

PRACTICE EXAM 23: ASE L3 SIMULATION (45 Questions)

Time Limit: 2 hours | Passing target: 80% or higher on simulation practice

1. A hybrid vehicle's HV battery using lithium iron phosphate (LFP) chemistry differs from NMC (nickel manganese cobalt) chemistry in that LFP:

- A. Has higher energy density and is the lightest lithium-ion chemistry available for hybrid applications
- B. Provides excellent thermal stability and a longer cycle life, but with somewhat lower energy density
- C. Uses pure cobalt cathode material and requires special cooling systems for safe operation in vehicles
- D. Cannot be used in hybrid vehicles because of its incompatibility with most battery management systems

2. The Atkinson cycle engine commonly used in hybrid vehicles differs from a conventional Otto cycle engine in that the Atkinson:

- A. Uses turbocharging to provide higher peak power output from a smaller engine displacement value
- B. Operates exclusively on diesel fuel rather than gasoline for improved efficiency at light loads
- C. Includes a separate combustion chamber for each cylinder powered by direct injection of fuel
- D. Has a different compression-to-expansion ratio, sacrificing low-end torque for thermodynamic efficiency

3. A permanent magnet synchronous motor (PMSM) used in hybrid drive systems:

- A. Uses high-strength permanent magnets on the rotor and electromagnets in the stator windings
- B. Uses electromagnets on both the rotor and the stator to create rotating magnetic fields together

- C. Operates only on direct current with mechanical commutators and brushes for rotor switching
- D. Uses no magnets and relies entirely on induction effects between rotor and stator components

4. The "B" mode (sometimes labeled "L" or paddle-controlled) on a hybrid transmission selector:

- A. Locks the engine to the wheels for maximum engine braking similar to a conventional manual transmission
- B. Disables regenerative braking to reduce battery wear during downhill driving on steep mountain grades
- C. Increases regenerative braking force for stronger deceleration during downhill driving or coasting
- D. Activates a separate hydraulic brake circuit specifically designed for low-speed urban driving conditions

5. Stray voltage on a hybrid vehicle's chassis can be detected by:

- A. Disconnecting the 12-volt battery and measuring resistance across the chassis ground connection points
- B. Using a refrigerant leak detector to find areas where the HV system may be leaking current to ground
- C. Measuring voltage between the chassis and a known ground reference with a high-impedance meter
- D. Inspecting the orange HV cables visually for any signs of arcing or discoloration along their length

6. The metal shielding around hybrid HV cables is connected to:

- A. Chassis ground at one or both ends of the cable assembly to drain EMI and fault currents to ground
- B. The HV positive bus to provide a return current path during normal vehicle operation modes always
- C. The 12-volt battery negative terminal exclusively to combine the LV and HV ground systems together
- D. Each cell module in the HV battery pack through individual sensing wires for voltage monitoring

7. Before removing the engine's accessory belt on a hybrid vehicle for engine service, the technician should:

- A. Remove the HV battery pack to ensure the belt can be accessed without any HV interference during work
- B. Disconnect both the 12-volt battery and the HV service plug as a precaution during belt service work
- C. Drain the engine coolant completely to prevent any spillage during the belt removal procedure work
- D. Verify the HV system is in OFF mode (not Ready) and follow the OEM-published belt service procedure

8. Once thermal runaway begins in a single cell of a hybrid HV battery pack, propagation to adjacent cells can be slowed by:

- A. Increasing the cooling fan speed temporarily to draw additional ambient air across the cell modules
- B. Thermal barriers and mechanical separators designed into the pack to limit heat transfer between cells
- C. The conductive copper bus bars that interconnect cells, which act as heat sinks during the event
- D. Discharging the pack completely through the inverter to remove all stored chemical energy quickly

9. Solid-state batteries currently being developed for hybrid and EV applications differ from current lithium-ion in that solid-state batteries:

- A. Use a liquid electrolyte that flows freely between the anode and cathode during charging cycles
- B. Operate at much lower temperatures and require external heating for proper charge acceptance
- C. Use a solid electrolyte rather than a liquid one, improving energy density and reducing fire risk
- D. Cannot be recharged after manufacture and must be replaced like primary batteries every five years

10. The CHAdeMO charging connector found on some hybrid and EV vehicles is:

- A. A DC fast charging connector developed in Japan, separate from the AC charging port on the vehicle
- B. An AC charging connector that uses a unique pin arrangement for European charging stations only
- C. A wireless charging connector that requires no physical connection between the vehicle and station
- D. A combined AC and DC connector that replaces the standard J1772 connector on Japanese hybrid models

11. The typical service interval for the inverter cooling loop coolant on a hybrid vehicle is:
- A. Every 3,000 miles, matching the conventional engine oil change interval for standard motor oils
 - B. Every 100,000 miles for all hybrid vehicles regardless of operating conditions or chemistry differences
 - C. Never; the inverter coolant is sealed for life and never requires replacement during the vehicle's life
 - D. OEM-specified, typically every 50,000 to 100,000 miles or specific time interval depending on the model
12. The BMW i3 (range-extended version) uses:
- A. A parallel hybrid configuration with the engine mechanically connected to the front drive wheels directly
 - B. A series hybrid configuration with a small range-extender engine that drives only a generator on the vehicle
 - C. A traditional belt-driven mild hybrid system with a single belt-starter-generator unit only on the engine
 - D. A fully mechanical CVT transmission with no electric drive motor for vehicle propulsion at all on board
13. A typical insulation resistance test on a hybrid HV system applies test voltage for:
- A. Several seconds only to avoid damaging the components under test during the insulation measurement
 - B. Continuously while the vehicle is being driven to monitor insulation health during normal operation
 - C. A specified duration (often 60 seconds or as published) to allow the reading to stabilize before recording
 - D. Several hours to provide the most accurate assessment of insulation breakdown over extended exposure
14. The main HV system fuse on a hybrid vehicle's battery pack typically has a current rating of:
- A. About 30 amps, similar to a typical 12-volt automotive accessory fuse rating used elsewhere on the vehicle

- B. Less than 10 amps because the HV system uses very small currents at high voltage during normal operation
- C. About 5 amps, sized to protect the 12-volt control circuit feeding the contactor coils inside the pack
- D. Several hundred amps, sized to handle normal HV current draw and clear under HV fault conditions

15. On a hybrid vehicle, the air bag crash sensor:

- A. Signals the hybrid control module to immediately open the main HV contactors during a collision event
- B. Has no effect on the HV system because the air bag and HV systems are completely independent on hybrids
- C. Triggers automatic refrigerant venting from the air-conditioning system to depressurize the HV cooling loop
- D. Activates the regenerative braking system at maximum strength to slow the vehicle during a collision

16. A plug-in hybrid vehicle's "all-electric range" refers to:

- A. The total distance the vehicle can travel on a single tank of fuel with the engine running continuously
- B. The distance the vehicle can travel on HV battery power alone before the engine must start to assist
- C. The distance the vehicle can be towed on a flatbed truck without damaging the HV battery components
- D. The maximum highway range under cruise control conditions with the climate control system disabled

17. A DC fast charging session for a plug-in hybrid that delivers 50 kW for 30 minutes provides approximately:

- A. 1.5 kWh of energy to the battery pack, suitable for adding only a few miles of driving range to the vehicle
- B. 50 kWh of energy regardless of the duration because the charging rate sets the total energy delivered
- C. 25 kWh of energy to the battery pack, calculated as 50 kW multiplied by 0.5 hours of charging time
- D. 1,500 kWh of energy, calculated as 50 kW times 30 minutes treated as a unit of time multiplied by power

18. Modern DC fast charging connectors include temperature sensors that:

- A. Monitor connector temperature during high-power charging to detect overheating and reduce current
- B. Measure ambient outdoor temperature to adjust the charging rate based on environmental conditions
- C. Detect refrigerant leaks in the vehicle's air-conditioning system that may be near the charging port
- D. Report the HV battery temperature directly through the charging cable for OEM-monitored diagnostics

19. The Hyundai/Kia P2 hybrid architecture places the electric motor:

- A. At the rear axle, driving the rear wheels independently from the front-wheel-drive engine system
- B. Inside each wheel hub, providing independent torque vectoring during normal vehicle operation modes
- C. Between the engine and a planetary gear set similar to the Toyota power-split design concept
- D. Between the engine and the transmission with an engine disconnect clutch for EV-only operation

20. The insulation on a typical hybrid HV cable is rated for:

- A. About 50 volts AC, since hybrid systems operate at relatively low voltages compared to industrial systems
- B. At least 600 volts AC or higher, well above the typical hybrid pack operating voltage to provide safety margin
- C. 12 volts DC, matching the auxiliary battery system voltage used throughout the rest of the vehicle wiring
- D. About 24 volts AC, sufficient for the typical motor-control three-phase wiring found in hybrid drive systems

21. Maximum workplace exposure limits to time-varying magnetic fields are established by:

- A. The automotive industry's voluntary safety guidelines, with no government enforcement of any limits
- B. The vehicle manufacturer alone, with each OEM setting different limits for service work on their vehicles

C. ICNIRP guidelines or equivalent national standards that limit exposure based on field frequency and strength

D. Local building codes that apply to commercial structures but not to vehicle service environments at all

22. A heat pump cabin heater on a hybrid vehicle is more efficient than a resistive heater because the heat pump:

A. Generates heat through chemical combustion of small amounts of fuel during cold weather operation

B. Operates at lower current draw because the resistive heater requires less power to produce heat

C. Stores heat from the engine in a high-pressure container for use during EV-only operation phases only

D. Transfers heat from ambient air using refrigerant, moving more heat energy than electrical energy used

23. The HV current sensor on a hybrid battery pack typically uses:

A. A Hall-effect sensor that measures the magnetic field around a conductor to determine current flow

B. A shunt resistor that directly measures voltage drop across the conductor for very accurate readings

C. A thermocouple that measures temperature rise in a known resistor to calculate the current value

D. A capacitive coupling sensor that detects charge accumulation on plates near the current conductor

24. Most hybrid vehicle inverter cooling loops use:

A. A mechanical pump driven by the engine's accessory belt similar to a conventional water pump design

B. An electric pump powered by the 12-volt system that operates independently of engine operation cycles

C. A thermosiphon pump that uses temperature differences to create flow without any electrical input

D. A hydraulic pump driven by the transmission output shaft during all driving conditions on the road

25. A code indicating "Inverter DC Bus Capacitor Voltage Below Threshold" most likely indicates:

- A. The HV battery pack has reached end-of-life and requires immediate replacement before further operation
- B. A failed coolant temperature sensor reporting cold readings during the engine warm-up cycle at startup
- C. A discharged or shorted DC link capacitor, an open pre-charge resistor, or a wiring fault to the inverter
- D. The 12-volt auxiliary battery has dropped below the minimum voltage for hybrid system operation modes

26. A vehicle manufacturer's Emergency Response Guide (ERG) provides:

- A. Information on safe disabling procedures, cut zones, and HV identification for first responders during emergencies
- B. Detailed customer service information about routine maintenance intervals for vehicle owners during normal use
- C. Pricing information for replacement parts and labor estimates for collision repair at authorized dealerships
- D. Federal regulations on vehicle emissions standards that apply to all hybrid vehicles sold in the United States

27. A "full" hybrid vehicle that cannot be plugged in typically has an HV battery sized for:

- A. Driving distances of 50-100 miles on electric power alone before the engine starts to provide assist
- B. Storing weeks of energy from regenerative braking events to use during long-distance highway driving
- C. Replacing the engine entirely during city driving at speeds below 25 miles per hour for extended periods
- D. Short-duration electric operation and energy capture from regen, with the engine providing the primary power

28. Hybrid vehicle wheel and tire assemblies are sometimes:

- A. Heavier than conventional vehicles to provide additional inertia for smoother engine auto-stop transitions

- B. Made of magnesium alloy exclusively to reduce weight at the cost of significantly higher manufacturing cost
- C. Lighter and aerodynamically optimized to reduce rolling resistance and improve overall fuel economy of the vehicle
- D. Identical to conventional vehicles since wheel design does not affect any hybrid efficiency metrics during driving

29. Hybrid vehicles with electric A/C compressors typically use:

- A. Significantly more refrigerant than conventional vehicles because the electric compressor displaces more refrigerant
- B. Refrigerant capacities similar to conventional vehicles, with the exact amount specified by the OEM service info
- C. No refrigerant at all because the hybrid HVAC system uses electric resistive heating and cooling elements only
- D. Industrial-grade refrigerant available only through specialized commercial refrigeration suppliers and contractors

30. The three phases of AC output from a hybrid inverter to the drive motor are timed:

- A. 120 degrees apart from each other so that the three windings produce a smooth rotating magnetic field
- B. 180 degrees apart from each other so that the windings cancel each other during normal operation cycles
- C. 90 degrees apart from each other to match the quarter-wave pattern of typical electrical generation cycles
- D. In phase with each other to provide maximum combined current to the motor windings at all times during operation

31. A hybrid vehicle has set multiple DTCs during a single ignition cycle. The technician should:

- A. Replace the most expensive component first because the highest-cost item is most likely to be the cause
- B. Clear the codes immediately and release the vehicle to see if any of them return during normal operation

C. Address the codes in the order specified by the OEM diagnostic procedure to avoid chasing secondary symptoms

D. Disconnect the 12-volt battery for 30 minutes to reset the system before performing any further diagnostic work

32. A typical hybrid inverter switches its IGBTs at a frequency in the range of:

A. 50-60 Hz, matching the standard line frequency used in household electrical outlets in North America

B. 1-2 Hz, providing very slow switching that allows the motor to respond gradually to torque commands

C. 1-2 GHz, providing extremely fast switching for precise motor control during high-speed operation cycles

D. Several kilohertz, typically between 5 and 20 kHz, balancing motor smoothness with switching losses

33. The audible whine sometimes heard from a hybrid inverter or motor during operation is caused by:

A. The internal combustion engine's exhaust resonating against the inverter housing during normal idle conditions

B. PWM switching of the IGBTs at audible frequencies, which the motor windings convert to physical vibrations

C. A failed inverter coolant pump that is unable to circulate fluid through the inverter cooling passages now

D. The HV battery cells expanding and contracting during charge and discharge cycles during normal driving

34. On some plug-in hybrids, the charging cable is automatically locked into the vehicle's charging port during a charging session because:

A. Theft prevention and safety considerations require the cable to be secured until the user releases it intentionally

B. The lock prevents the customer from interrupting the charging session even if they need to stop immediately

C. The OEM manufacturer charges a fee for unlocking the cable through a subscription service to customers

D. The cable cannot be removed under any circumstances after a charging session has been started by the user

35. Before any HV service work, the technician must confirm the HV system is disabled by:

A. Listening for the hybrid system's audible alert tone that signals when the HV system is energized fully

B. Reading the dashboard "Ready" indicator status and noting whether the light is illuminated or not visible

C. Using a CAT III rated meter to verify zero voltage at the HV bus or designated test points after de-energization

D. Touching the orange HV cable to feel for any electrical sensation that would indicate the system is energized

36. The "formation" cycle on a new lithium-ion hybrid battery cell refers to:

A. The molding process used to shape the cell during manufacturing inside the OEM facility for production

B. The chemical reaction that creates the cathode and anode materials during the initial cell production phase

C. The mechanical assembly of cell components into the final cylindrical, prismatic, or pouch cell form factor

D. Initial charge and discharge cycles performed at the factory to stabilize the solid electrolyte interface layer

37. Subaru's plug-in hybrid system uses:

A. A modified version of the Toyota Hybrid Synergy Drive adapted for all-wheel drive operation with a Boxer engine

B. A series hybrid configuration with no mechanical engine-to-wheel connection in any operating mode at all

C. A fuel cell electric drivetrain that uses hydrogen as fuel and produces only water as exhaust emissions output

D. A pure mild hybrid system with a single belt-starter-generator unit and no EV-only capability whatsoever

38. A hybrid vehicle's multiple coolant reservoirs should be:

A. Checked only when the engine is fully warmed up and the radiator cap is hot to the touch on the engine loop

B. Inspected at OEM-specified intervals, with the vehicle cold and parked on a level surface for accurate readings

C. Combined into a single sample for analysis during each service visit to evaluate all loops at once together

D. Topped off with the same coolant from a single container regardless of which loop is being serviced at the time

39. A hybrid HV battery pack in long-term storage will gradually:

A. Increase its state of charge spontaneously due to chemical reactions inside the cells during inactivity

B. Maintain its state of charge indefinitely without any change in cell condition over months of storage

C. Develop internal short circuits that require external charging to clear before the pack can be returned to use

D. Self-discharge slowly, requiring periodic monitoring and potentially recharging per OEM storage guidelines

40. An induction motor used in some hybrid and EV drivetrains differs from a permanent magnet synchronous motor (PMSM) in that the induction motor:

A. Uses permanent magnets in the rotor for stronger magnetic flux during normal motor operation cycles

B. Cannot produce torque at zero RPM because it requires rotation to generate field current in the rotor

C. Induces current in the rotor through electromagnetic induction, eliminating the need for permanent magnets

D. Requires a separate excitation system with a small auxiliary battery to power the rotor field windings

41. The Mercedes plug-in hybrid (PHEV) system typically uses:

A. A series hybrid configuration in which the engine and the drive motor are never mechanically connected

B. A P2 architecture with a single motor between the engine and an automatic transmission with engine clutch

C. A power-split planetary system identical to the Toyota Hybrid Synergy Drive used in the Prius and others

D. A wheel hub motor at each corner driven by individual inverters and a centralized HV battery pack on board

42. A plug-in hybrid (PHEV) differs from a battery electric vehicle (BEV) in that the PHEV:

A. Has both a smaller HV battery and an internal combustion engine for extended driving range capability

B. Uses only AC charging exclusively, while BEVs use only DC fast charging from commercial stations always

C. Cannot use any of the same charging connectors as a BEV due to incompatible connector standards entirely

D. Requires manual switching between engine and electric mode by the driver during every change in operation

43. A megohmmeter (insulation resistance tester) used on hybrid HV systems typically applies a test voltage of:

A. 12 volts DC matching the auxiliary battery system voltage used throughout the rest of the vehicle wiring

B. 24 volts AC similar to the voltage used for telephone systems and other low-voltage signaling circuits

C. 100 volts AC matching the residential line voltage in some countries outside of North America for testing

D. 500 volts DC or higher, applied for a specified duration to test insulation breakdown of HV components

44. Hybrid and EV vehicles often qualify for:

- A. Exemption from all routine state emissions testing programs in every US state without exception requirements
- B. Free unlimited registration renewal for the life of the vehicle in all 50 US states and federal territories
- C. Various federal, state, or local tax incentives and HOV lane access depending on jurisdiction and program rules
- D. Mandatory specialized vehicle insurance coverage that costs significantly more than conventional vehicle insurance

45. The communication between a J1772-equipped plug-in hybrid and its EVSE uses:

- A. A control pilot signal (CP) with a pulse-width modulated waveform that negotiates current capacity between them
- B. A continuous DC voltage on the proximity pilot pin to signal the charging session start and stop conditions
- C. A wireless Bluetooth connection between the EVSE and the vehicle's infotainment system during charging sessions
- D. Direct CAN bus communication through the charging cable that exchanges full vehicle diagnostic data between them

ANSWER KEY – PRACTICE EXAM 23 (Q1-Q45)

1. B — LFP (lithium iron phosphate) chemistry provides excellent thermal stability and significantly longer cycle life than NMC, but at the cost of somewhat lower energy density per kilogram. The trade-off is durability and safety versus range. LFP is increasingly chosen for hybrids where the smaller pack benefits from longer life and lower fire risk over the vehicle's lifetime.

2. D — The Atkinson cycle uses a different compression-to-expansion ratio (intake valve held open part way through the compression stroke) to extract more work from the expansion stroke, raising thermal efficiency at the cost of low-end torque and peak power. Hybrids can tolerate the soft low-end because the electric motor fills in torque. This is why so many full-hybrid engines use Atkinson cycle timing.

- 3. A** — A permanent magnet synchronous motor (PMSM) places high-strength permanent magnets on the rotor while the stator carries the three-phase electromagnetic windings driven by the inverter. The rotating stator field pulls the magnet-bearing rotor with it in synchronous rotation. This design is compact, efficient, and the standard hybrid traction motor type.
- 4. C** — B (or L) mode on a hybrid increases regenerative braking force so the vehicle decelerates more strongly when the accelerator is released, providing engine-brake-like behavior during downhill driving and recovering more energy. It does not change the friction brake hydraulic circuit. Drivers use B mode on long descents to limit friction brake wear and capture energy.
- 5. C** — Stray voltage is detected by measuring voltage between the chassis and a known ground reference using a high-impedance digital meter. Any reading above background indicates leakage from an HV conductor or a damaged isolation barrier. The high-impedance meter avoids loading the circuit and giving a falsely low reading.
- 6. A** — The metal shielding around an HV cable is bonded to chassis ground at one or both ends so it can drain electromagnetic interference from inverter switching currents and conduct fault current to ground for the isolation monitor. It is not part of the HV positive path or the cell sensing system. A broken shield ground sets HV EMI and isolation codes.
- 7. D** — Before any belt service on a hybrid, the technician verifies the HV system is in OFF mode (not Ready) and follows the OEM-published procedure for the specific belt and accessories involved. Removing the HV pack or service plug is not required for a belt change, and draining coolant has nothing to do with belt access. Verification of OFF mode prevents an auto-start during service.
- 8. B** — Once a single cell enters thermal runaway, propagation to adjacent cells is slowed by thermal barriers and mechanical separators designed into the pack — phase-change materials, intumescent coatings, ceramic insulators, and physical spacing all play this role. Bus bars actually conduct heat between cells and can speed propagation. Pack-level design features are the key safety mitigation.
- 9. C** — Solid-state batteries replace the liquid electrolyte with a solid ionic conductor, allowing higher energy density, eliminating the flammable liquid that drives lithium-ion fire risk, and tolerating wider temperature ranges. They are not yet mainstream in production hybrids but are under active development. Servicing them will follow many of the same HV safety principles as current packs.
- 10. A** — CHAdeMO is a DC fast charging connector developed in Japan, used on a separate vehicle port from any AC charging connector. It allows the off-board station to deliver high-power DC straight to the HV battery while bypassing the onboard charger. Technicians may see CHAdeMO ports on Japanese-market hybrids and EVs.
- 11. D** — Inverter coolant service intervals are OEM-specified and vary by model — commonly in the range of 50,000 to 100,000 miles or a specific calendar interval — and must be followed exactly. Skipping the change risks degraded heat transfer and rising electrical conductivity. The service info specifies the fluid, capacity, and procedure.

12. B — The BMW i3 with range extender is a series hybrid: a small two-cylinder gasoline engine drives a generator to recharge the HV battery or feed the inverter, but the engine has no mechanical link to the drive wheels. The electric drive motor handles all wheel torque at all times. Recognizing the architecture is essential to diagnosing power-flow and charge concerns.

13. C — A standard insulation resistance test applies the test voltage for a specified duration (often 60 seconds, or as published by the OEM) so that the reading stabilizes after the initial charging current decays. Recording the value before stabilization gives a falsely low reading. The procedure is part of every HV insulation verification step.

14. D — The main HV system fuse inside the battery pack carries the full pack current under normal operation and clears the circuit during a serious HV fault, so it is rated for several hundred amps. This is far above the 12-volt fuses elsewhere on the vehicle. Replacing this fuse requires the OEM-specified part and full HV de-energization procedures.

15. A — In a collision, the air bag (SRS) controller's crash signal is shared with the hybrid control module, which immediately commands the main HV contactors open to isolate the pack. This crash-triggered HV shutdown is part of the vehicle's collision safety design. SRS and HV systems work together even though they are otherwise independent.

16. B — All-electric range (AER) on a plug-in hybrid is the distance the vehicle can travel on HV battery energy alone before the engine starts to provide assist or charge. After AER is exhausted, the vehicle continues to operate as a conventional hybrid using gasoline. AER is a key marketing and regulatory specification for PHEVs.

17. C — Energy delivered equals power times time: $50 \text{ kW} \times 0.5 \text{ hour} = 25 \text{ kWh}$. The kilowatt-hour relationship is fundamental to interpreting charging speed and battery capacity. Misapplying the calculation produces wildly wrong answers (1,500 kWh, 50 kWh) that should be rejected on a sanity check.

18. A — DC fast charging connectors include temperature sensors that monitor connector and pin temperature during high-power charging; if temperature rises above threshold, the station automatically reduces current to prevent damage to the connector or vehicle inlet. Connector overheating is a common limiter during long fast-charge sessions. Damaged or contaminated pins make this protection trigger more aggressively.

19. D — The Hyundai/Kia P2 hybrid architecture places a single electric motor between the engine and the transmission, with an engine disconnect clutch that allows the motor to drive the wheels independently during EV-only operation. The motor is not at the rear axle, in the wheels, or in a planetary set. Knowing the architecture guides diagnosis of clutch and motor concerns.

20. B — Orange HV cable insulation is rated for at least 600 V AC or higher — well above the typical 200–650 V DC operating voltage of hybrid packs — to provide a safety margin under transient conditions. Lower-voltage ratings would not be safe. The voltage rating, conductor size, shielding, and connectors all combine to meet the cable's HV duty.

21. C — Workplace exposure to time-varying magnetic fields is governed by ICNIRP guidelines (or equivalent national standards such as IEEE C95) that set limits as a function of field frequency and strength. These provide the technical basis for shop policy on HV proximity, especially for technicians with implanted medical devices. Compliance is part of occupational health programs.

22. D — A heat pump transfers heat from ambient air using a refrigerant cycle, delivering more heat energy into the cabin than the electrical energy it consumes (coefficient of performance greater than 1). Resistive heaters can only deliver one watt of heat for each watt of electricity. The efficiency advantage is significant in moderate cold weather and extends EV-only range.

23. A — HV current sensors on hybrid packs are typically Hall-effect devices that sense the magnetic field around the current-carrying conductor without breaking the circuit, producing an analog signal proportional to current. Shunt resistors generate too much heat at the currents involved, and the other listed methods are not used in this application. Hall-effect sensors are reliable and compact.

24. B — Hybrid inverter cooling loops use an electric pump powered from the 12-volt system, which lets the pump run whenever needed regardless of engine state — including key-off cool-down after high-load driving. Belt-driven, thermosiphon, and hydraulic pumps would not match those requirements. A failed electric pump is a common cause of inverter overtemperature codes.

25. C — A "DC bus capacitor voltage below threshold" code points to a discharged or shorted DC link capacitor, an open pre-charge resistor, or a wiring fault between the battery and the inverter — anything preventing the bus from charging to expected voltage. The cause is electrical, not battery end-of-life or 12-volt-related. Diagnosis works back from the bus through the pre-charge circuit.

26. A — A manufacturer's Emergency Response Guide (ERG) gives first responders the safe disabling procedures, designated cut zones, HV component locations, and HV cable identification for the specific vehicle. It is not a customer service publication or a pricing document. ERGs are typically available free through the OEM and the National Fire Protection Association.

27. D — A non-plug-in full hybrid uses a relatively small HV battery sized for short-duration electric operation and to capture energy from regenerative braking; the engine remains the primary source of energy. EV-only range is typically a mile or less, not tens of miles. Recognizing the role of the pack guides realistic customer expectations.

28. C — Hybrid wheels and tires are commonly lighter and aerodynamically optimized, and the tires are low-rolling-resistance, all aimed at preserving the fuel-economy advantage of the hybrid drivetrain. Heavier wheels would increase rotational inertia and degrade economy. Replacing them with heavier non-hybrid wheels measurably reduces fuel economy.

29. B — Electric A/C compressors use refrigerant capacities similar to conventional vehicles, with the exact amount specified in the OEM service information for each application. Overcharge causes high-side pressure issues; undercharge reduces cooling and compressor life. EPA Section 609 procedures for refrigerant handling still apply.

30. A — The three phases of a hybrid inverter output are offset by 120 degrees from one another, which causes the three stator windings to produce a smooth rotating magnetic field that pulls the rotor with it. This is the defining feature of three-phase AC motor operation. Loss of phase symmetry produces torque ripple and overheating.

31. C — When multiple DTCs appear in one ignition cycle, the technician addresses them in the order specified by the OEM diagnostic procedure, because some codes are root causes and others are downstream symptoms set by the same fault. Chasing symptom codes first wastes time and may replace parts unnecessarily. The diagnostic flow is engineered to lead to the root cause.

32. D — Modern hybrid inverters typically switch their IGBTs at several kilohertz, generally between 5 and 20 kHz, balancing motor smoothness (higher frequency reduces torque ripple) with switching losses (higher frequency wastes more energy in the IGBTs). Audible whine is sometimes produced when the switching frequency is in the audible band. Switching frequency is a design choice managed by the inverter firmware.

33. B — The audible whine sometimes heard from a hybrid drivetrain comes from PWM switching of the IGBTs at frequencies in the human hearing range, exciting the motor windings and the stator core into mechanical vibration. It is a normal characteristic of inverter-driven motors. The whine is not a fault unless its character changes substantially.

34. A — Plug-in hybrid charging cables lock into the vehicle's port during a session to prevent theft of the cable and to prevent disconnection under load, which would create a small arc and damage the connector. The customer can release the lock through the vehicle interface or key fob when the session ends. The lock does not prevent emergency stopping of the session itself.

35. C — Confirming HV de-energization requires verifying zero voltage at the HV bus or designated test points with a CAT III rated meter after following the OEM disable procedure. Audible signals, dashboard indicators, and physical touch are not reliable safety verifications. Meter verification is the only acceptable final step before exposing oneself to HV components.

36. D — The formation cycle of a new lithium-ion cell consists of carefully controlled initial charge and discharge cycles performed at the factory to build a stable solid-electrolyte interphase (SEI) layer on the electrode surfaces. This layer affects cell performance and life for the rest of the cell's service. Improperly formed cells have shorter life and inconsistent behavior.

37. A — Subaru's plug-in hybrid Crosstrek uses a Toyota Hybrid Synergy Drive variant adapted for Subaru's symmetrical all-wheel drive layout with the Boxer engine. This is the result of the Toyota-Subaru technical partnership. Recognizing the architecture lets the technician apply Toyota HSD diagnostic logic to the Subaru implementation.

38. B — Hybrid coolant reservoirs are inspected at OEM-specified intervals, with the vehicle cold and parked on a level surface so the level readings are accurate and uninfluenced by thermal expansion. Hot inspection causes scalding and inaccurate readings; combining samples or sharing coolant types creates contamination. Each loop has its own specified coolant and procedure.

39. D — A stored HV battery pack slowly self-discharges through internal chemical reactions, so OEM storage guidelines specify periodic monitoring and topping-off charging to keep the cells within safe SOC limits. Letting a stored pack run flat damages the cells and can void warranty. Cycling neglected packs occasionally is part of responsible storage.

40. C — An induction motor induces current in the rotor through electromagnetic induction from the rotating stator field, eliminating the need for permanent magnets in the rotor. This makes induction motors robust and free of rare-earth-magnet supply concerns, at the cost of slightly lower efficiency than a comparable PMSM. Many EV drivetrains use induction motors for these reasons.

41. B — The Mercedes-Benz plug-in hybrid system uses a P2 architecture with a single electric motor between the engine and a multi-speed automatic transmission, with an engine disconnect clutch that allows EV-only operation. It is not a series, power-split, or wheel-hub design. Recognizing P2 architecture guides clutch and motor diagnostic strategy.

42. A — A plug-in hybrid has both a smaller HV battery (compared to a BEV) and an internal combustion engine, giving it electric-only operation for short trips and extended range from gasoline for longer drives. A BEV has only the battery and electric drivetrain. The difference matters when sizing replacement parts and explaining drive modes to customers.

43. D — Megohmmeters used on hybrid HV systems typically apply 500 V DC or higher between the conductor and ground, held for a specified duration, to reveal insulation breakdown that does not appear at low voltages. Lower test voltages cannot stress the insulation enough to detect realistic faults. The exact voltage and duration are OEM-specified.

44. C — Hybrid and EV ownership often qualifies for federal, state, or local tax incentives, single-occupancy HOV lane access, parking benefits, and other programs that vary by jurisdiction. Mandatory specialized insurance and free unlimited registration are not standard. The technician can point customers to current local programs without making specific guarantees.

45. A — J1772 uses a control pilot (CP) signal — a pulse-width modulated 1 kHz square wave riding on a DC bias — to negotiate maximum allowed current capacity between the EVSE and the vehicle. The proximity pilot is a separate function for connector detection. Disturbances on the CP signal interrupt charging and set diagnostic codes.