PRACTICE EXAM 21: ASE L3 SIMULATION (45 Questions)

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

1. In addition to a thermal runaway rupture disk, an HV battery pack typically includes a small breathable membrane vent. The purpose of this small vent is to:

A. Provide a service access port that the technician can use to test pack internal pressure during diagnostics

B. Allow controlled venting if a single cell experiences a mild venting event without pressure buildup

C. Equalize internal pack pressure with ambient as temperature and altitude change during normal operation

D. Release coolant vapor from inside the pack housing during high-temperature operation conditions

2. A "three-level" inverter (such as an NPC or T-type design) uses additional switching devices to produce three voltage levels at each phase output instead of two. The advantage of three-level topology over two-level is:

A. Reduced harmonic content in the motor current along with lower voltage stress per switching device

B. Higher peak power output by allowing each switching device to be operated above its rated voltage

C. Elimination of the need for a DC link capacitor due to the inherent voltage division across stages

D. Compatibility with both AC and DC charging without requiring a separate on-board charger circuit

3. A flexible braided copper strap is bolted between an EV drive unit and the vehicle chassis. The purpose of this ground strap is to:

A. Provide a return path for the three-phase motor currents flowing through the inverter to the motor

B. Bond the drive unit housing to the vehicle chassis, providing a low-resistance path for fault and shield currents

C. Cool the drive unit by conducting heat from the housing into the vehicle structure during operation

D. Serve as a mechanical safety tether that prevents the drive unit from falling if its mounts fail entirely

4. A 2022 Type-2 hybrid uses a positive crankcase ventilation (PCV) system similar to a conventional engine, but with one modification suited to hybrid operation. The hybrid-specific modification typically:

A. Eliminates the PCV valve entirely and seals the crankcase to prevent any vapor emissions during operation

B. Adds a heating element to the PCV passages to prevent ice from forming during stop/start operation cycles

C. Routes PCV gases directly to the exhaust system to bypass the intake during hybrid drive modes entirely

D. Uses an electric pump to maintain ventilation when the engine is off rather than during operation only

5. A customer with a 2008 NiMH hybrid asks if they should "deep discharge" the HV battery periodically to prevent memory effect. The technician should explain that:

A. NiMH cells in hybrid applications do not exhibit any clinically significant memory effect under normal usage patterns

B. Memory effect does occur in hybrid NiMH packs and requires a monthly deep discharge for proper service

C. Memory effect is only a concern with the lithium-ion packs that have replaced NiMH in newer hybrids

D. Memory effect requires a special factory tool to reset, available only at authorized dealer service centers

6. Film capacitors used in modern automotive inverters exhibit a property called "self-healing." Self-healing means that if a small dielectric breakdown occurs:

A. The capacitor automatically reduces its operating voltage to prevent further breakdown from occurring

B. The capacitor's internal pressure builds up, signaling the BMS that the cap requires immediate replacement

C. The film capacitor uses an internal redundant element that automatically engages to maintain functionality

D. The metallized film vaporizes near the fault, isolating the damaged spot and allowing continued operation

7. A 2023 EV with electro-hydraulic brakes specifies a different brake fluid than a conventional vehicle. The EV typically requires:

A. DOT 5 silicone-based brake fluid that resists moisture absorption better than glycol-based fluids do

B. DOT 4 LV (low viscosity) fluid that flows more readily through the EHB system's narrow control passages

C. Mineral oil hydraulic fluid that does not react with the elastomers used in EV brake calipers as much

D. DOT 3 fluid identical to that used in older conventional vehicles, the same fluid for both system types

8. An EV with a 7:1 final drive ratio differs from one with a 10:1 ratio in that the 7:1 vehicle will typically have:

A. Higher top speed but reduced wheel torque at low vehicle speeds compared to the 10:1 vehicle

B. Lower top speed and reduced wheel torque, with the trade-off being improved efficiency overall

C. The same top speed but improved efficiency, due to the reduced gear engagement during cruise

D. Faster acceleration from a standstill due to the reduced mechanical losses in the simpler gear set

9. The safety vents on lithium-ion cells inside an HV battery pack are intentionally oriented so that any released gas:

A. Flows toward the BMS control unit, where pressure sensors can detect venting events immediately

B. Flows back into the cell through a one-way valve, preventing premature pack-level vent triggering

C. Discharges into a defined venting channel that routes gases to the pack's external rupture disk safely

D. Vents into the vehicle's air intake system, where the gases are then routed to the exhaust system

10. An EV stored at -20°C for several days is started for the first drive. The inverter:

A. Must be heated by an external source before operation; the vehicle cannot drive in this condition

B. Operates normally but may show reduced peak power capability until components warm to normal range

C. Cannot operate until the HV battery has been brought to room temperature, taking several hours

D. Operates exclusively at low PWM frequencies (under 1 kHz) until all internal components warm up

11. An EV drive unit includes a "parking pawl" — a mechanical device that engages when the vehicle is placed in Park. The parking pawl works by:

A. Activating the regenerative brake system to maintain the vehicle stationary using the drive motor itself

B. Closing the main HV contactors so the motor can be commanded to hold position electronically

C. Engaging a tooth into a gear in the drive unit, mechanically locking the output shaft from rotating

D. Applying a mechanical drum brake at the motor shaft to prevent unintended vehicle movement reliably

12. The coolant specified for a 2023 Type-2 hybrid engine differs from conventional coolant in that the hybrid coolant typically:

A. Contains a higher concentration of ethylene glycol than conventional coolant for extreme cold weather use

B. Uses a propylene glycol base instead of ethylene glycol to reduce environmental and health impact significantly

C. Uses an extended-life low-silicate formulation compatible with the materials in hybrid engine components

D. Contains conductive additives that allow the coolant to be sensed by the BMS for level and temperature

13. A 2024 EV battery pack includes an electric coolant heater that draws power from the HV bus. The heater's primary purpose is to:

A. Warm the battery pack toward its operating temperature range in cold weather before high-rate use

B. Replace the cabin heater function when the heat pump's coefficient of performance falls below 1.0

C. Provide redundant heating capability if the primary cabin heater fails during cold-weather operation

D. Maintain coolant flow at higher viscosity by providing localized heat to the pump impeller assembly

14. Modern gate drivers for high-power SiC devices use "active gate control" to:

A. Automatically disable the driver if the gate voltage exceeds a preset threshold value during operation

B. Vary the gate current profile during turn-on and turn-off, optimizing the trade-off between losses and EMI

C. Power the driver from the motor itself, eliminating the need for a separate low-voltage gate supply circuit

D. Detect the rotor position from the gate current waveform shape during normal switching operation

15. During EV drive unit reassembly after a teardown, the technician measures gear backlash using a dial indicator. The measured backlash should:

A. Be set to the maximum value within the OEM tolerance range to allow for thermal expansion during operation

B. Be set to zero to eliminate any noise produced by gear teeth not contacting each other during operation

C. Fall within the OEM-specified range, with adjustment made by shim selection at the bearing carriers

D. Be adjusted to match the backlash of the original drive unit before disassembly, regardless of OEM spec

16. An advanced battery diagnostic technique called "electrochemical impedance spectroscopy" (EIS) measures pack health by:

A. Applying a small AC signal across the cells and analyzing the impedance response across frequencies

B. Discharging the pack at a constant high rate and measuring the resulting voltage sag over time

C. Heating individual cells and measuring the temperature rise rate as an indicator of internal resistance

D. Measuring the pack's open-circuit voltage at multiple temperatures to characterize cell-to-cell aging

17. A modern smart IGBT module includes built-in fault detection that can identify an "open-circuit" condition in any of the three motor phases. This detection works by:

A. Comparing the gate drive command against the measured collector-emitter voltage continuously in real time

B. Monitoring the temperature of each IGBT for the absence of switching losses, indicating no current flow

C. Detecting reverse current in the antiparallel diode that would only occur during normal switching operation

D. Sensing the absence of expected current in a phase when the IGBT is commanded to conduct in service

18. A current-generation EV drive unit does not typically include a direct torque sensor on the motor shaft. Output torque is instead determined by:

A. Calculating from measured motor phase currents and known motor parameters using inverter algorithms

B. Reading the actual mechanical torque from a strain gauge embedded in the motor's output shaft assembly

C. Inferring from wheel speed sensor data combined with vehicle weight and current acceleration values

D. Estimating from the HV battery's instantaneous current draw and the vehicle's road speed measurement

19. Compared to a conventional gasoline vehicle, a battery electric vehicle's scheduled maintenance is typically:

A. More frequent due to the additional electrical components requiring periodic inspection during operation

B. Less frequent and less involved, with fewer fluids, no engine oil changes, and reduced brake wear from regen

C. The same overall, with electrical service intervals replacing the fluid service intervals one-for-one

D. Eliminated entirely for the first 100,000 miles under federal warranty requirements for new vehicles

20. An aftermarket service shop wants to verify the actual capacity of a used HV battery pack before reselling it. The most direct method is to:

A. Read the SOH value from the BMS over the diagnostic port using a manufacturer-specific scan tool

B. Perform a controlled charge and discharge cycle, integrating current over time to measure actual capacity

C. Measure the open-circuit voltage at full charge and use the OEM nominal capacity value as a baseline

D. Apply a high-rate discharge for a short period and extrapolate capacity from the voltage drop response

21. During a CCS DC fast charging session, the vehicle and station perform a defined handshake before high current flows. This handshake includes:

A. Identifying both parties, negotiating maximum voltage and current, and verifying isolation before contactors close

B. Exchanging GPS coordinates so the station can verify the vehicle is parked at the correct charging stall

C. Transmitting the vehicle's full diagnostic data history to the station for storage in the charging network

D. Running a self-test of the vehicle's HV battery contactors by cycling them rapidly through the charging cable

22. At the motor manufacturer's end of line, each completed motor undergoes a "burn-in" test before shipping. The purpose of this burn-in is to:

A. Calibrate the resolver to a specific zero-position reference required by the motor controller during installation

B. Reduce magnet flux density to the level specified by the vehicle OEM for use in the specific application

C. Verify that the cooling system can dissipate heat at the rated power level under controlled conditions

D. Identify infant-mortality defects through extended testing under representative load conditions before shipping

23. A 2024 Type-2 hybrid engine uses hydraulic lifters in its valve train, the same as most modern conventional engines. This design choice was made because:

A. Hydraulic lifters allow the engine to operate as both Atkinson and Otto cycles with the same hardware

B. Hydraulic lifters eliminate the need for periodic valve clearance adjustment, supporting hybrid maintenance reduction

C. Hydraulic lifters provide additional cooling to the valve seats during high-load engine operation conditions

D. Hydraulic lifters reduce the engine's overall mass compared to solid lifters in lightweight hybrid applications

24. Some compact automotive inverters have their power electronics encapsulated in a gel or potting compound. The primary purpose of this potting is to:

A. Provide additional capacitance between the IGBTs and chassis ground for improved EMC compliance ratings

B. Allow technicians to easily inspect the internal components by removing the gel during service procedures

C. Increase the thermal mass of the inverter to reduce temperature swings during transient load conditions

D. Provide protection against moisture, contamination, and mechanical vibration in the harsh automotive environment

25. In a cylindrical lithium-ion cell, the crimp seal at the top of the can serves to:

A. Provide the positive terminal connection between the internal cell stack and the external bus bar surface

B. Allow the cell to be recharged through the seal by ion movement between the electrolyte and external bus

C. Provide a vent path for any gases generated inside the cell during normal charge and discharge cycles

D. Seal the cell against electrolyte leakage and external contamination throughout the cell's service life

26. A 2023 EV requires periodic wheel alignment service. Compared to a conventional vehicle, the EV alignment specification typically:

A. Calls for slightly different camber and toe values optimized for low rolling resistance tires used on EVs

B. Specifies negative camber values to compensate for the additional weight of the HV battery pack underneath

C. Eliminates toe-in entirely, since EV regenerative braking compensates for any toe-related alignment errors

D. Requires the technician to disconnect the HV battery before any alignment service work can be performed

27. The wheel speed sensors on a 2023 EV serve multiple vehicle systems beyond traditional ABS. The inverter uses these signals to:

A. Cross-check the motor's calculated speed against the wheel speed to detect drive system faults

B. Determine when to engage the parking pawl during deceleration to a complete vehicle stop position

C. Calculate the battery's instantaneous state of charge as it drops during high-load driving conditions

D. Verify that the regenerative braking software is producing the correct stopping distance for each event

28. During a DC fast charging session, the BMS commands the charger to derate (reduce) the charging current as the pack approaches full charge. This derating occurs because:

A. The charging station applies a fee penalty for charging beyond a certain SOC threshold during the session

B. Lithium-ion cells become less able to accept high current as they approach full charge, requiring CC-to-CV transition

C. The vehicle's air conditioning load must be reduced as the battery heats during charging operations

D. The HV battery contactors require a cooling period after every 80% SOC threshold during DC charging

29. Compared to lithium-ion cells, NiMH cells in older hybrid packs typically exhibit:

A. Higher energy density per unit mass, with reduced self-discharge over storage time at room temperature

B. Equivalent self-discharge rates to lithium-ion, with the main difference being voltage rather than chemistry

C. Lower self-discharge rates than lithium-ion, making them better suited for long-term storage applications

D. Higher self-discharge rates than lithium-ion, particularly at elevated temperatures during prolonged storage

30. A Type-2 hybrid engine typically does not have a conventional engine-driven accessory belt. Functions normally performed by belt-driven accessories on conventional vehicles are instead performed by:

A. Belt-driven accessories that operate only when the vehicle is in motion, locking out during auto-stop events

B. A single electrically-clutched accessory drive shaft that engages only when an accessory load is requested

C. Hydraulic pumps powered by the engine's main oil pressure system, eliminating the conventional belt drive

D. Individual electric motors for each function: A/C compressor, power steering pump, and water pump units

31. A 2024 EV features a large fixed glass roof panel. From a thermal management perspective, this roof:

A. Reduces cabin heat gain compared to a conventional steel roof because glass reflects more solar radiation

B. Has no impact on cabin temperature because the glass is treated with a special EV-only coating during manufacture

C. Increases solar heat gain into the cabin, requiring additional A/C capacity to maintain comfort in sunny conditions

D. Acts as a passive solar collector, contributing energy to the HV battery through embedded photovoltaic cells

32. A wireless inductive charging system (such as SAE J2954) transfers energy from a ground assembly to a vehicle assembly using:

A. A high-frequency laser beam that the ground unit directs at a receiver on the underside of the vehicle

B. A capacitive coupling between metal plates on the ground unit and matching plates on the vehicle floor

C. A magnetic field produced by an oscillating current in the ground coil, which induces current in the vehicle coil

D. An ultrasonic transducer that converts acoustic energy into electrical current at the vehicle's receiver pad

33. The constant velocity (CV) joints on a front-wheel-drive EV with a centrally-mounted drive unit are typically:

A. Identical to conventional FWD vehicle CV joints, with no modification for the EV's higher torque output

B. Eliminated entirely because the drive unit transmits torque without any rotating shaft to the wheel hub

C. Larger than conventional CV joints to handle the additional weight of the battery pack on the front axle

D. Designed for the higher instantaneous torque delivery characteristic of electric motor drive systems

34. During the pre-charge sequence after the vehicle ignition is switched on, the BMS monitors:

A. The DC link capacitor voltage, allowing the main contactor to close only after the cap is sufficiently charged

B. The HV battery temperature, delaying contactor closure until cells reach minimum operating temperature

C. The 12V auxiliary battery voltage, ensuring the battery can supply the contactor coil current adequately

D. The motor phase current, verifying that no spurious phase currents are present before energizing the bus

35. A customer reports their EV cannot communicate with a particular public Level 2 charging station despite the cord being plugged in correctly. The most likely cause is:

A. The vehicle's HV battery is at maximum SOC and the station is refusing to initiate the charging session

B. The 12V battery is too low to power the vehicle's charging communication electronics during plug-in

C. A CP signal communication fault between the vehicle and the EVSE preventing session negotiation

D. The local utility's grid voltage has fallen outside the J1772 specified range for the station's location

36. Some plug-in hybrids in cold climates include an engine block heater that operates from grid power while the vehicle is plugged in. The purpose of this block heater is to:

A. Maintain HV battery temperature in cold weather without consuming battery energy for self-heating purposes

B. Prevent the engine oil from solidifying during extreme cold storage in regions like the upper midwest

C. Warm the cabin via the engine heater core before the driver enters the vehicle in cold weather

D. Preheat the engine before its first cold start of the drive, reducing cold-start emissions and engine wear

37. A pyrotechnic pack-level fuse (sometimes called a pyrofuse) in an HV battery pack is designed to:

A. Open the HV bus instantly during a severe fault by triggering an explosive charge that severs the conductor

B. Disconnect individual cells when their internal pressure indicates an imminent thermal runaway event

C. Reset automatically after the fault clears, allowing the HV system to be re-energized without service work

D. Provide overcurrent protection for the 12V auxiliary system that the DC/DC converter supplies during use

38. A customer notes that their 2022 EV's brake pads have shown unusually little wear despite high mileage. The primary reason for this reduced brake pad wear is:

A. EV brake pads are made of harder material than conventional vehicle pads to extend their service life

B. The regenerative braking system handles most of the deceleration, reducing the friction brake workload

C. EV vehicles are typically driven more conservatively than conventional vehicles by environmentally conscious drivers

D. EV brake calipers automatically retract further between brake applications, reducing pad-to-rotor contact

39. During a DC fast charging session using a CCS connector, the charging connector latches into the vehicle inlet. The latch:

A. Engages automatically as the connector is inserted and releases automatically when charging completes successfully

B. Must be engaged manually by the operator before the charging station will begin the session entirely

C. Releases automatically every 30 minutes during long charging sessions to allow operator inspection of the cable

D. Engages after the handshake completes and releases only after the session is properly terminated by both ends

40. The state of health (SOH) of a lithium-ion battery typically declines over its service life in a characteristic pattern. SOH degradation is:

A. Linear, with capacity dropping at a constant percentage per year regardless of use intensity throughout life

B. Exponential, with most degradation occurring in the first year and very little thereafter throughout life

C. Step-wise, dropping suddenly when the BMS reaches certain mileage thresholds during the service life

D. Initially fast (SEI formation period), then slow and relatively linear, then accelerating near end of life

41. In an HV system, "galvanic isolation" specifically means that:

A. The HV components are mounted on rubber bushings to prevent vibration from being transmitted to the chassis

B. The HV bus is connected to ground through a high-impedance path that allows fault detection during operation

C. There is no direct conductive path for current to flow between the HV system and the vehicle chassis

D. The HV battery is electrically connected to the chassis through a small resistor for static charge dissipation

42. A rear-drive EV with a centrally-mounted motor uses a short driveshaft between the motor and the differential. This driveshaft is typically:

A. Made of solid steel to handle the high instantaneous torque produced by the electric drive motor

B. Replaced annually as part of preventive maintenance to prevent fatigue failure from EV torque pulses

C. Dynamically balanced like a conventional driveshaft to prevent vibration at high motor speeds during driving

D. Eliminated entirely on all current-generation EVs in favor of in-wheel motors at each rear wheel hub

43. A 2023 EV's telematics system continuously collects driving and vehicle data. Under federal regulations, the vehicle owner:

A. Has no rights regarding this data, which is the property of the manufacturer until the vehicle is sold

B. Has the right to know what data is being collected, with privacy disclosures provided by the manufacturer

C. Must pay a monthly subscription fee to the manufacturer to access their own vehicle's diagnostic data

D. Has full ownership of the data, and the manufacturer cannot use it for any purpose without explicit consent

44. A modern J1772 or CCS charging coupler may include a temperature sensor on the connector contacts. The purpose of this sensor is to:

A. Provide additional weather sealing between the connector contacts and the moisture in the air during use

B. Calibrate the EVSE's current output to maintain constant power despite ambient temperature variations

C. Heat the connector to body temperature so that condensation does not form during cold-weather charging

D. Detect overheating from high-resistance connections that would otherwise damage the connector or cable

45. After replacing the throttle body on a Type-2 hybrid engine, the technician must perform an "idle relearn" procedure because:

A. The new throttle body has different physical dimensions that require manual calibration of the throttle stop screw

B. The throttle position sensor's voltage range must be reset to match the BMS's expected operating window

C. The ECM stores adapted values for closed throttle position that do not match the new component's characteristics

D. The hybrid control system must be re-coded to recognize the throttle body's manufacturer ID for warranty purposes

PRACTICE EXAM 21 – ANSWER KEY AND EXPLANATIONS

1. C — The breathable membrane vent equalizes pressure between the pack interior and ambient air as temperature and altitude change during normal driving. The pack housing is sealed against liquid water, but daily thermal cycling builds significant pressure differential — a Gore-Tex-style membrane allows air exchange while blocking moisture and contaminants.

2. A — A three-level inverter produces three discrete voltage levels per phase output, creating a stepped waveform much closer to a true sine than two-level PWM can. This reduces harmonic content in the motor current (cleaner torque, less iron loss) and cuts the voltage stress on each switching device roughly in half — both critical advantages in high-voltage EV designs.

3. B — The braided copper strap bonds the drive unit housing electrically to the vehicle chassis, providing a low-resistance path for any fault current or HV cable shield current to flow safely back to ground. Without this bond, the drive unit could float at a different potential than chassis, defeating EMC shielding and creating shock hazard during a HV fault.

4. B — Hybrid engines that frequently stop and start may not always reach full operating temperature, so PCV passages can accumulate condensed crankcase moisture and ice up in cold weather. A small heating element prevents this icing, which would otherwise plug the PCV system and cause crankcase pressure problems that lead to oil leaks and emissions DTCs.

5. A — NiMH cells in hybrid applications do not exhibit clinically significant memory effect. The partial-charge cycles typical of hybrid operation — never reaching full charge or full discharge — actually mitigate any tendency. The "memory effect" myth carries over from older NiCd cordless tools and does not apply meaningfully to modern NiMH hybrid packs.

6. D — Film capacitors use a thin metallized conductive layer. When a localized dielectric breakdown occurs, the high current at the fault vaporizes the surrounding metallization, isolating the damaged spot from the rest of the foil. The capacitor continues to function with only a tiny capacitance loss — a major reliability advantage that allows film caps to handle the high ripple currents inside automotive inverters.

7. B — DOT 4 LV (low viscosity) brake fluid flows more readily through the narrow control passages and electronic valves of electro-hydraulic brake systems. Standard DOT 4 is too thick for these passages,

slowing response and increasing pump load; DOT 5 silicone is chemically incompatible with EHB system seals, so it must never be substituted.

8. A — A lower final drive ratio (7:1 versus 10:1) means the motor turns fewer revolutions per wheel revolution, so the same maximum motor RPM yields higher vehicle top speed. The trade-off is reduced torque multiplication at the wheels, so torque at low vehicle speeds is correspondingly lower. Designers choose the ratio to match the vehicle's intended use balance.

9. C — Cells are oriented so their safety vents point toward a defined venting channel routed through the pack interior. The channel directs vented gases to the pack's external rupture disk, where they exit the pack and (per OEM design) away from the passenger compartment. This deliberate routing prevents hot gases from building up adjacent to other cells or reaching occupants.

10. B — At -20°C the inverter's components still function, but with reduced peak capability — gate timing margins shrink, capacitor ESR shifts, and the BMS commands lower power output until the pack warms. The vehicle drives normally and the inverter operates safely; what's limited is the maximum acceleration available until the system reaches normal operating temperature.

11. C — The parking pawl is a small mechanical tooth or lever that engages into a notched gear inside the drive unit when the driver shifts to Park. This locks the drive output shaft mechanically, preventing the vehicle from rolling. The mechanism is functionally identical to the parking pawl found in any conventional automatic transmission.

12. C — Hybrid engine coolant is typically an extended-life OAT or HOAT formulation with low silicate content, chemically compatible with the aluminum heat exchangers and elastomer seals used throughout modern hybrid powertrains. The older high-silicate "green" coolants attack these components and accelerate corrosion, which is why the formulations are not interchangeable.

13. A — An HV-bus-powered resistive coolant heater warms the battery thermal management loop in cold weather, bringing pack temperature into the acceptance range before high-rate charging or aggressive driving. Without this heater, the pack would limit power until ambient warming naturally raised cell temperature — degrading both performance and the customer experience.

14. B — Active gate control varies the gate current profile during the turn-on and turn-off transitions, allowing the gate driver to optimize the trade-off between switching losses and EMI/voltage overshoot. SiC devices switch extremely fast, which makes this fine control particularly valuable for managing the resulting di/dt and dv/dt without sacrificing efficiency.

15. C — Gear backlash must fall within the OEM-specified tolerance range, with adjustment made by selecting appropriate shims at the bearing carrier locations. Outside-spec values cause problems on either side: too little backlash binds and accelerates wear; too much produces clunk on torque reversal and damages tooth contact surfaces over time.

16. A — Electrochemical impedance spectroscopy applies a small AC signal across the cell at a range of frequencies and measures how impedance varies with frequency. The resulting impedance signature

reveals information about electrode condition, electrolyte conductivity, and internal resistance that is invisible to simple DC measurements.

17. D — Open-circuit detection senses the absence of expected current in a phase when the IGBT is commanded to conduct. If the gate drive is applied but no current rises, the system flags an open-circuit condition — typically an interrupted motor winding, a broken bond wire, or a failed IGBT die. This catches faults that voltage measurement alone would miss.

18. A — The motor controller calculates output torque in real time from measured phase currents (transformed into d-axis and q-axis components) combined with known motor parameters such as flux linkage and inductance. A direct mechanical torque sensor would add cost, complexity, and a reliability risk for information that current-based calculation already provides accurately.

19. B — EV scheduled maintenance is dramatically reduced compared to a conventional vehicle: no engine oil, oil filter, or oil changes; no spark plugs; no timing belts; no exhaust components; and significantly reduced brake wear thanks to regenerative braking. Tire rotation, cabin filter replacement, and brake fluid service remain, but the overall service burden is much lighter.

20. B — The most direct way to verify actual usable capacity is to perform a controlled full charge followed by a controlled full discharge while integrating current over time. BMS-reported SOH is an estimate that may not reflect true capacity, particularly in used or aged packs where the BMS calibration may have drifted from accumulated coulomb-counting error.

21. A — The CCS handshake (per ISO 15118) begins with mutual identification of vehicle and station, then negotiates maximum voltage and current parameters, then performs an isolation check on both the charging cable and the vehicle's HV system. Only after all these checks pass do the contactors close and high current begin flowing into the battery.

22. D — Burn-in subjects each motor to extended operation under representative load conditions before shipping from the factory. Components with manufacturing defects ("infant mortality" failures) tend to fail early under stress; the burn-in process catches these failures at the factory rather than letting them reach the customer, dramatically improving field reliability.

23. B — Hydraulic lifters automatically compensate for thermal expansion and wear in the valve train, eliminating the need for scheduled valve clearance adjustment. This fits the hybrid emphasis on reduced scheduled maintenance — every eliminated service interval improves the vehicle's long-term value proposition and customer satisfaction.

24. D — Potting compound (typically silicone gel or filled epoxy) provides protection against moisture, contamination, and mechanical vibration in the harsh automotive environment. The potted inverter cannot be easily serviced internally, but the trade-off is dramatically improved reliability and resistance to environmental ingress that makes it worthwhile.

25. D — The crimp seal at the top of a cylindrical lithium-ion cell hermetically seals the cell against electrolyte leakage and external contamination throughout the cell's service life. Any breach allows

volatile electrolyte to escape (a serious fire hazard) and lets moisture or air enter (which rapidly degrades cell chemistry through unwanted side reactions).

26. A — EV alignment specifications are calibrated for the specific low-rolling-resistance tires that EVs typically use. Slightly different camber and toe values optimize for LRR tire characteristics, preserving range while maintaining handling and even tire wear. Service must use the OEM specification rather than generic conventional-vehicle values.

27. A — The inverter uses wheel speed sensor data to cross-check its own internally-calculated motor speed. Any disagreement between the two sources flags a fault in the drive system, the resolver, or the wheel speed sensor itself. This cross-check is part of the safety architecture that catches sensor failures before they cause incorrect torque commands or unintended acceleration events.

28. B — As lithium-ion cells approach full charge, their effective internal resistance rises and they become physically less able to accept high current without lithium plating or overvoltage at the anode. The charging protocol transitions from constant-current (CC) to constant-voltage (CV) mode, with current naturally tapering down as the cells approach full SOC.

29. D — NiMH cells exhibit notably higher self-discharge rates than lithium-ion cells, particularly at elevated temperatures. A NiMH pack stored at warm ambient temperatures can lose several percent of charge per day, while a comparable Li-ion pack would hold its charge for weeks under similar conditions. This is one of the reasons Li-ion has displaced NiMH in newer hybrids.

30. D — Type-2 hybrids replace the serpentine belt entirely with individual electric motors for each accessory: HV-powered A/C compressor, electric power steering pump (or EPS motor), electric water pump, and so on. Eliminating the belt and its accessories reduces parasitic engine load and allows each accessory to run only when needed at its optimal speed.

31. C — A fixed glass roof admits substantially more solar heat into the cabin than a conventional steel roof, even with tinting. The HVAC system must work harder (drawing more battery energy) to maintain cabin comfort in sunny conditions — a real range penalty in hot climates that designers compensate for with low-emissivity coatings, IR-blocking films, and increased A/C capacity.

32. C — SAE J2954 wireless inductive charging uses a magnetic field produced by oscillating AC current in the ground-side coil, which induces current in the vehicle-side coil through electromagnetic coupling across the air gap. This is the same principle as a transformer, just with the primary and secondary separated by several inches of air.

33. D — EV CV joints are typically uprated compared to conventional FWD vehicle parts because electric motors produce maximum torque instantly from zero RPM. The joints must handle this peak torque from rest without fatigue, requiring more robust internal components, larger overall dimensions, and often improved boot materials to handle the higher operating stresses.

34. A — During the pre-charge sequence, the BMS monitors DC link capacitor voltage as it rises through the precharge resistor. The main contactor closes only after the capacitor voltage reaches a threshold close

to pack voltage. This minimizes the inrush current that would otherwise weld the main contactor's contacts together on first closure.

35. C — Control Pilot (CP) signal communication faults are by far the most common cause of EV-to-EVSE handshake failures. The PWM-modulated signal can be disrupted by a damaged cable, dirty contacts, a faulty pilot circuit in either device, or signal-integrity issues. Most "won't communicate" symptoms trace back to CP signal problems rather than HV-side or grid-side issues.

36. D — Block heaters preheat the engine before the first cold start of the day, dramatically reducing the cold-start emissions spike (most of a drive cycle's emissions occur in the first minute of operation) and reducing wear from oil that hasn't reached operating viscosity. In cold climates this is a meaningful customer benefit on PHEVs with grid power available.

37. A — A pyrotechnic fuse uses a small explosive charge that, when triggered by the BMS during a severe fault, instantly severs the conductor and opens the HV bus. This is faster and more reliable than electromechanical contactors for crash scenarios or short-circuit events where milliseconds matter to prevent fire or further damage to the vehicle and occupants.

38. B — Regenerative braking handles most of the deceleration in normal EV driving — the motor absorbs kinetic energy and converts it back to charge, while friction brakes only engage for the final stop or hard braking events. The dramatically reduced friction brake workload extends pad and rotor life substantially, sometimes to the point where pads outlast multiple sets in a comparable conventional vehicle.

39. D — The CCS connector latch engages after the handshake completes successfully and remains engaged until the session is properly terminated by both vehicle and station. This prevents unintended disconnect during high-current charging — which would arc destructively at the contacts and create a serious safety hazard for anyone nearby.

40. D — The typical Li-ion SOH degradation curve has three distinct phases: an initial fast drop during the first 10-50 cycles as the SEI layer stabilizes, a long middle phase of slow nearly-linear degradation, and an accelerating "knee" near end of life. Recognizing the knee allows the BMS to warn of impending end-of-life before catastrophic capacity loss occurs.

41. C — Galvanic isolation specifically means there is no direct conductive path for current to flow between the HV system and the vehicle chassis. The HV system "floats" relative to chassis ground; current can only flow through the intended HV bus conductors, not through the chassis. This is precisely what makes the chassis safe to touch even while HV is present.

42. C — The driveshaft between the motor and differential is dynamically balanced like any conventional driveshaft to prevent vibration at high motor speeds. EV motors can spin to 15,000+ RPM, putting the driveshaft well into speeds where even small imbalance becomes audibly noticeable and mechanically damaging — careful balancing during manufacture is essential.

43. B — Under current federal regulations, vehicle owners have the right to know what data is being collected from their vehicle, with privacy disclosures required to be provided by the manufacturer. Data

ownership specifics and permitted use vary by jurisdiction and OEM, but transparency about what is collected is required at minimum.

44. D — Connector temperature sensors detect overheating from high-resistance contact conditions — typically caused by worn contacts, dirty surfaces, partial seating, or damaged crimps. Overheating connections waste energy as heat and can damage the connector, the cable, or the vehicle inlet; the sensor lets the EVSE derate or stop charging before damage occurs.

45. C — The ECM stores adapted values for closed throttle position that match the original throttle body's specific mechanical characteristics. When the throttle body is replaced, those adapted values no longer match the new component, causing idle issues until the ECM re-learns. The idle relearn procedure clears the old adaptations and allows new ones to be acquired against the new hardware.