. If the high voltage (HV) safety plug was removed, the vehicle would enter the POWER ON (KOEO) mode, but would not enter the READY TO DRIVE (KOER) mode. However, with the safety plug removed, a DTC would be stored.

Answer (B) is correct. If the brake on/off weitch was failed, the vehicle would enter the POWER ON (KOEO) mode. However, a failed breake on/off switch would not allow the hybrid ECU to confirm that the brake pedal is applied, which is necessary for entering the READY TO DRIVE (KOER) mode. It is possible that the ECU may not yet have recognized the lack of a feedback signal from the failed switch so a DTC may not yet be stored.

Answer (C) is wrong. With an empty fuel tank, the vehicle would enter the POWER ON (KOEO) mode and the READY TO DRIVE (KOER) modes as long as the high voltage battery maintains a sufficient state-of-charge. However, the internal combustion engine (ICE) would crank, but would not start due to the lack of fuel in the tank. This condition would set a DTC because the ICE did not start.

Answer (D) is wrong. A disconnected 12 V battery would prevent the vehicle from entering any operational power mode since the hybrid ECU would not power up.

2. A hybrid vehicle equipped with a separate pump driven inverter cooling system has a diagnostic trouble code (DTC) for inverter overheating. The coolant is at the “full” level in the inverter coolant reservoir tank.

   Technician A says that a failed inverter coolant pump could be the cause.

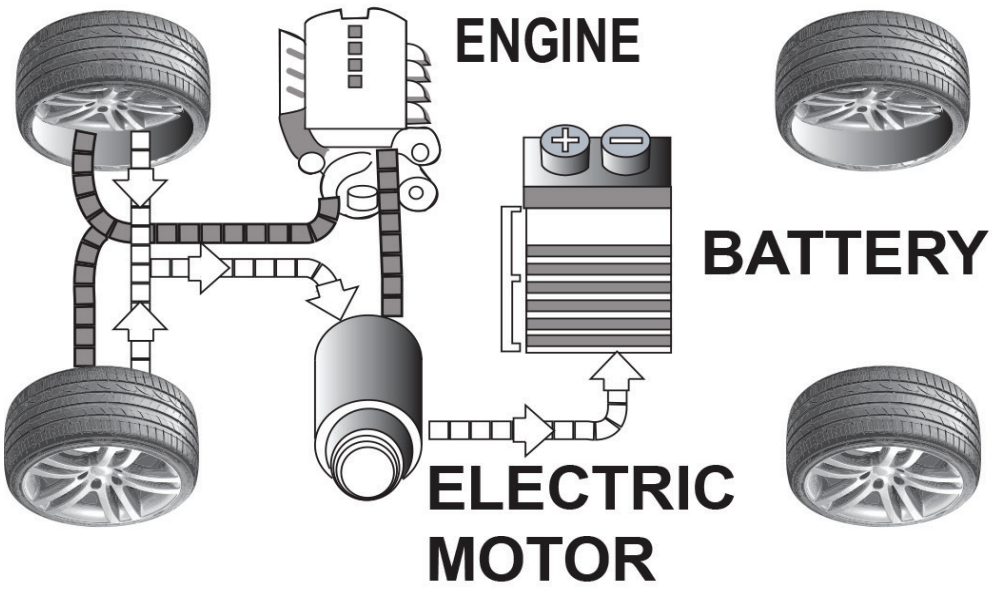
   Technician B says that insufficient coolant in the internal combustion engine (ICE) cooling system could be the cause.

   Who is right?

   (A) A only
   (B) B only
   (C) Both A and B
   (D) Neither A nor B

3. A Type-1 hybrid vehicle will enter READY TO DRIVE (KOER) mode but will not crank the internal combusion engine (ICE). When the vehicle is pushed in NEUTRAL gear range, the engine spins. Which of these could be the cause?

(A) A depleted high voltage battery
(B) A seized MG2
(C) A failed crankshaft position sensor
(D) A seized planetary gear set



4. During deceleration, the arrows on the power flow display appear as shown. This indicates:

(A) the engine is running with energy flowing to the drive wheels.
(B) the engine is running and driving the motor/generator to recharge the battery pack.
(C) energy from the battery pack and the engine are blended and flowing to the drive wheels.
(D) energy from the drive wheels is being used to recharge the battery pack.

5. A Type-2 hybrid vehicle with a belt-type continuously variable transmission (CVT) bucks and jerks when accelerating from a stop.

Technician A says that using the wrong type of transmission fluid could be the cause.

Technician B says that a failing split pulley/steel belt could be the cause.

Who is right?

A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B

6. The MIL is illuminated and a “Battery Module Deterioration” diagnostic trouble code (DTC) is stored. The cause could be a failed:

   (A) high voltage battery.
   (B) high voltage inverter.
   (C) motor/generator.
   (D) DC/DC converter.

Answer Key: 1.**B** 2.**A** 3.**D** 4.**D** 5.**C** 6.**A**

Light Duty Hybrid/Electric Vehicle Specialist Test Industry Training

The training sources listed in this guide are designed to help you sharpen your technical skills in hybrid/electric vehicle diagnostics. Since the L3 test reflects these skills - the more you learn, the better your chances are of passing this test.

Please contact the listed organizations for availability, schedules, and prices. In addition, many new sources of training in this area are being developed. You may wish to check with auto manufacturers, community colleges, tool and equipment suppliers, and technical training organizations for the latest training information. Training resources can also be found on ASE's home page at www.ase.com, the International Automotive Technicians Network (iATN) at www.iatn.net, or the Diagnostics Network at www.diag.net.

ACDelco offers training in a variety of delivery methods to ensure the maximum learning benefit for the service professional. In addition to traditional instructor-led technical training courses and seminars, a wide selection of online courses are also available. For more information about all training offerings, visit www.acdelco.com/for-professionals/training or call ACDelco at (800) 825-5886.

Automotive Technician Training Services offers seminars, webinars, and self-study training courses all designed to help technicians stay in touch with the latest diagnostic and repair procedures. Instructor-led/hands-on training is also offered for hybrid vehicle diagnosis. Technician-trainers deliver the instructor-led seminars and webinars. Self-study materials deliver information that will both teach, and enhance diagnostic skills. ATTS Training Center, 10 Lupi Plaza, Mahopac, NY 10541 Call:(845) 628-1062. Internet: www.attstraining.com

Auto Career Development Center (ACDC) offers training classes, seminars, webinars, DVDs and manuals covering all aspects of hybrid and electric vehicle diagnosis and repair. Instructor-led training classes are a comprehensive mix of classroom education followed up by hands-on application in the shop working on hybrid/electric vehicles. All material covers the most popular hybrid/electric vehicles found in production today. For more information, call 800-939-7909. Internet: www.fixhybrid.com.

AVI OnDemand offers several different video training programs covering hybrid vehicle diagnosis and repair. These include HVAC systems, case studies, and safety for first responders. For more information, call: (800) 718-7246. Internet: www.aviondemand.com

CARQUEST The Training and Certification System (TACS) provides a full scope of training solutions. This includes the ability to setup a career path for instructor-led training, online training, ASE Test Prep Study Guides, Technical Assessments, and more. Visit their website for more information. Internet: www.ctionline.com

Cengage Learning provides training textbooks and online, interactive courseware covering many areas of automotive repair, including hybrid/electric vehicles. The online interactive computer program is called Technician Test Preparation (TTP). TTP is designed to help prepare technicians for the ASE tests. For a free catalog, write: Cengage Learning, P.O. Box 8007, Clifton Park, NY 12065, or call (800) 347-7707. Internet: www.trainingbay.cengage.com.

Delphi Product and Service Solutions offers technical training materials and classes with real world applications to today's vehicles. All content has been developed by drawing on experience from working with many different vehicle manufacturers. Training products include textbook and CD-ROM formats, including hybrid/electric vehicles. Instructor led training classes covering a wide range of topics are also available. An overview of all training products and services is available on the website. Phone: (877) 550-TECH Internet:www.delphiautoparts.com/toolbox

Motor Age Training for ASE Certification is a self-study training guide that is updated regularly and contains both technical information and sample questions. For ordering information, write: Motor Age Training, P.O. Box 6310, Duluth, MN 55806.Phone: (800) 240-1968; Web:www.PassTheASE.com

NAPA Auto Parts is an ASE Accredited Training Provider offering a broad spectrum of automobile and light/medium duty vehicle training options. These include ASE test preparation classes, assessments, e-learning and instructor-led training. NAPA Autotech provides quality real world / problem solving technical training solutions for today's technicians that include leading technologies and the latest repair techniques. Regularly scheduled classes are offered nationwide as well as custom training solutions. For more information about training offerings, visit www.NAPAAutotech.com or call (800) 292-6428.

Perfect Sky conducts hands-on workshops for technicians who want to learn how to diagnose and repair hybrid, plug-in hybrid, and electric vehicles. Workshop size is restricted to a maximum of twelve students. For more information, call (310) 383-4800.

Standard Motor Products, Inc. offers professional technician seminars that focus on real-world problems and solutions, not just theory. Engage in actual diagnosis using case studies in the shop to apply what you've learned. An ASE-Certified professional instructor conducts the four-hour seminars during the evening, with a heavy emphasis on diagnostics and troubleshooting. Each seminar includes a workbook for your reference after the class. SMP also offers live, as well as a number of archived, one-hour long webinars. These can be viewed anywhere an internet connection is available, including at home. Internet: http://pts.smpcorp.com

VEEJER Enterprises offers training in automotive electrical diagnosis and repair and vehicle electronics troubleshooting. Training programs are designed to teach step-by-step methods used for performing electrical repairs, as well as the skills necessary for troubleshooting electrical and electronic problems in both low voltage and high voltage (HV) systems. Training programs cover the use of a DMM, current clamp, digital logic probe, scope meter, and dual-trace lab scope when testing and diagnosing electrical and electronic circuits. Training is offered through home-study programs, as well as hands-on instructor led electrical/electronics trouble-shooting training workshops. For more information, contact: Veejer Enterprises, 3701 Lariat Lane, Garland, TX 75042-5419, or call (972) 276-9642. Internet: www.veejer.com.

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