# PRACTICE EXAM 13: ASE L3 SIMULATION (45 Questions)

1. A hybrid vehicle technician is referencing safety standards for electric vehicle service procedures. Which industry standard primarily addresses electric vehicle and hybrid vehicle safety requirements for the service technician working on these vehicles?

A. SAE J1772 standards for charging connector dimensions and pin assignments only on AC charging cords

B. SAE J2344 guidelines for electric vehicle and hybrid vehicle safety procedures during service operations

C. ASTM D120 standards covering rubber glove construction materials and dimensions for utility worker use

D. FMVSS 305 standards covering crashworthiness requirements of electric vehicle components in collisions

2. A lithium-ion HV battery pack is being inspected during routine service. Several cells in one module appear visibly enlarged or "swollen" compared to the adjacent cells in the same module. What does this cell swelling typically indicate about the affected cells?

A. Normal lithium-ion cell behavior during sustained high state-of-charge operation in hot summer ambient conditions

B. Overcooling of the cells causing internal electrolyte contraction and the resulting cell pouch deformation issues

C. Manufacturing variance that does not affect cell performance or safety significantly during normal vehicle operation

D. Internal gas generation from cell degradation creating a safety hazard that requires immediate cell replacement

3. A hybrid vehicle uses an AC induction motor rather than a permanent magnet motor in its drive system. What is one operational advantage of an induction motor over a permanent magnet motor in EV applications?

A. Induction motors produce higher peak torque than PM motors of equal physical size and weight in operation

B. Induction motors operate with higher efficiency at light load conditions compared to PM motor designs

C. Induction motors do not produce back-EMF at no-load conditions reducing high-speed drag losses

D. Induction motors require fewer power electronics components than PM motor designs to operate properly

4. A hybrid vehicle uses silicon carbide (SiC) MOSFETs rather than traditional IGBT transistors in its drive inverter. What is the primary technical advantage of SiC MOSFETs over IGBTs in this hybrid drive application?

A. SiC MOSFETs switch faster with lower losses providing higher overall conversion efficiency in inverter operation

B. SiC MOSFETs operate at lower temperatures than IGBTs and require simpler cooling systems for thermal management

C. SiC MOSFETs cost significantly less than IGBTs which reduces the inverter assembly manufacturing cost overall

D. SiC MOSFETs can handle higher peak current than IGBTs of comparable physical size and current rating directly

5. A hybrid vehicle's electric A/C compressor is being diagnosed for poor cooling performance. The technician finds the compressor running normally but the high-side pressure is only slightly above the low-side pressure. The refrigerant charge has been verified correct. What is the most likely cause?

A. The compressor is operating at full commanded speed but has external air leakage from system housing seals

B. The compressor has internal mechanical failure preventing proper refrigerant compression during normal operation

C. The expansion valve is stuck closed restricting all refrigerant flow through the system at the evaporator inlet

D. The condenser cooling fan motor has failed causing reduced heat rejection from the high-pressure side

6. A hybrid vehicle uses a 14.5V DC-DC converter that charges a 12V lithium-ion auxiliary battery rather than a conventional AGM battery. What is the most important consideration when servicing this lithium-ion auxiliary battery?

A. The lithium-ion auxiliary battery can be replaced with an AGM unit of equivalent amp-hour capacity safely

B. The lithium-ion battery requires a different charging voltage than the standard DC-DC converter outputs continuously

C. The lithium-ion battery has specific BMS communication requirements with the DC-DC converter and vehicle modules

D. The lithium-ion battery does not require any communication with vehicle systems during normal operation or charging

7. A NiMH hybrid battery pack shows a stable open-circuit voltage of 220V at rest after the vehicle has been parked overnight. The pack consists of 30 modules connected in series. What is the average open-circuit voltage per module in this pack at rest?

A. 5.5 volts per module which is below the normal voltage range for NiMH module open-circuit measurements

B. 6.7 volts per module which is within the typical NiMH module open-circuit voltage operating range for the pack

C. 7.0 volts per module which is at the high end of NiMH module open-circuit voltage during normal operation

D. 7.3 volts per module which is normal for NiMH modules at rest and ready for hybrid system operation

8. A hybrid drive motor exhibits a high-pitched whining noise that varies with motor rotational speed. The whine is most noticeable during electric-only acceleration at low road speeds. The motor produces correct torque output. What is the most likely cause of this whine?

A. PWM switching frequency from the inverter producing audible noise in the motor windings during operation

B. Worn motor bearings producing audible noise that varies directly with motor speed and load conditions

C. Loose stator laminations vibrating against each other during the motor magnetic field operation cycles

D. Failed cooling fan motor producing whine during electric-only acceleration at lower vehicle road speeds

9. A hybrid inverter is rated for continuous operation at 80 kW with peak operation at 120 kW allowed for short durations. What protection mechanism is most commonly used to prevent extended peak operation beyond the inverter's continuous rating?

A. Mechanical disengagement of the inverter from the drive motor through an internal clutching mechanism in the housing

B. Thermal protection that reduces inverter output when component temperatures exceed the specified safe thresholds for IGBTs

C. Voltage regulation that limits HV bus voltage during peak load operating periods to a maximum allowed level

D. Current limiting that prevents the inverter from delivering more than the continuous current rating ever during operation

10. A hybrid vehicle's electric A/C compressor is being replaced after a winding insulation failure. The refrigerant system was contaminated with metallic debris and oil carbonization byproducts from the failed compressor. What additional service is required beyond just the compressor replacement?

A. Replace only the receiver/drier and recharge the system with new refrigerant after a thorough evacuation procedure

B. Replace the expansion valve assembly and recharge the system without any further system cleaning steps needed

C. Flush all accessible refrigerant lines and replace the receiver/drier or accumulator unit to remove contamination

D. Replace the condenser coil assembly as the only required additional step after the new compressor installation

11. A hybrid vehicle's HV system has been properly de-energized for service. The technician needs to remove an inverter assembly from the engine compartment. What is the recommended technique for safely handling the inverter assembly during the removal procedure?

A. Use mechanical lifting equipment if the inverter exceeds the OSHA single-person lifting weight limit for shop service

B. Disconnect all HV connectors and pull the inverter straight up out of its mounting location using firm hand strength

C. Drain inverter coolant first, then disconnect all electrical connectors and lift the unit by hand to the workbench area

D. Remove all retaining bolts first, then disconnect electrical connectors during the lift event for efficient service workflow

12. A lithium-ion HV battery pack has a "Cell Voltage Limit Exceeded" DTC stored in the BMM. The scan tool data shows all cells reading between 3.85V and 4.15V. The vehicle was driven immediately before the technician retrieved the data. What does this data indicate?

A. The cells are all within the safe operating voltage range for lithium-ion battery chemistry in this hybrid pack

B. The battery management module has set an incorrect calibration during the drive cycle that should be ignored

C. The cells are imbalanced but still within acceptable operating limits for normal hybrid pack operation overall

D. One or more cells exceeded the maximum allowed voltage limit of 4.15V during the previous drive cycle event

13. A power-split hybrid uses a planetary gear set with the engine driving the planet carrier, MG1 connected to the sun gear, and MG2 connected to the ring gear. If MG1 is held stationary at zero RPM while the engine drives the carrier, what is the relationship between engine RPM and the ring gear RPM?

A. The ring gear rotates at exactly the same speed as the engine through direct mechanical coupling through the planet gears

B. The ring gear rotates at a higher speed than the engine determined by the planetary gear ratios in the design

C. The ring gear rotates in the opposite direction to the engine at a variable speed ratio depending on gear sizes

D. The ring gear remains stationary while only the engine and planet gears rotate through the planetary gear set

14. A hybrid vehicle's HV bus voltage is being measured at the inverter input during deceleration with regenerative braking active. The HV bus voltage rises from 320V to 360V momentarily during the regen event. What does this voltage rise across the HV bus indicate?

A. The HV bus voltage is being incorrectly measured due to capacitor charging effects in the inverter bus during regen

B. The regenerative braking system has failed and is feeding excessive voltage to the HV bus exceeding the design limits

C. The motor/generator is producing current that charges the HV battery and causes the bus voltage to rise during regen

D. The DC-DC converter is reducing its output causing the HV bus voltage to rise above the normal operating range

15. A hybrid vehicle's PTC electric cabin heater operates directly from the HV bus during cold-weather cabin heating events. The heater draws 5 kW at its full power setting. At an HV bus voltage of 360V, what is the current draw of this heater at full power?

A. 13.9 amperes of current draw from the HV bus during full PTC heater power operation in cold weather

B. 18.5 amperes of current draw from the HV bus during full PTC heater power operation in cold weather

C. 24.0 amperes of current draw from the HV bus during full PTC heater power operation in cold weather

D. 36.0 amperes of current draw from the HV bus during full PTC heater power operation in cold weather

16. A hybrid vehicle uses an electric vacuum pump to provide brake booster vacuum since the engine cycles off during operation. The pump is controlled by a vacuum switch that activates the pump when manifold vacuum drops below a threshold. If the vacuum switch fails in the open position, what is the most likely symptom?

A. The vacuum pump runs continuously even when sufficient vacuum is present in the brake booster during operation

B. The vacuum pump runs intermittently with poor brake assistance during heavy pedal pressure during stopping events

C. The vacuum pump operates normally but with reduced output capacity over time during continued driving operation

D. The vacuum pump does not run at all leading to a hard brake pedal during brake application by the driver

17. A hybrid vehicle's HV battery pack uses a contactor pre-charge circuit with a current-limiting resistor in series with a pre-charge contactor. The pre-charge resistor has failed open after extended use. What symptom is most likely to occur during attempted vehicle startup?

A. The vehicle will start normally because the pre-charge circuit is only used during fault events not during startup

B. The vehicle will start with reduced power because the main contactor will close in a limp-home operating mode

C. The vehicle will not enter READY mode because the inverter bus capacitors cannot pre-charge to operating voltage

D. The vehicle will start but the HV battery state of charge will deplete rapidly during driving from inefficient operation

18. A technician is reviewing scan tool data on a hybrid vehicle with a "P0AA6 Hybrid Battery Voltage System Isolation Fault" code stored. The isolation resistance measured by the BMM is 250 ohms per volt of system voltage. The OEM specification minimum is 500 ohms per volt. What does this measurement indicate?

A. The isolation is acceptable at twice the minimum specification level required for safe hybrid system operation

B. The isolation is below specification indicating an HV system leakage path that requires technician investigation

C. The isolation measurement is reported in incorrect units and should be ignored by the diagnosing technician

D. The isolation reading is normal during high humidity conditions and will improve in dry weather conditions

19. A hybrid drive motor has been replaced following an internal failure. After mechanical installation, the resolver-to-motor offset calibration procedure was not performed by the technician. What symptom is most likely to occur during initial vehicle operation?

A. The motor will not operate at all because the inverter cannot determine the motor type without offset calibration

B. The motor will operate normally because most modern inverters self-calibrate the resolver during normal operation

C. The motor will operate at maximum efficiency but with reduced peak torque output during heavy acceleration events

D. The motor may produce reduced torque, draw excessive current, or operate roughly during all driving conditions

20. A hybrid vehicle equipped with R-1234yf refrigerant requires A/C system service. The technician's refrigerant recovery equipment is rated only for R-134a refrigerant systems. What is the correct procedure for this service situation?

A. Use only R-1234yf-rated equipment because cross-use of refrigerant equipment can contaminate the recovery machines

B. Use the R-134a equipment after running it through a self-cleaning cycle to remove any residual R-134a from inside

C. Use R-134a equipment for system evacuation only but not for refrigerant recovery operations during the service

D. Mix R-134a and R-1234yf is permitted if the customer accepts reduced cooling performance after the service

21. A hybrid vehicle's HV battery has been depleted to 0% state of charge during long-term vehicle storage. The technician attempts to recover the pack by trickle charging at a low current rate. What concern exists with this recovery attempt for a lithium-ion battery?

A. Lithium-ion batteries can never be recovered after reaching 0% state of charge under any circumstances during service

B. Trickle charging takes too long to be practical for hybrid vehicle service warranty considerations during the recovery

C. Deep discharge of lithium-ion batteries can cause copper dissolution creating permanent damage risk to the cells

D. The HV battery management module will not accept any recovery charging input under any circumstances during service

22. A Toyota Prius MG2 uses a permanent magnet AC synchronous motor design for vehicle propulsion. During motor operation, what mechanism produces torque in this type of electric motor?

A. Eddy currents induced in a squirrel-cage rotor by the rotating stator magnetic field interaction during normal motor operation

B. Interaction between the rotor permanent magnet field and the stator-controlled rotating magnetic field during operation

C. Mechanical coupling between rotor brushes and a commutator delivering current to the rotor windings during motor operation

D. Mechanical contact between the rotor's spinning commutator and the stator's wound poles during normal motor operation

23. A hybrid vehicle uses an integrated DC-DC converter and inverter assembly housed in a single combined unit. The DC-DC converter portion outputs 14.0V to the 12V system. If the DC-DC converter section fails completely, what is the most likely effect on the inverter section in the same combined assembly?

A. The inverter will continue to operate normally because the two sections share no critical components in the combined unit

B. The inverter will overheat because the failed DC-DC section creates additional heat in the shared assembly housing

C. The inverter will fail simultaneously because both sections share the same internal control circuitry and power supply

D. The inverter may continue to operate but the 12V auxiliary battery will not be charged during vehicle operation

24. A hybrid vehicle's brake-by-wire system uses a hydraulic accumulator for pressure storage during regenerative braking events. The accumulator is precharged with nitrogen gas at the factory. During service, the technician finds the accumulator precharge pressure is significantly below specification. What is the most likely effect on system operation?

A. Reduced brake response and possible pedal feedback issues during normal vehicle braking and operation by the driver

B. Complete loss of all braking capability requiring immediate vehicle service intervention to restore safe stopping function

C. Increased regenerative braking force to compensate for the reduced friction brake hydraulic pressure capability available

D. No effect on brake operation because the accumulator is only used in emergency braking events not normal stopping events

25. A hybrid vehicle has been involved in a moderate rear-impact collision during a low-speed accident. The HV system shows no fault codes when scanned. The technician notices the HV battery pack has shifted slightly in its mounting hardware. What is the most appropriate next step?

A. Continue with normal vehicle service since no DTCs are present in the hybrid control module memory at this time

B. Follow OEM post-collision inspection procedures including detailed inspection of the HV battery pack and mounting

C. Replace the HV battery pack as a precaution since collision damage may be present in the cells from the impact

D. Test drive the vehicle to verify no symptoms before further inspection of the HV battery pack assembly is performed

26. A lithium-ion HV battery is being checked for capacity using a controlled discharge test procedure. The pack is charged to 100% SOC then discharged to 0% SOC at a constant 10 ampere rate. The discharge takes exactly 8 hours to complete from start to finish. What is the measured pack capacity?

A. 50 amp-hours of discharge capacity at the specific test conditions used during the discharge measurement procedure

B. 60 amp-hours of discharge capacity at the specific test conditions used during the discharge measurement procedure

C. 70 amp-hours of discharge capacity at the specific test conditions used during the discharge measurement procedure

D. 80 amp-hours of discharge capacity at the specific test conditions used during the discharge measurement procedure

27. A hybrid drive motor is being tested with a megohmmeter at 1000V DC. The technician measures phase-to-ground insulation resistance of 50 megohms on each of the three motor phase terminals. The OEM specification minimum is 10 megohms. What does this measurement indicate about the motor?

A. The motor insulation has degraded below acceptable specification limits for safe continued operation in the vehicle

B. The motor windings are open and the megohmmeter is only measuring through capacitive coupling between phases

C. The motor insulation is in good condition with significant margin above the OEM specification minimum required

D. The megohmmeter test voltage is too high and may be damaging the motor insulation system during the test event

28. A hybrid vehicle uses an 800V battery architecture for enhanced high-power charging capability at DC fast charging stations. Compared to a conventional 400V architecture, what is one primary advantage of the 800V system design?

A. Reduced DC fast charging time due to lower current required at any given power level for the charger and vehicle

B. Improved low-speed driving efficiency at the cost of high-speed performance during normal vehicle driving operation

C. Lower component cost throughout the entire system because of the reduced voltage requirements for major parts

D. Better compatibility with existing Level 2 AC charging infrastructure than the conventional 400V architecture provides

29. A hybrid vehicle uses a heat pump A/C system that can recover waste heat from the HV battery cooling loop for cabin heating during cold weather. What is the primary advantage of this heat recovery feature in the system design?

A. Reduced refrigerant charge requirement compared to a conventional automotive A/C system design without heat recovery

B. Improved cabin heating efficiency without requiring additional electrical energy from the HV battery during the heating

C. Elimination of the need for a PTC supplemental electric heater in cold weather operating conditions for the vehicle

D. Higher cooling capacity during summer driving compared to conventional automotive A/C systems without heat recovery

30. A hybrid technician is preparing to test HV system isolation after a major repair. The technician uses a 1000V megohmmeter for the test. The OEM specification requires a minimum of 100 kΩ between the HV bus and chassis ground for the system operating voltage of 400V. What is the minimum acceptable reading in megohms?

A. 0.01 megohms minimum to meet the OEM test specification at the system voltage being applied to the test

B. 0.05 megohms minimum to meet the OEM test specification at the system voltage being applied to the test

C. 0.1 megohms minimum to meet the OEM test specification at the system voltage being applied to the test

D. 1.0 megohms minimum to meet the OEM test specification at the system voltage being applied to the test

31. A hybrid vehicle's HV battery pack uses individual cell voltage sensing wires that run from each cell group to the battery management module. The technician finds one cell sensing wire has been damaged at a connector during inspection. What symptom is most likely to occur from this damage?

A. The BMM will set a cell voltage sense fault code and the system may enter a reduced-power operating mode for protection

B. The pack will overcharge that specific cell because the BMM cannot detect its voltage during charging operations event

C. The cell will permanently lose capacity because the BMM cannot balance the affected cell through the damaged sense wire

D. The pack will operate normally because cell sensing is redundant through multiple monitoring circuits in the assembly

32. A hybrid drive motor has been disassembled for internal inspection following a customer concern. The technician notes the stator windings show evidence of heat discoloration concentrated on one phase. The other two phases appear normal with no discoloration present. What does this finding most likely indicate about the motor?

A. Normal heat coloration that develops uniformly on all motor windings during the course of routine vehicle operation

B. Manufacturing defect in the discolored phase that was present from the original motor production at the factory

C. Improper installation of the affected phase windings during the original motor assembly process at the manufacturer

D. Past overload condition or shorted turns in the discolored phase requiring motor service or replacement of the unit

33. A hybrid vehicle's DC-DC converter is being bench-tested. The technician applies a 360V DC source to the converter input and measures the output voltage. The output reads 14.0V at light load conditions but drops to 11.5V under heavy load conditions. What does this voltage behavior indicate?

A. Normal regulation behavior since DC-DC converters always reduce output voltage under heavy load conditions during operation

B. The 12V auxiliary battery is restricting current flow from the converter output under heavy load demand at the terminals

C. The DC-DC converter has degraded regulation capability or internal current limit issues affecting heavy load performance

D. The 360V input source is providing insufficient power to drive the converter at the rated full output current capability

34. A hybrid vehicle's HV battery cooling system uses an HVAC-style refrigerant evaporator to cool the battery cells directly. The battery cooling system shares refrigerant circulation with the cabin A/C system through shared components. What is the primary advantage of this refrigerant-based battery cooling design?

A. Simplifies the overall cooling system design by using only liquid coolant in the battery pack circuit during operation

B. Provides higher cooling capacity than liquid-only cooling systems for high-power battery operation during fast charging

C. Eliminates the need for any cooling system service during the entire battery pack service life in normal operation

D. Reduces the total refrigerant cost required for the cabin A/C system through shared system usage between the loops

35. A hybrid vehicle's electric power steering system uses a brushless DC motor with three-phase windings driven by an integrated controller. The EPS module controls motor speed and torque through PWM switching of the three phases. What symptom is most likely if one of the three motor phases develops an open circuit condition?

A. Reduced steering assist with possible irregular pedal feel and an EPS-related fault code being set in the control module

B. Complete loss of all electric power steering assistance during all driving conditions until the system is fully repaired

C. The motor will rotate in the opposite direction during normal steering input from the driver at the steering wheel

D. The motor will overheat severely because the remaining two phases must carry all the steering load alone during use

36. A hybrid drive motor uses oil cooling rather than coolant cooling for the stator windings. The oil is circulated through internal passages in the motor housing and directly over the windings during operation. What is the primary advantage of this oil cooling design over liquid coolant cooling?

A. Lower overall cost than coolant cooling systems for hybrid vehicle drive motor applications during manufacturing

B. Reduced motor weight compared to similar coolant-cooled motor designs of the same power output capability

C. Compatibility with conventional engine oil supply reducing parts inventory requirements at service facilities

D. Direct contact with winding insulation provides superior heat extraction from the windings during high-power operation

37. A hybrid vehicle technician is required to use insulated tools when working on the HV system to prevent accidental short circuits and electrocution. What is the typical voltage rating of insulated tools used for hybrid vehicle HV service work in the shop?

A. 250 volts AC and DC rating which matches the typical hybrid auxiliary 12V system operating voltage range

B. 1,000 volts AC and DC rating which safely exceeds the typical hybrid HV system operating voltage range

C. 7,500 volts AC and DC rating which is intended for utility-grade electrical work outside of automotive service

D. 17,000 volts AC and DC rating which is intended for high-voltage power transmission work outside automotive

38. A lithium-ion HV battery pack uses an active thermal management system that maintains pack temperature between 20°C and 35°C during normal vehicle operation. What is the primary reason for this relatively tight temperature control range during operation?

A. Lithium-ion cells require very cold operation to maximize charge acceptance during regen braking events in normal driving

B. Lithium-ion cells require elevated operating temperatures above 40°C to function properly during all driving conditions

C. Lithium-ion cell aging accelerates significantly at temperature extremes affecting overall pack service life in operation

D. Lithium-ion cells produce dangerous gases when operated outside this specific temperature range during normal operation

39. A hybrid vehicle's HV system uses "Y-capacitor" filter networks between the HV bus and chassis ground for EMI suppression. During service of the HV system, what additional consideration applies specifically when handling these Y-capacitors?

A. Y-capacitors may retain residual stored voltage and must be properly discharged before any HV bus work is performed

B. Y-capacitors operate at very low voltage and require no special service considerations during normal HV system service

C. Y-capacitors automatically discharge through the chassis ground connection during HV system shutdown procedures

D. Y-capacitors are sealed components that never require service or any special handling during HV system service work

40. An EV equipped with a heat pump A/C system uses an electronic expansion valve (EEV) rather than a conventional thermal expansion valve (TXV). What is one operational advantage of the EEV over a conventional TXV in this heat pump application?

A. The EEV is mechanically simpler than a TXV which reduces overall manufacturing cost significantly during production

B. The EEV operates without any electrical input from the climate control module during normal vehicle operation

C. The EEV provides higher refrigerant pressure than a TXV during peak cooling operation in summer driving conditions

D. The EEV provides precise refrigerant flow control across both heat pump heating and A/C cooling operating modes

41. A hybrid vehicle's HV battery pack is being inspected for thermal damage after a customer complaint of reduced vehicle power and acceleration capability. The technician finds heat-discolored bus bars in one section of the pack assembly. What does this finding most likely indicate about the affected section?

A. Normal heat coloration that develops on all bus bars during routine pack operation cycles over the service life

B. Manufacturing defect in the affected bus bars that was present from the initial battery pack assembly at the factory

C. High-resistance electrical connection in that section causing localized heating during high-current operation events

D. Failed bus bar electroplating that requires only resurfacing and reinstallation procedures to restore proper function

42. A hybrid vehicle's drive motor uses a winding configuration called "hairpin" rather than traditional round wire windings for the stator. What is the primary advantage of hairpin windings over traditional round wire windings in this drive motor design?

A. Hairpin windings produce more back-EMF than round wire windings at the same motor rotational speed during operation

B. Hairpin windings have higher slot fill factor allowing more copper conductor for the same physical motor size and weight

C. Hairpin windings cost significantly less to manufacture than traditional round wire windings in mass production volume

D. Hairpin windings eliminate the need for any insulation between adjacent winding conductors during normal operation

43. A hybrid vehicle is being diagnosed for an inverter coolant leak inside the inverter housing assembly. The technician finds coolant has migrated inside the inverter electronics section. What is the most appropriate action to take in response to this finding?

A. Replace the inverter assembly because internal coolant contamination damages the sensitive electronics and is non-repairable

B. Drain the coolant from inside the inverter housing and reassemble the unit for continued vehicle operation in service

C. Flush the inverter internal components with isopropyl alcohol then reassemble the unit for continued operation in vehicle

D. Continue with normal vehicle service since small amounts of coolant inside the inverter housing cause no significant damage

44. A hybrid vehicle has been jump-started from another vehicle to recover from a discharged 12V auxiliary battery. The donor vehicle was a conventional gas-powered vehicle in good operating condition

with a charged battery. After 30 minutes of continuous charging, the hybrid still will not start. What is the most likely cause of the persistent no-start condition?

A. The donor vehicle was not capable of providing sufficient cranking current to charge the hybrid 12V battery adequately

B. The hybrid's HV system has experienced damage from improperly performed jump-starting from the gas vehicle source

C. The hybrid requires a special jump-starting procedure that the technician did not follow per the OEM service manual

D. The hybrid's 12V auxiliary battery has internal damage preventing it from accepting normal charging current from the jumper

45. A hybrid vehicle's HV battery pack uses a "split pack" architecture with two separate battery sections that can be electrically isolated from each other through internal contactors. What is the primary advantage of this split pack design over a single-section pack?

A. Lower overall manufacturing cost than single-section pack designs for the same total energy capacity of the assembly

B. Improved pack cooling because each section can be cooled by a separate independent cooling loop in parallel design

C. Enhanced safety because a fault in one section can be electrically isolated from the other section during a fault event

D. Simplified service because each section can be replaced individually without complete pack removal from the vehicle

# FULL ANSWER KEY WITH EXPLANATIONS – PRACTICE EXAM 13

**1.** B — SAE J2344 is the industry guideline specifically for electric and hybrid vehicle safety procedures, covering technician PPE, de-energization, and service practices for HV systems. It addresses the unique hazards of working on high-voltage vehicle systems. The other standards address different aspects entirely: J1772 covers charging connectors, D120 covers rubber glove construction, and FMVSS 305 covers crash safety.

**2.** D — Cell swelling in lithium-ion batteries indicates internal gas generation from electrolyte decomposition or other chemical degradation. Swollen cells present a thermal runaway and rupture hazard and must be replaced before further service. Visible swelling is never normal and must be treated as a safety-critical condition requiring immediate action.

**3.** C — Induction motors have no permanent magnets, so they produce no back-EMF when no current flows through the rotor. This eliminates the magnetic drag losses at high speeds that PM motors experience when coasting or operating without torque demand. The benefit is reduced no-load losses during highway cruising or coasting.

**4.** A — Silicon carbide MOSFETs switch much faster than IGBTs and have significantly lower conduction and switching losses across the operating range. This translates directly to higher inverter efficiency, smaller heat sinks, and reduced cooling requirements. The trade-off is higher component cost, but the efficiency gain justifies the cost in many EV applications.

**5.** B — A running compressor producing little differential between high and low side pressures indicates the compressor is not effectively pumping refrigerant. With electrical input and refrigerant charge both verified correct, the remaining cause is internal mechanical failure such as worn scrolls, broken valves, or internal bypass. The compressor must be replaced because internal damage cannot be repaired in the field.

**6.** C — Lithium-ion auxiliary batteries include a built-in BMS that communicates with the DC-DC converter and vehicle control modules to manage charging, balancing, and protection. Replacing or servicing this battery requires maintaining the communication link, and loss of communication can prevent charging, set DTCs, or cause the battery to enter protection mode. AGM replacement is not permitted because the communication and charging characteristics differ.

**7.** D — Pack voltage divided by module count gives 220V ÷ 30 = 7.33V per module. This is within the typical NiMH module open-circuit voltage range for a fully rested healthy module. Each module contains six 1.2V NiMH cells in series, producing a nominal 7.2V that rises slightly above this at full rest charge.

**8.** A — PWM switching frequencies in hybrid inverters typically fall within or just above the human hearing range, producing the characteristic whine heard during low-speed electric operation. The frequency of the audible component varies with motor speed because the inverter modulates its output to match the motor's commanded operating point. This is normal operating characteristic, not a fault condition.

**9.** B — Peak power operation creates more heat than the cooling system can sustain indefinitely, so the inverter monitors IGBT and module temperatures and reduces output as temperatures approach thermal limits. This thermal derating allows brief peak operation for acceleration while protecting components from damage during extended high-load operation. It is the primary mechanism limiting continuous peak power output.

**10.** C — A compressor burnout releases burnt oil, refrigerant breakdown products, and metallic debris throughout the entire refrigerant circuit. The accessible lines must be flushed to remove contamination, and the drier or accumulator must be replaced because its desiccant has absorbed contaminants. Failing to perform this cleanup will contaminate the new compressor and cause it to fail prematurely.

**11.** A — OSHA establishes lifting weight limits to prevent technician back injury during heavy equipment removal. Hybrid inverters typically weigh more than the single-person lift limit, so mechanical lifting equipment such as a hoist, lift table, or sling assembly is required for safe removal. Manual lifting beyond OSHA limits creates real injury risk and may violate workplace safety rules.

**12.** D — Lithium-ion cells used in hybrid applications typically have a maximum voltage limit of approximately 4.15V to 4.20V to prevent damage from overcharging. A cell voltage of exactly 4.15V indicates that one or more cells reached or briefly exceeded the maximum, triggering the BMM to log the DTC. The fault code is logged to flag the overvoltage event and prompt service before further degradation.

**13.** B — With the sun gear held stationary and the carrier driven by the engine, the planet gears walk around the fixed sun, forcing the ring gear to rotate in the same direction at a higher speed than the carrier. This is the overdrive configuration of a planetary gear set. The exact speed ratio depends on the relative tooth counts of the sun and ring gears.

**14.** C — During regenerative braking, the motor/generator produces current that flows back into the HV battery, raising the bus voltage above the battery's resting voltage. The voltage rise reflects the IR drop across the battery's internal resistance plus the charging voltage offset. This is normal regenerative braking behavior, not a fault condition.

**15.** A — Current equals power divided by voltage, so 5,000W ÷ 360V = 13.89A. This is the average current the PTC heater draws from the HV bus during full power operation. Higher HV bus voltage reduces the current required for the same power output, which is part of why high-voltage architectures are preferred for high-power resistive heating loads.

**16.** D — The vacuum switch normally completes the pump's power circuit when manifold vacuum drops below threshold. If the switch fails in the open position, the pump's control circuit never receives the activation signal and the pump never runs. Without pump operation, brake booster vacuum is not maintained, resulting in a hard pedal during brake application.

**17.** C — The pre-charge resistor is the only path for current to flow into the inverter's bulk capacitors before the main contactor closes. With the resistor open, the capacitors cannot charge to bus voltage, and the control module detects the failed pre-charge sequence and prevents the main contactor from closing. The vehicle cannot enter READY mode until the pre-charge circuit is restored.

**18.** B — The OEM specifies 500 ohms per volt as the minimum acceptable isolation, and the measured 250 ohms per volt is half of that minimum. This indicates an active leakage path exists from the HV system to chassis ground that exceeds safety thresholds. The technician must locate and repair the leakage source before the vehicle can be returned to service.

**19.** D — Resolver-to-motor offset calibration aligns the rotor's electrical zero with the inverter's switching reference, ensuring current is applied at the correct angle for maximum torque per amp. Without this calibration, the inverter applies current at the wrong rotor angles, producing reduced torque, excessive current draw, and rough motor operation. Most OEM procedures require this calibration after motor or inverter replacement.

**20.** A — R-134a and R-1234yf must never be mixed or share recovery equipment because cross-contamination ruins both refrigerants and damages future systems serviced with the equipment. The refrigerants are not interchangeable, and using the wrong equipment voids equipment warranty and refrigerant purity certifications. The technician must use only R-1234yf-rated equipment for an R-1234yf system.

**21.** C — Deep-discharging lithium-ion cells below their minimum cell voltage causes the copper current collector at the anode to dissolve into the electrolyte. When charging resumes, copper plates internally on the anode surface, creating internal short risks and permanent damage. This is the reason lithium-ion batteries should never be deeply discharged, even during long-term storage.

**22.** B — A PMSM produces torque through the magnetic interaction between the permanent magnets on the rotor and the rotating magnetic field generated by current in the stator windings. The inverter controls the stator field's frequency and phase to align with rotor position, producing continuous torque. This brushless design has no commutator and no rotor electrical connections to wear out.

**23.** D — The inverter and DC-DC sections share a housing and cooling system but operate as independent power conversion circuits with separate control logic. A failed DC-DC section stops 12V charging but does not directly prevent inverter operation, so the vehicle continues running until the 12V battery depletes. The vehicle eventually stops when the 12V system cannot support module operation any longer.

**24.** A — The brake accumulator stores pressure for rapid response and reduces pump cycling, with the nitrogen precharge providing the spring force behind the hydraulic fluid. Low precharge pressure reduces stored energy, increases pump duty cycle, and causes inconsistent pedal feel. Braking still works mechanically, but performance degrades and the system may set DTCs related to brake performance.

**25.** B — Manufacturer post-collision procedures specify exact inspection steps required to verify HV system integrity, including physical pack inspection, isolation testing, and mounting verification. A shifted pack is a clear indication that impact forces exceeded design margins, even without DTCs present. The OEM procedure must be followed to ensure the vehicle is safe before any other service is performed.

**26.** D — Battery capacity equals current multiplied by discharge time, so 10A × 8 hours = 80 Ah. This is the standard method of measuring battery capacity through controlled discharge testing. The result indicates how much charge the pack can deliver at the specified test current before reaching the cutoff voltage.

**27.** C — A reading of 50 megohms phase-to-ground is well above the OEM minimum of 10 megohms, indicating the stator insulation is in healthy condition with significant safety margin. Insulation resistance readings above specification confirm the windings are properly isolated from chassis ground and no service is required. Higher readings provide additional safety against shock and isolation faults.

**28.** A — At the same charging power level, an 800V system requires only half the current of a 400V system, reducing $I^2R$ losses in cables and connectors. This allows the system to accept more power from a DC fast charger without overheating, significantly reducing charging time at high-power stations. The 800V architecture is becoming standard for high-performance EVs for this reason.

**29.** B — Recovering battery waste heat for cabin heating uses energy that would otherwise be rejected to ambient air, dramatically improving overall vehicle efficiency in cold weather. The heat pump moves this thermal energy into the cabin without consuming significant additional battery energy. This recovery extends winter driving range compared to systems using only resistive heating.

**30.** C — One megohm equals 1,000 kilohms, so 100 kΩ equals 0.1 megohms. The OEM specification of 100 kΩ minimum is the same as 0.1 MΩ in standard units. The technician must read at least this value on the megohmmeter for the HV system to pass the isolation test at the specified system voltage.

**31.** A — A damaged cell sensing wire prevents the BMM from reading the affected cell's voltage, creating a missing data condition that triggers a sense-fault DTC. To protect the affected cell from possible undetected overcharge or over-discharge, the system enters a reduced-power mode that limits current draw and charging. The wiring must be repaired before normal operation resumes.

**32.** D — Heat discoloration concentrated on one phase indicates that phase carried abnormally high current at some point in its service history. This pattern is characteristic of past overload, shorted turns, or imbalanced current sharing, all of which produce localized heating. The motor requires service or replacement because the damaged phase has reduced insulation life and may fail entirely under load.

**33.** C — A drop from 14.0V at light load to 11.5V under heavy load represents excessive regulation droop that indicates internal converter problems. Normal converters maintain regulation within a fraction of a volt under load, and a 2.5V sag suggests degraded switching components, failing capacitors, or current limit issues. The converter requires service or replacement to restore proper 12V system operation.

**34.** B — Refrigerant-based battery cooling provides significantly higher cooling capacity than liquid-only systems because refrigerant absorbs large amounts of heat during phase change at the evaporator. This allows the battery to dissipate the heat generated during DC fast charging and high-power driving without exceeding safe operating temperatures. Liquid coolant alone cannot match this cooling capacity in compact pack designs.

**35.** A — An open phase in a three-phase motor disrupts the balanced rotating magnetic field, producing reduced and uneven torque output. The EPS module detects the imbalance and sets a phase-related DTC while continuing to operate with reduced assist using the remaining phases. The driver feels reduced and inconsistent steering effort, but the system does not fail completely or lose all assistance.

**36.** D — Oil cooling allows the cooling medium to contact the windings directly, providing far better heat transfer than coolant separated from windings by housing walls. This direct contact extracts heat from the windings before it must conduct through insulation and metal, allowing higher continuous power output from the same motor size. The trade-off is a more complex oil management system.

**37.** B — Insulated tools for hybrid HV service are rated to 1,000 volts AC and DC, which safely exceeds the 200V to 800V operating voltage of typical hybrid HV systems. The 1,000V rating provides margin against transient voltages and ensures the tools remain safe across the entire range of hybrid system voltages encountered in service. This rating is the industry standard for hybrid technician toolsets.

**38.** C — Lithium-ion cell aging accelerates significantly above 35°C through chemical degradation of the electrolyte and SEI layer, and slows dramatically below 0°C where lithium plating risk increases during charging. The 20–35°C window represents the optimal range where calendar and cycle life are maximized. Active thermal management maintains the pack within this range to maximize battery service life.

**39.** A — Y-capacitors connect between the HV bus and chassis ground and can retain charge after the main HV system is de-energized. The technician must verify these capacitors have discharged before working on the HV bus, because a charged Y-capacitor can deliver a dangerous shock through inadvertent contact. They are treated with the same caution as the main DC bus filter capacitors.

**40.** D — Heat pump systems require precise refrigerant flow control across a wide range of operating conditions including cooling, heating, dehumidification, and defrost modes. EEVs use stepper-motor-driven needle valves controlled by the climate module to provide the precise, mode-specific metering that mechanical TXVs cannot match. The flow control flexibility is essential for efficient heat pump operation across all modes.

**41.** C — Bus bar discoloration from heat indicates a high-resistance connection at that location, because resistive losses produce localized heating during high-current operation. The discoloration appears where current flow creates $I^2R$ heating that exceeds the bus bar's normal operating temperature. Cleaning, retorquing, or replacing the affected hardware is required to restore proper conductivity and prevent further damage.

**42.** B — Hairpin windings use rectangular cross-section conductors that pack more efficiently into stator slots than traditional round wires, increasing the copper-to-air ratio in the slot significantly. The higher slot fill factor reduces winding resistance and improves thermal performance, increasing motor efficiency and power density. This is the dominant winding technology in modern hybrid and EV drive motors.

**43.** A — Coolant inside the inverter housing damages sensitive electronics through corrosion, short circuits, and insulation failure that cannot be reliably repaired in the field. Even after drying, residual moisture and contamination remain in connectors and PCB traces, leading to future intermittent failures. The inverter assembly must be replaced rather than attempting field repair of contaminated electronics.

**44.** D — After 30 minutes of charging from a good donor vehicle, a healthy 12V battery should have accepted enough charge to support hybrid startup. Failure to start after this time indicates the 12V battery itself has internal damage such as a shorted cell, sulfation, or capacity loss that prevents it from accepting charge. Battery replacement is required to restore vehicle operation.

**45.** C — A split pack architecture allows the BMM to isolate one section from the other if a fault occurs in either section, containing the fault and preventing it from affecting the entire pack. This is a critical safety feature for high-energy lithium-ion packs where a single-section fault could otherwise cascade through the entire assembly. The isolation contactors are commanded open in response to detected internal faults to limit damage and shock risk.