PRACTICE EXAM 15: RED SEAL 310T SIMULATION (135 QUESTIONS)

1. A technician is preparing to weld a mounting bracket onto a truck's frame rail. The truck has aluminum fuel tanks on both sides of the frame. The nearest fuel tank is 600 mm from the proposed weld location. What precaution is necessary regarding the fuel tanks before welding begins?

A. The fuel tanks must be removed or their surfaces protected with a welding blanket, and a fire extinguisher must be positioned within reach — even at 600 mm, welding spatter, radiant heat, and sparks can ignite fuel vapors escaping from the tank's vent, heat the aluminum tank wall to the point of fuel ignition, or melt through the aluminum; the area must be prepared to contain any fire that may start despite precautions

B. The fuel tanks do not need protection because diesel fuel's high flash point makes it safe at 600 mm distance from a welding operation

C. The fuel tanks should be topped off completely to eliminate the air space above the fuel where vapors could ignite

D. A sheet of cardboard should be placed between the welding area and the fuel tank to block sparks from reaching the tank surface

2. A technician is using a hydraulic press to remove a frozen king pin from a steer axle knuckle. The press has been building pressure for 30 seconds and the king pin has not moved. The press gauge shows 15 tons of force. What is the safety concern if the technician continues to increase pressure?

A. The hydraulic press cylinder will overheat from the sustained pressure and may rupture at the cylinder seal

B. The press frame will flex under the excessive load and the workpiece may shift to an unsafe angle

C. The king pin, the knuckle, or the press tooling can shatter explosively under the extreme concentrated force — hardened steel components under high compressive load store enormous energy; if a component fractures, the stored energy releases instantly, projecting fragments at lethal velocity; the technician should stop increasing pressure, apply penetrating oil, use localized heat, and allow time for the oil to work before re-attempting the press operation

D. The hydraulic fluid in the press will cavitate under the high pressure and cause the press ram to drop suddenly

3. A shop has a strict policy that technicians must disconnect the battery negative cable before performing any electrical work on a truck. A technician argues that disconnecting the negative cable is unnecessary when working on a lighting circuit because the circuit is low-voltage and low-amperage. Why is the disconnect policy correct?

A. Low-voltage lighting circuits can still cause electric shock to a technician with wet hands or cuts on their skin

B. Even a 12V lighting circuit can produce a short circuit if a tool or wire contacts a grounded component — the short circuit draws hundreds of amps from the battery through the unintended path, generating enough heat to melt wiring insulation, ignite surrounding materials, and cause severe burns to the technician; disconnecting the negative cable eliminates the ground return path and prevents short circuits

C. The lighting circuit's wiring runs near the fuel system and an accidental spark could ignite fuel vapors in the wiring channel

D. Disconnecting the battery is required by Transport Canada regulations for all electrical work on commercial vehicles regardless of the circuit type

4. A technician is lifting a heavy-duty truck engine (approximately 900 kg) with the shop's engine crane. During the lift, the technician notices the crane is tilting forward — the front casters are lifting off the floor. What does this indicate?

A. The crane's hydraulic cylinder has a slow leak that is reducing the lifting force during the lift

B. The crane's boom has extended beyond the manufacturer's recommended length for the engine's weight

C. The engine's weight has shifted to one side of the lifting bracket, creating an imbalanced load on the crane

D. The engine's weight exceeds the crane's capacity at the current boom extension — the crane is overloaded and is tipping forward; the technician must immediately lower the load before the crane tips

over completely; continuing to lift or move the load will cause the crane to topple, dropping the 900 kg engine and the crane onto anyone or anything in the area

5. A technician is replacing a leaf spring on a heavy-duty truck. The spring is under significant preload from the vehicle's weight. The technician begins removing the U-bolt nuts without first supporting the axle with a jack stand. What is the hazard?

A. When the last U-bolt is removed, the spring's stored energy will release suddenly — the compressed spring can launch the axle downward (if the vehicle is on a lift) or allow the vehicle's frame to rise abruptly; the sudden uncontrolled movement can strike the technician, pinch hands between components, or cause the vehicle to shift on its supports; the axle must be supported independently before the U-bolts are removed to control the spring's energy release

B. The U-bolts will be difficult to remove without a jack supporting the axle because the spring preload presses the nuts tightly against the spring pad

C. The leaf spring will slide out of its mounting brackets when the U-bolts are removed and the spring's weight could injure the technician

D. The brake lines connected to the axle will be stretched beyond their safe limit when the axle drops after the U-bolts are removed

6. A technician is draining used transmission fluid from an automatic transmission into a drain pan. The fluid has a strong burnt odor and is dark brown. Can this fluid be poured into the shop's waste oil collection drum?

A. No — automatic transmission fluid with a burnt odor must be disposed of separately from waste oil because the burnt additives are classified as a different waste category

B. No — the burnt fluid must be tested for hazardous contaminants before it can be mixed with any other waste stream

C. Yes — used automatic transmission fluid is classified as used petroleum product and can be collected in the same waste oil drum as engine oil, hydraulic oil, and other petroleum-based fluids for recycling; the burnt odor and dark color do not change its classification

D. Yes, but only if the waste oil drum is less than half full to allow adequate dilution of the burnt fluid's contaminants

7. A technician is assigned to perform an undercarriage inspection on a heavy-duty truck. The truck is parked on level ground with the engine off and the keys removed. Before crawling under the truck, what additional safety step is required?

A. Verify the truck's parking brake is set and place the keys in the technician's pocket to prevent anyone from starting or moving the vehicle

B. Set the parking brake, chock the wheels, and verify the vehicle is stable on its supports — if the vehicle is on jack stands, verify the stands are on solid, level ground and the vehicle is stable; if the vehicle is on the ground, wheel chocks prevent any rolling movement; removing the keys prevents engine start but does not prevent the vehicle from rolling if the parking brake fails or was not set

C. Set the parking brake and place a "Do Not Move" placard on the steering wheel

D. Set the parking brake and notify the shop foreman that the truck is being inspected

8. A technician is inflating a truck tire that was driven while flat. The tire has visible sidewall damage from the run-flat operation — the sidewall rubber shows creasing, cracking, and separation. Should the technician inflate this tire?

A. The tire can be inflated to 50% of its rated pressure for a temporary limp-to-the-shop drive at low speed

B. The tire can be inflated if the sidewall damage is limited to the outer rubber and does not extend to the internal cords

C. The tire can be inflated inside a safety cage for testing purposes to determine if the sidewall holds pressure

D. The tire must not be inflated — sidewall damage from run-flat operation compromises the tire's structural integrity; the internal cords may be broken, delaminated, or heat-damaged from the flat operation even if the external damage appears minor; inflating a structurally compromised tire risks a blowout that can cause severe injury; the tire must be removed from service and replaced

9. A heavy-duty diesel engine has a condition where the engine starts and runs, but the ECM does not enter closed-loop fuel control — it remains in open-loop mode continuously. The scan tool shows all sensor values are within normal range. What single sensor fault could prevent the ECM from transitioning to closed-loop control?

A. The intake air temperature sensor reading is within range but is reading 10°C lower than the actual temperature

B. The fuel temperature sensor reading is normal but has a slow response time that delays the ECM's fuel density calculation

C. The coolant temperature sensor is reading within its normal electrical range but is stuck at a fixed value (such as −30°C) — the ECM requires the coolant temperature to reach a minimum threshold before transitioning to closed-loop control; a sensor stuck at −30°C tells the ECM the engine has not warmed up, so it remains in open-loop enrichment indefinitely; the value is within the sensor's electrical range, so no fault code is set

D. The barometric pressure sensor has a calibration offset that makes the ECM believe the vehicle is at a higher altitude than actual

10. A diesel engine's oil analysis shows a steady downward trend in the total base number (TBN) — the TBN has dropped from 10.0 (new oil) to 3.5 over the current oil change interval. The oil change interval still has 5,000 km remaining. What does the declining TBN indicate, and what should be done?

A. The TBN measures the oil's remaining alkaline reserve — the alkaline additives neutralize the acidic byproducts of combustion (sulfuric acid from sulfur in the fuel, nitric acid from nitrogen compounds); a TBN of 3.5 is approaching the condemning limit (typically 2.0-3.0); the oil should be changed before the remaining 5,000 km to prevent the acid from attacking the engine's bearing surfaces, seals, and internal components

B. The TBN decline is normal and the oil can safely complete the remaining 5,000 km as long as the viscosity remains within specification

C. The TBN measures the oil's viscosity stability and the declining value indicates the oil is thinning from fuel dilution

D. The TBN measures the oil's oxidation resistance and the low value indicates the oil has exceeded its thermal stability limit

11. A heavy-duty diesel engine equipped with a common rail fuel system has a condition where the fuel rail pressure oscillates wildly (±500 bar) during idle but stabilizes at higher RPM. No fault codes are present during the oscillation. What is the most likely cause?

A. The high-pressure pump's inlet metering valve has contamination that causes it to stick and release at the low flow rates of idle operation

B. The fuel rail pressure sensor has a noisy signal at idle that the ECM's filtering algorithm cannot smooth

C. The fuel return line has a restriction that creates a standing wave in the rail at the specific flow frequency of idle operation

D. A fuel injector has an intermittent internal leak that is significant at the low fuel volumes of idle but inconsequential at the higher volumes of elevated RPM — at idle, each injection event delivers a tiny fuel volume, and the intermittent leak represents a large percentage of that volume; the rail pressure drops sharply during the leak and recovers when the leak seals, creating the oscillation; at higher RPM, the leak is a smaller percentage of the larger fuel volume and the oscillation is dampened

12. A diesel engine has a condition where the engine's power output has decreased gradually over 100,000 km. The turbocharger boost pressure is 2 psi below specification at full load. The air filter is clean, the intake ducting has no leaks, and the exhaust system has no restrictions. What is the most likely cause of the low boost?

A. The fuel injection timing has retarded gradually, reducing the exhaust energy available to drive the turbocharger

B. The turbocharger's compressor wheel and housing have accumulated a layer of oil residue and dirt that reduces the compressor's aerodynamic efficiency — the contamination reduces the wheel's ability to compress air, and the reduced output produces lower boost; cleaning the compressor housing and wheel (if no blade damage is found) can restore the lost boost without replacing the turbocharger

C. The wastegate actuator's diaphragm has stretched from age, allowing the wastegate to open at a lower boost pressure than designed

D. The turbocharger's bearing has worn, increasing the shaft play and reducing the compressor wheel's tip clearance from the housing

13. A heavy-duty diesel engine equipped with an EGR system has a condition where the engine produces excessive NOx emissions (confirmed by the downstream NOx sensor reading above the target value). The EGR valve position sensor shows the valve is at the ECM's commanded position. What could cause elevated NOx despite the EGR valve being at the correct position?

A. The EGR cooler is completely bypassed due to a failed cooler bypass valve, and the hot, uncooled exhaust gas is less effective at suppressing combustion temperatures

B. The EGR valve is at the correct position but the EGR flow is restricted downstream of the valve by carbon deposits in the intake manifold — the valve opens to the commanded position, but the restricted passage limits the actual gas flow below the intended volume; the reduced EGR flow allows higher combustion temperatures that produce elevated NOx

C. The EGR cooler has developed a restriction that reduces the EGR flow rate below the designed volume — the valve opens to the commanded angle, but the cooler cannot pass the designed flow volume through its contaminated passages; the ECM sees the correct valve position but the actual EGR mass flow is less than needed for NOx suppression

D. The fuel injection timing has advanced from its calibrated position, creating higher peak combustion temperatures that produce more NOx than the correctly functioning EGR system can suppress

14. A diesel engine's coolant test shows the freeze point protection is adequate (−45°C), the pH is normal (9.5), and the nitrite level is within specification. However, the coolant's color has changed from the original pink to a dark brown. What is the most likely cause of the discoloration?

A. The coolant has been contaminated with engine oil from a leaking oil cooler — even a small amount of petroleum oil mixing with the coolant changes its color from the original dye color to dark brown; the oil floats on the coolant surface in the degas bottle and creates a brown film on the reservoir walls; the freeze point and pH remain unaffected in the early stages of contamination because the oil does not immediately react with the coolant's chemistry

B. The coolant's dye has degraded from UV exposure through the transparent degas bottle

C. The coolant has absorbed iron particles from internal corrosion despite the acceptable nitrite level

D. The coolant has reached the end of its service life and the dark color indicates the organic acid inhibitors have exhausted

15. A heavy-duty diesel engine has a condition where the engine produces a rhythmic exhaust puff visible at the tailpipe approximately once per second at idle. The puff is distinctly different from the normal exhaust flow — it appears as a discrete puff of smoke or condensate separated by periods of clean exhaust. What does this rhythmic puff indicate?

A. The turbocharger wastegate is cycling open and closed at approximately 1 Hz from a calibration instability

B. The EGR valve is pulsing from an oscillating control signal that creates rhythmic exhaust flow disturbances

C. The DPF is releasing stored soot in periodic pulses from a thermal cycling condition within the filter substrate

D. One cylinder is misfiring or producing significantly weaker combustion than the others — the rhythmic puff at approximately 1 Hz corresponds to one cylinder's firing interval at idle RPM (a 6-cylinder engine at 600 RPM fires each cylinder 5 times per second, with each individual cylinder firing once per second at idle); the weak cylinder produces unburned fuel or incomplete combustion products that appear as the discrete puff at its specific firing interval

16. A diesel engine equipped with a fuel-water separator has a condition where the separator bowl has been cracked by freezing water. How did water accumulate to a level that could crack the bowl, and how can this be prevented?

A. The fuel-water separator's heater element has failed, allowing accumulated water to freeze in cold weather

B. Water accumulates in the separator bowl from normal condensation and fuel contamination — the separator is designed to collect and hold water for periodic draining; if the bowl is not drained regularly (as specified in the maintenance schedule), the water level rises until the bowl is nearly full; in freezing weather, the water expands as it freezes and cracks the bowl; regular draining at the specified interval and a functional bowl heater (if equipped) prevent freeze damage

C. The fuel supplier has delivered water-contaminated fuel that overwhelmed the separator's capacity

D. The separator element has degraded and is allowing water to pass through to the engine instead of collecting in the bowl

17. A heavy-duty diesel engine has a condition where the engine oil level has risen above the full mark on the dipstick. The oil has a fuel odor and the viscosity feels thinner than fresh oil. The engine is equipped with a DPF that uses in-cylinder post-injection for regeneration. What is the most likely cause?

A. The DPF regeneration strategy's post-injection fuel is washing past the piston rings into the crankcase — during active regeneration, the ECM commands a late injection event to raise exhaust temperatures; some of this late-injected fuel contacts the cylinder walls and migrates past the rings; the frequency of regeneration events and the volume of post-injection fuel determine the dilution rate; the rising oil level, fuel odor, and reduced viscosity collectively confirm fuel dilution from the regeneration strategy

B. A fuel injector is leaking fuel into the cylinder during the engine-off period from a worn nozzle seat

C. The fuel transfer pump has an internal diaphragm leak that directs fuel into the crankcase through the pump mounting gasket

D. The crankcase ventilation system has a cross-connection to the fuel tank vent that introduces fuel vapors into the crankcase

18. A diesel engine's radiator has been recently replaced. After the replacement, the engine overheats during loaded uphill driving but maintains normal temperature during flat highway driving. The thermostat, water pump, and fan have been verified as functional. What is the most likely cause?

A. The replacement radiator has a higher pressure cap rating that changes the coolant's boiling point and overheating threshold

B. The replacement radiator is mounted with a slight forward tilt that creates an air pocket in the upper tank during uphill driving

C. The replacement radiator has fewer cooling tubes or a smaller core than the original specification — the reduced cooling capacity handles the moderate heat load of flat highway driving but cannot reject the increased heat generated during the heavy load of uphill operation; the replacement radiator must be verified against the original part number and specifications

D. The replacement radiator has the inlet and outlet connections reversed, creating a counter-flow pattern that reduces cooling efficiency during loaded conditions

19. A heavy-duty diesel engine equipped with a VGT turbocharger has a condition where the engine produces a surge (rhythmic power fluctuation) during steady-state cruise at 1,800 RPM. The surge frequency is approximately 2-3 Hz. What is the most likely cause?

A. The fuel system has a pulsation at the injection pump frequency that interferes with the steady-state fuel delivery

B. The engine's drive belt slips intermittently at 1,800 RPM from a resonance between the belt's natural frequency and the crankshaft frequency

C. The exhaust brake butterfly valve is partially open from a faulty solenoid, creating a rhythmic backpressure fluctuation

D. The VGT control system is hunting — the ECM commands a vane position for the cruise condition, the turbocharger responds with a boost pressure that slightly overshoots the target, the ECM adjusts the vanes to reduce boost, the boost undershoots, and the correction cycle repeats at 2-3 Hz; a contaminated VGT actuator, a sticky vane mechanism, or an ECM control loop calibration issue causes the instability

20. A diesel engine has a condition where the engine's coolant temperature drops below thermostat-opening temperature during sustained highway driving in cold weather (−20°C ambient). The thermostat has been replaced and is confirmed functional. What is the most likely cause?

A. The engine's fan clutch has seized in the engaged position, providing maximum cooling continuously regardless of the temperature

B. The winterfront (grille shutter or cold weather cover) is missing or damaged — in extreme cold ambient temperatures, the ram airflow through the radiator at highway speed removes heat faster than the engine generates it; the thermostat closes to block radiator flow, but the cold air flowing through the charge air cooler and around the engine still removes significant heat; a winterfront blocks the excessive ram airflow and allows the engine to maintain operating temperature

C. The coolant mixture has too high a water-to-antifreeze ratio, reducing the coolant's heat retention capacity

D. The EGR cooler is extracting excessive heat from the coolant circuit, dropping the temperature below normal

21. A heavy-duty diesel engine equipped with a DOC, DPF, and SCR aftertreatment system has a condition where the SCR system produces a strong ammonia odor from the tailpipe during highway driving. What does the ammonia odor indicate?

A. The DEF dosing system is injecting more DEF than the SCR catalyst can convert — the excess urea decomposes to ammonia inside the exhaust stream, and the ammonia passes through the SCR catalyst without reacting (ammonia slip); the odor indicates the dosing rate is too high for the current exhaust

conditions, the SCR catalyst's conversion efficiency has decreased, or the exhaust temperature is too low for the SCR reaction to consume all the injected ammonia

B. The DEF has degraded from age or heat exposure and is producing ammonia during decomposition instead of the intended isocyanic acid

C. The DPF is contaminated with DEF that leaked through a failed DPF-to-SCR gasket

D. The engine's combustion produces excessive NOx that the SCR cannot fully convert, and the remaining NOx reacts with the excess ammonia to produce the odor

22. A diesel engine's exhaust manifold bolt has broken off flush with the cylinder head surface. The technician attempts to drill the broken bolt and extract it using an easy-out (screw extractor). During the extraction, the easy-out breaks inside the drilled hole. What makes this a particularly difficult repair situation?

A. The easy-out fragments will contaminate the cylinder head's coolant passages if they fall into the bolt hole

B. The drilled hole has been weakened by the extraction attempt and a helicoil repair is no longer viable

C. The easy-out is hardened tool steel that cannot be drilled with standard drill bits — the broken extractor is harder than the drill bits available in the shop; it must be removed by EDM (electrical discharge machining), carbide burring, or specialized extraction by a machine shop; standard drill bits will dull instantly against the hardened extractor without removing material

D. The easy-out has expanded the bolt hole beyond the repair size for the cylinder head specification

23. A heavy-duty diesel engine has a condition where the engine oil pressure is normal at all engine speeds except during hard acceleration from idle — the oil pressure drops briefly to near zero during the first 2 seconds of rapid acceleration, then recovers to normal. What is the most likely cause?

A. The oil pump relief valve is sticking open from contamination during the sudden pressure spike of rapid acceleration

B. The oil filter bypass valve opens during the rapid acceleration pressure change, momentarily dumping unfiltered oil and dropping the gauge pressure

C. The oil pickup tube has a loose connection or a cracked joint at the oil pump inlet — during rapid acceleration, the engine's tilting force (from the torque reaction) shifts the oil mass in the pan and momentarily exposes the pickup tube to air or reduces the oil level at the pickup; the brief air ingestion drops the pressure to near zero until the oil settles and covers the pickup again

D. The oil pan's windage tray has shifted from a broken mounting bracket and is deflecting oil away from the pickup tube during the acceleration-induced oil surge

24. A diesel engine equipped with an electronic fuel injection system has a condition where the engine runs normally but the exhaust produces a faint but continuous grey haze. The haze does not change with load or speed. The turbocharger has been inspected and is not leaking oil. What is the most likely source of the grey haze?

A. The fuel has been blended with a biodiesel concentration that produces the grey haze from the different combustion characteristics of the bio-component

B. A small but continuous oil consumption source is producing the grey haze — the valve stem seals are allowing a constant small amount of oil to seep into the intake ports and burn in the combustion chambers; the oil consumption rate is too low to affect the oil level noticeably between changes but is visible as the faint grey haze

C. The EGR system is introducing a small amount of soot into the intake that recirculates through the cylinders and exits as the grey haze

D. The DPF substrate has a micro-crack that allows a small percentage of the soot to bypass the filter and exit the tailpipe as the grey haze

25. A heavy-duty diesel engine has been overhauled with new pistons, rings, liners, and bearings. After the first 1,000 km, the oil analysis shows elevated iron and chromium but the levels are declining from the previous 500 km sample. What does this declining trend indicate?

A. The elevated iron (from the liners) and chromium (from the ring plating) during the first 1,000 km are normal break-in wear — the new rings and liners mate their surfaces during the initial operating period, producing fine wear particles; the declining trend confirms the break-in process is progressing normally and the wear rate is decreasing as the surfaces polish and conform; continued monitoring should show the metals stabilizing at low levels

B. The declining trend indicates the oil additive package is capturing and neutralizing the wear metals more effectively as it reaches its operating concentration

C. The wear metals are settling out of the oil into the sump and are no longer suspended for the analysis to detect

D. The declining trend indicates the new components are defective and are wearing past their plating into the base metal

26. A diesel engine's cooling system has a condition where the coolant level in the degas bottle drops by approximately 200 ml per week. There are no visible external leaks, the oil is clean, and the exhaust shows no white smoke. A pressure test holds for 20 minutes. The combustion gas test (block tester) is negative. Where else could the coolant be going?

A. The cab heater core has a micro-leak that evaporates the coolant into the HVAC airstream before it can drip visibly onto the cab floor

B. The coolant is evaporating through the degas bottle's pressure cap during normal thermal cycling

C. The coolant is being consumed through a path that the standard tests do not detect — the cab heater core may have a micro-leak that vaporizes the coolant into the HVAC airstream (the driver may notice a sweet smell or foggy windshield); the air compressor may draw coolant through a failed head gasket between the compressor mounting and the block's coolant passage; or the EGR cooler may have a leak small enough that the coolant vaporizes in the exhaust without producing visible white smoke

D. The coolant test strip is inaccurate and the actual coolant level has not changed

27. A heavy-duty diesel engine has a condition where the engine produces a single, loud metallic clunk from the front of the engine when the key is turned to the off position. The clunk does not occur during startup or during normal operation. What is the most likely cause?

A. The starter motor's Bendix drive is momentarily engaging the flywheel ring gear from a residual electrical current during shutdown

B. The fuel injection pump's shutdown solenoid retracts with a loud impact against its internal stop — the solenoid is spring-loaded to the fuel-off position and is held in the fuel-on position by electrical current during operation; when the key is turned off, the solenoid releases and the spring drives the plunger to the fuel-off position with enough force to produce an audible clunk

C. The engine's harmonic balancer is shifting position on the crankshaft from a deteriorated rubber isolator that allows movement during the shutdown deceleration

D. The exhaust brake butterfly valve snaps closed when the engine is shut off from a faulty control signal that commands the brake during shutdown

28. A diesel engine equipped with a common rail fuel system has a condition where the engine cranks but will not start. The scan tool shows the fuel rail pressure reaches only 800 bar during cranking. The minimum starting pressure is 2,000 bar. What should be investigated first?

A. The fuel injectors for excessive return flow — if one or more injectors have worn internal seals, the high-pressure fuel leaks back to the return line instead of being retained in the rail; the pump cannot build adequate pressure because the leaking injectors drain the rail faster than the pump can fill it; a return flow test (measuring each injector's return volume during cranking) identifies the leaking injector(s)

B. The high-pressure fuel pump for worn internal components that cannot generate adequate pressure

C. The fuel rail pressure sensor for a calibration error that reads lower than the actual pressure

D. The fuel rail pressure relief valve for a leak that vents the high-pressure fuel back to the tank — a stuck-open relief valve drains the rail pressure as fast as the pump builds it; the relief valve's function is to protect the system from overpressure, but a faulty valve opens at normal operating pressure

29. A heavy-duty diesel engine has a condition where the engine's idle quality deteriorates gradually over 6 months without producing any fault codes. A cylinder contribution test shows all cylinders contributing equally. The injectors have been replaced with calibrated units. What less-obvious component should be investigated?

A. The exhaust system for a developing restriction that increases backpressure gradually, reducing the engine's ability to scavenge the cylinders efficiently at idle

B. The engine's valve lash — if the valves have not been adjusted within the maintenance interval, the lash on one or more valves may have tightened (from valve seat recession or wear) to the point where the valve does not close completely; a slightly open valve leaks compression, reduces that cylinder's power contribution at idle, and the gradual seat recession correlates with the 6-month progressive deterioration; the cylinder contribution test may not detect the small individual differences because all cylinders have aged similarly

C. The crankcase ventilation system for a progressive restriction that increases crankcase pressure and reduces ring sealing

D. The turbocharger for compressor wheel contamination that reduces the air charge at idle progressively over 6 months

30. A heavy-duty truck's air brake system has a condition where the compressor builds air pressure from 0 to cut-out in the normal time, but the air dryer's desiccant cartridge requires replacement every 2 weeks instead of the normal 6-month interval. The compressor's oil pass-by has been checked and is within specification. What else could cause the premature desiccant saturation?

A. The air dryer purge cycle is too short — the governor signals the purge, but the purge duration is insufficient to regenerate the desiccant bed completely; the partially regenerated bed carries residual moisture into the next loading cycle, progressively reducing the bed's capacity until it saturates in 2 weeks; the purge volume may be restricted by an undersized purge orifice, a partially blocked purge valve, or a supply tank that does not provide adequate reverse-flow volume for regeneration

B. The air compressor is producing more moisture than normal because the compressor's cooling circuit has a partial restriction that raises the discharge temperature

C. The air dryer is mounted in a location that exposes it to direct engine heat, raising the desiccant temperature above its effective operating range

D. The desiccant cartridge is the wrong specification for the air dryer model installed on the truck

31. A tractor-trailer combination has a condition where the trailer's ABS light illuminates during every downhill brake application but extinguishes on flat road braking. The trailer's ABS functions correctly on flat terrain. What could cause the downhill-only ABS fault?

A. The trailer's ABS wheel speed sensors are mounted too close to a heat source (brake drum) and overheat during the sustained downhill braking

B. The trailer's electrical connector has a marginal pin that maintains contact during normal driving vibration but loses contact during the specific vibration frequency of sustained downhill braking

C. The trailer's ABS modulator valves overheat from the sustained downhill brake application and trigger a thermal protection fault — the modulators cycle continuously during the prolonged downhill braking, generating heat in their electromagnetic coils; when the coil temperature exceeds the ABS

module's thermal threshold, the module sets a fault and illuminates the lamp; on flat terrain, the modulator cycling is brief and the coils do not reach the thermal limit

D. The downhill grade changes the trailer's weight distribution and overloads the rear axle ABS sensors beyond their calibrated range

32. A heavy-duty truck equipped with drum brakes on the drive axle has a condition where both rear brakes grab sharply during light brake applications but function normally during moderate to heavy applications. What is the most likely cause?

A. The brake shoes have a contamination (oil or grease) pattern that creates inconsistent friction during light contact but is overwhelmed during heavy contact

B. The brake drums have developed a bell-mouth shape (the open end of the drum is larger than the closed end) from uneven thermal expansion — during light application, the shoes contact only the narrow closed end of the bell-mouth, creating a small contact area with high unit pressure that produces the grabbing feel; during heavier application, the shoes expand to contact the full drum width and the braking smooths out

C. The relay valve for the drive axle delivers full pressure during light applications from a failed proportioning mechanism

D. The brake drums have developed hard spots from previous overheating events that create grabbing at the high-friction spots — the hard spots have a higher friction coefficient than the surrounding drum surface; during light application, the shoes contact the hard spots with sufficient force to grab; during heavier application, the shoes contact the entire drum surface and the hard spots' effect is averaged across the larger contact area

33. A heavy-duty truck has a condition where the air compressor's duty cycle is 40% (loaded 40% of the time). The specification maximum is 25%. The system passes all static leak tests. What is consuming the excess air?

A. The air-operated accessories (air seats, air horns, air-operated PTO, air-operated fifth wheel lock) are consuming air during normal operation at a rate that increases the compressor's duty cycle beyond the brake system's designed demand

B. The air system has multiple small leaks that individually pass the per-minute static test but collectively consume enough air to increase the duty cycle from 25% to 40% — the cumulative effect of

many small leaks is not captured by the static test's short measurement window but is reflected in the elevated duty cycle over the full driving cycle

C. The compressor's volumetric efficiency has decreased from wear, requiring it to run longer to deliver the same air volume

D. The air dryer's purge cycle is consuming excessive air during each purge event, depleting the system faster than the brake-only demand would

34. A school bus equipped with air brakes has a condition where the brake pedal has a noticeable dead zone at the top of its travel — the first 25 mm of pedal travel produces no braking action. After the dead zone, the brakes apply normally. What is the most likely cause?

A. The foot valve (treadle valve) has excessive free play between the pedal mechanism and the valve's internal piston — a worn pivot pin, elongated clevis hole, or compressed pedal return stop creates mechanical travel that must be consumed before the pedal begins to actuate the valve's piston; the brakes apply normally once the dead zone is taken up and the piston begins to move

B. The relay valve for the front brakes has a high crack pressure that requires significant pedal travel before it opens

C. The air lines between the foot valve and the relay valves have expansion joints that absorb the initial pedal travel before transmitting pressure

D. The brake chambers have air springs that must be compressed before the pushrod begins to extend

35. A heavy-duty truck has a condition where one automatic slack adjuster on the drive axle consistently over-adjusts — the pushrod stroke is shorter than the minimum specification, keeping the brake shoes in constant contact with the drum. The ASA has been replaced twice and the problem recurs. What is causing the over-adjustment?

A. The wrong ASA part number has been installed — the ASA is designed for a specific chamber size, slack adjuster arm length, and drum diameter; installing an ASA with the wrong internal gear ratio or arm length causes it to advance the adjustment beyond the correct stroke range; the correct part number must be verified against the axle's brake component specifications

B. The brake drum has been machined undersized, and the ASA compensates for the reduced drum diameter by advancing the adjustment beyond the normal range

C. The anchor pin is seized, preventing the shoes from retracting, which the ASA interprets as a need for further adjustment — the ASA continuously advances because it senses the shoes are not returning to their designed clearance position; the seized anchor pin is the root cause that three ASAs have failed to overcome

D. The brake chamber diaphragm has a wrinkle that changes the effective stroke length and confuses the ASA's adjustment mechanism

36. A tractor-trailer combination has a condition where the driver reports a long delay (approximately 5 seconds) between pressing the brake pedal and the trailer brakes beginning to apply. The tractor brakes respond immediately. What is the most likely cause?

A. The trailer's relay valve has a contaminated or corroded inlet port that severely restricts the air flow to the brake chambers

B. The air line routing between the tractor's service gladhand and the trailer's relay valve has excessive length or volume — the foot valve must pressurize this entire length of line before the signal reaches the trailer's relay valve; an excessively long line, an oversized line, or additional volume from improper routing creates a delay between the foot valve's output and the signal's arrival at the relay valve

C. The trailer's ABS modulator is adding a time delay to the application signal as part of its electronic stability program

D. The tractor protection valve has a slow-opening inlet valve that delays the signal to the trailer service line

37. A heavy-duty truck equipped with ABS has a condition where the ABS activates on only one wheel during a moderate stop on dry pavement. All other wheels decelerate normally without ABS activation. What should be investigated on the wheel where the ABS is activating?

A. The ABS modulator valve for that wheel, which may be opening prematurely from an internal fault

B. The tire on that wheel for a significantly different size, tread depth, or inflation pressure than the other tires — a tire with less tread, lower pressure, or a smaller diameter reaches its lockup threshold at a lower brake force than the other tires; the ABS detects the earlier lockup tendency and modulates that wheel to prevent the under-performing tire from skidding

C. The ABS wheel speed sensor for that wheel, which may be producing an erratic signal that the module interprets as impending lockup

D. That wheel's brake for an issue that produces more braking force than the other wheels at the same air pressure — a brake that grabs excessively (from contaminated lining, an over-adjusted ASA, or a smaller-than-specification drum) will lock that wheel before the others during a moderate stop; the ABS correctly intervenes to prevent the one wheel from locking while the others decelerate normally

38. A transit bus equipped with air disc brakes has a condition where one caliper produces a continuous scraping noise during wheel rotation with the brakes released. The noise stops when the brakes are applied. What is the most likely cause?

A. The brake pad has a worn wear indicator tab that contacts the rotor during rotation with the brakes released — the tab is designed to scrape the rotor when the pad reaches its minimum thickness; when the brakes are applied, the application force presses the tab flat against the rotor surface and the scraping stops; the pad must be replaced

B. The rotor has a raised lip on its outer edge from uneven wear that contacts the pad's edge during rotation

C. The caliper piston has not retracted fully and holds the pad in light contact with the rotor

D. A piece of debris is trapped between the pad and the rotor, producing the scraping during rotation

39. A heavy-duty truck's air brake system has a condition where the system pressure drops to the governor cut-in point (95 psi) within 2 minutes of the engine being shut off. All static leak tests pass (within the per-minute specification). What is the most likely leak source?

A. The air compressor's discharge check valve is not sealing — the stored system air leaks backward through the compressor cylinders and exits through the compressor's intake; the leak rate is within the per-minute static test specification but over a 2-minute period, the cumulative loss depletes the system to the cut-in point

B. The governor has a leaking diaphragm that vents air continuously from the system at a rate below the static test threshold

C. The compressor's unloader mechanism has a slow leak in the unloaded position that drains the system after shutdown — the compressor's unloader pistons hold the intake valves open after the governor

signals cut-out; a leak in the unloader piston's seal allows system air to escape through the open intake valves continuously after shutdown

D. The air dryer's check valve is leaking and allowing system air to bleed backward through the dryer and exhaust through the purge valve

40. A heavy-duty truck has a condition where the left front brake drags intermittently — the driver notices the truck pulls to the left during coasting and the left front wheel is hotter than the right. The brake drag is not consistent and seems to come and go randomly. What is the most likely cause?

A. The left front brake caliper (or wheel cylinder on drum brakes) has a restriction in its return path

B. The left front brake application circuit has a hose with a deteriorated inner liner — the rubber liner has separated from the hose body and acts as a one-way valve; the application air pushes through the liner flap into the chamber, but when the application pressure releases, the liner flap blocks the return flow; the air is trapped in the chamber and the brake remains applied until the liner shifts and allows the air to slowly escape; the random nature matches the unpredictable behavior of the loose liner flap

C. The ABS modulator for the left front wheel has an intermittent electronic fault that holds residual pressure in the circuit after each application

D. The left front brake's quick release valve has a contaminated exhaust port that intermittently blocks the release air

41. A tractor-trailer combination has a condition where the driver makes an emergency stop and the ABS activates on all axle positions. During the emergency stop, the driver notices the steering feels heavy and the truck does not respond to steering input as quickly as expected. Is the heavy steering during ABS activation normal?

A. ABS activation should not affect steering effort or response — the heavy steering indicates a separate power steering fault that coincidentally manifests during emergency braking

B. The ABS is malfunctioning by modulating the steer axle brakes too aggressively, reducing the tire's available traction for steering

C. The heavy steering is caused by the extreme deceleration forces shifting the vehicle's weight forward, loading the steer tires beyond their designed contact area

D. During an ABS-active emergency stop, the extreme weight transfer to the front axle increases the steer tire loading, which increases the steering effort — additionally, the ABS is modulating the steer axle brakes to prevent lockup, and the rapid pressure cycling creates brief moments where the steer tires have reduced traction; both effects combine to make the steering feel heavier and less responsive during the emergency stop compared to normal driving

42. A heavy-duty truck has a condition where the parking brake hold-off pressure (the air that releases the spring brakes) slowly decreases when the vehicle is parked overnight with the parking brake released. After 8 hours, the spring brakes have partially applied from the reduced hold-off pressure. What is the most likely cause?

A. The spring brake relay valve has a slow internal leak on the hold-off circuit — air is leaking past an internal seal from the hold-off side to the exhaust; the leak rate is slow (taking 8 hours to noticeably apply the spring brakes) but continuous; the valve must be replaced because the slow leak will eventually fully apply the spring brakes during extended parking

B. The parking brake valve's internal check valve is leaking in the reverse direction, allowing hold-off air to bleed back through the valve

C. The spring brake chambers themselves have a slow leak through their diaphragm or fittings

D. The governor's signal to the compressor is leaking, draining the system pressure that feeds the spring brake hold-off circuit

43. A school bus equipped with drum brakes has a condition where both front brakes produce a squeal during light braking. The squeal disappears during moderate to heavy braking. The brake linings have adequate thickness. What is the most likely cause?

A. The brake shoe return springs are the wrong specification and are not holding the shoes firmly enough against the anchor pins during light application

B. The brake drums have glazed from extended highway driving with minimal brake use, creating a smooth surface that the shoes vibrate against during light contact

C. The brake shoes vibrate at their natural frequency during light application — the light contact force is insufficient to dampen the shoe-to-drum vibration; during heavier application, the increased contact pressure clamps the shoes against the drum firmly enough to suppress the vibration; anti-squeal

compound on the shoe backing plates or a slight chamfer on the lining edges typically eliminates the squeal

D. The brake drum has developed a slight out-of-round condition that excites the shoes' resonance during light contact

44. A heavy-duty truck equipped with ABS has a condition where the ABS activates during every stop when the vehicle is loaded to maximum gross weight but does not activate during stops at the same intensity when the vehicle is empty. What is the most likely cause?

A. The braking system's proportioning is incorrectly matched to the loaded weight distribution

B. The ABS is functioning correctly — the loaded weight should increase the tires' traction and reduce the tendency to lock up

C. The loaded vehicle's higher center of gravity increases the weight transfer during braking, overloading the front tires and causing them to reach lockup threshold before the rear tires

D. The loaded vehicle generates higher braking forces at the same deceleration rate — the heavier vehicle requires more brake force to decelerate at the same rate; the increased force exceeds the available traction at one or more wheel positions, and the ABS activates to prevent lockup; the brake proportioning may need adjustment to match the loaded weight distribution, or the tires may be at the limit of their traction capacity for the loaded weight

45. A heavy-duty truck has a condition where the emergency (supply) gladhand at the rear of the tractor is cracked and leaking air continuously. The driver wraps the gladhand with duct tape to stop the leak. Why is this repair unsafe?

A. The duct tape repair blocks the gladhand's spring-loaded check valve from closing if the trailer separates from the tractor

B. The duct tape repair prevents the gladhand from seating properly with the trailer's gladhand, which could cause the seals to bypass under pressure and release the trailer's spring brakes unexpectedly during driving — additionally, the cracked gladhand may fail completely during driving, causing a sudden loss of trailer air supply that triggers the trailer's spring brakes at highway speed; the gladhand must be replaced with the correct part

C. The duct tape repair will dissolve from exposure to the air system's oil contamination and fail within hours

D. The duct tape repair is acceptable for temporary use as long as the driver monitors the air pressure gauges during driving

46. A heavy-duty truck's air brake system has been modified with an aftermarket air horn that has a large air consumption. Since the horn installation, the driver notices that the first brake application after a long horn blast is weak. What is happening?

A. The aftermarket air horn consumes a large volume of air from the supply tank during each blast — the horn's air consumption depletes the reservoir faster than the compressor can replenish it; the first brake application after a long horn blast has less available air pressure, reducing the braking force; the system recovers after the compressor rebuilds pressure; the horn should be connected to a separate reservoir or a flow limiter should be installed

B. The horn's electrical circuit interferes with the ABS module during activation, causing a momentary brake delay

C. The horn's vibration loosens the air line connections near the dash panel, creating temporary leaks during and after horn activation

D. The horn's air consumption cools the air in the system (from the rapid expansion), temporarily reducing the pressure below the effective braking threshold

47. A heavy-duty truck has a condition where the dashboard warning lamps all illuminate briefly (flash once) when the turn signal is activated. The turn signal itself functions correctly. What is the most likely cause?

A. The turn signal circuit shares a ground with the warning lamp circuits, and the turn signal's current pulse creates a momentary voltage drop at the shared ground that activates the warning lamps

B. The body controller module has a software glitch that momentarily activates all outputs when the turn signal input changes state

C. The turn signal flasher produces a voltage spike at each flash cycle that couples into the warning lamp circuits through shared wiring or a common power bus — the spike is brief enough to flash the

warning lamps once but does not sustain long enough to keep them illuminated; the coupling path may be through a shared relay, a shared fuse, or electromagnetic induction between adjacent wires

D. The warning lamp circuits have defective isolation diodes that allow current to backfeed from the turn signal circuit

48. A truck's scan tool shows the engine ECM is broadcasting a barometric pressure of 90 kPa. The actual barometric pressure at the vehicle's location (sea level) is 101 kPa. The engine runs but with noticeable power loss. How does the incorrect barometric pressure affect engine performance?

A. The ECM uses barometric pressure to calculate the ambient air density for the fuel injection calculation

B. The ECM uses the barometric pressure to determine the altitude and adjusts the turbocharger boost target accordingly

C. The lower barometric reading has no effect on engine performance because the manifold pressure sensor overrides the barometric input during engine operation

D. The ECM reads 90 kPa and believes the vehicle is at approximately 1,000 metres altitude — the ECM limits the fuel injection quantity to match the perceived thinner air at altitude, even though the actual air density at sea level can support more fuel; the engine produces less power because it is being fueled for altitude conditions that do not exist at the vehicle's actual location

49. A heavy-duty truck has a condition where the alternator's output voltage is correct (14.2V) with the engine running and all accessories off, but drops to 12.8V when the headlights are turned on. The headlights draw 15 amps total. The alternator is rated at 160 amps. What does this voltage drop with a relatively small load indicate?

A. The alternator's diode trio (the internal components that power the field winding from the stator output) has partially failed, reducing the field current and limiting the alternator's current output

B. The alternator's output capacity has decreased significantly — a 15-amp headlight load should not cause the voltage to drop from 14.2V to 12.8V on a 160-amp rated alternator; the drop indicates the alternator can produce adequate voltage at no load but cannot sustain it under even a small load; the most likely cause is a failed stator winding, failed rectifier diodes, or severely worn brushes that limit the alternator's current capacity to a fraction of its rating

C. The headlight circuit has excessive resistance that creates a large voltage drop between the alternator and the headlights

D. The voltage regulator is intentionally reducing the output voltage when it detects the headlight load to protect the headlight bulbs from overvoltage

50. A truck equipped with a multiplexed electrical system has a condition where the BCM correctly commands the left rear clearance light on, but the light does not illuminate. The BCM's diagnostic feedback shows the circuit is drawing the expected current (0.2 amps). How is the circuit drawing current if the light is not illuminating?

A. The circuit has a short to ground downstream of the BCM's current sensor but upstream of the lamp — the short circuit provides a current path that the BCM measures as normal, but the current flows to ground through the short instead of through the lamp; the lamp receives no current because the short circuit provides an easier path to ground

B. The lamp has an internal fault where the filament is broken but the base of the bulb provides a parasitic current path that draws 0.2 amps without illuminating

C. The BCM's current sensor has a calibration error that reads 0.2 amps regardless of the actual circuit current

D. The lamp is illuminated but the lens cover has become opaque from UV degradation and the light is not visible from outside the vehicle

51. A heavy-duty truck has a condition where the engine fan runs at maximum speed continuously. The ECM commands a 30% fan speed through a PWM signal, but the fan controller ignores the command and runs at full speed. The scan tool confirms the ECM is outputting the correct PWM signal. What should be investigated?

A. The fan controller's internal electronics, which may have failed in the full-speed default mode

B. The fan clutch mechanism, which may have seized in the engaged position regardless of the control signal

C. The PWM signal wire between the ECM and the fan controller — the wire may be open, shorted to ground, or shorted to power; if the fan controller loses the PWM input, it defaults to full speed as a

cooling protection strategy; the ECM produces the correct signal at its output pin, but the signal does not reach the controller; the wire, its connectors, and the controller's input pin must be verified

D. The coolant temperature sensor, which may be reading higher than actual and causing the ECM to override its PWM output with a full-speed command

52. A truck's electronic instrument cluster has a condition where the high-beam indicator lamp stays on continuously even when the headlights are on low beam. The headlights physically switch between low and high beam correctly. What is the most likely cause?

A. The dimmer switch has an internal contact fault that sends the high-beam signal to the indicator even when the switch is in the low-beam position

B. The high-beam indicator is controlled by a separate sensor or switch on the headlight circuit that detects which beam is active

C. The instrument cluster has an internal fault on the high-beam indicator output

D. The high-beam indicator circuit has a wiring fault — the indicator wire may be shorted to a power source, connected to the wrong circuit, or the indicator's ground path has been cross-connected to the high-beam circuit; the indicator receives a constant signal regardless of the actual headlight beam position

53. A heavy-duty truck has a condition where one specific CAN bus module goes offline every time the engine starts (during the cranking event) and comes back online 3-5 seconds after the engine starts. All other modules remain online during cranking. What is the most likely cause?

A. The affected module has a higher minimum operating voltage than the other modules on the bus

B. The affected module's power supply drops below its minimum operating voltage during the cranking event — the starter motor draws hundreds of amps from the batteries, temporarily dropping the system voltage; most modules are designed to operate through this voltage dip, but the affected module has a marginal power supply circuit (corroded power connector, thin power wire, or a long wire run with excessive resistance) that drops the voltage at the module's input below its minimum threshold during cranking

C. The CAN bus backbone voltage drops below the communication threshold during cranking, but this module recovers more slowly than the others

D. The starter motor's electromagnetic interference disrupts the affected module's CAN bus transceiver during the cranking event

54. A truck's electronic throttle pedal has been diagnosed with a failed APP1 sensor. The APP2 sensor is functioning correctly. With only APP2 functional, the ECM limits the engine to 50% throttle. The technician connects a jumper wire between the APP2 signal and the APP1 input at the ECM connector. What is wrong with this approach?

A. The jumper wire creates a signal loop that confuses the ECM's internal processing

B. The APP1 and APP2 sensors are designed to have different voltage ranges and different slopes — connecting APP2's signal to APP1's input provides the same voltage to both inputs; the ECM expects a specific mathematical relationship between the two sensor signals (such as APP1 being double APP2's voltage); identical signals on both inputs do not match the expected relationship, and the ECM will detect a correlation error and may derate the engine further or refuse to operate

C. The jumper wire bypasses the APP1 sensor's built-in safety circuit that limits the maximum throttle signal

D. The ECM's APP1 input has a different impedance than the APP2 input and the shared signal will be distorted

55. A heavy-duty truck has a condition where the backup alarm sounds continuously even when the transmission is in Park or Neutral. The alarm functions correctly in all forward gears (silent). What is the most likely cause?

A. The body controller module has a configuration error that activates the backup alarm whenever the vehicle is stationary

B. The backup alarm has failed internally and sounds continuously regardless of the input signal

C. The reverse switch or its circuit has a fault that continuously provides the "reverse" signal to the backup alarm — the switch may be stuck closed, the signal wire may be shorted to ground (if the alarm activates on a ground-trigger system), or a wiring fault connects the alarm to a circuit that is always energized; the alarm does not sound in forward gears because the transmission's forward gear engagement opens the circuit through a different mechanism

D. The transmission's internal range sensor has a calibration error that reports reverse position in all non-drive positions

56. A truck's scan tool shows the battery voltage fluctuating between 13.8V and 14.5V at a rate of approximately 1 Hz with the engine running at steady idle. The voltage should be stable at approximately 14.2V. What is the most likely cause?

A. The voltage regulator is cycling between charge and float modes — a marginal connection in the regulator's voltage sense circuit causes the regulator to alternately read the voltage as too low (increasing the field current to charge) and too high (decreasing the field current to float); the 1 Hz cycling is the control loop's response time as it hunts between the two states

B. The alternator's stator has a shorted winding that produces a pulsating output at the alternator's rotational frequency

C. The battery has a weak cell that alternately accepts and rejects the charging current at a 1 Hz rate

D. The engine's idle speed fluctuation creates a proportional alternator output fluctuation at the same frequency

57. A heavy-duty truck has a condition where the starter motor spins freely (high-speed whirring) when the key is turned to start, but the engine does not crank. What does the free-spinning starter indicate?

A. The starter motor's solenoid is energizing the motor but is not engaging the starter drive with the flywheel ring gear

B. The starter motor's Bendix drive mechanism has failed and the drive gear is not engaging the flywheel ring gear

C. The flywheel ring gear has damaged teeth at the engagement point that prevent the starter drive from meshing

D. The starter motor's pinion gear is not engaging with the flywheel ring gear — the solenoid energizes the motor (confirmed by the spinning), but the drive mechanism (Bendix or solenoid-actuated plunger) is not pushing the pinion into mesh with the ring gear; the motor spins freely because there is no mechanical load; the cause could be a failed Bendix mechanism, a worn solenoid plunger, or a broken shift fork inside the solenoid

58. A truck's electronic gauge cluster has a condition where the voltmeter reads approximately 1V higher than the actual battery voltage measured with a calibrated multimeter. The discrepancy is consistent at all voltage levels. What is the most likely cause?

A. The voltmeter circuit in the cluster has a resistance in the ground path that offsets the reading by 1V

B. The instrument cluster's voltmeter has a calibration offset — the cluster receives voltage data from either a direct measurement or a CAN bus message; if the cluster's internal scaling factor, its analog-to-digital converter, or its voltage sense circuit has drifted, the display reads consistently higher than actual; a 1V offset indicates a systematic calibration error rather than a variable fault

C. The alternator's voltage sense wire is connected to the alternator output instead of the battery, creating a higher reading at the cluster

D. The dashboard wiring harness has a higher-gauge wire in the voltmeter circuit that reads a higher voltage from its lower resistance

59. A heavy-duty truck has a condition where the horn works correctly when the engine is off but does not sound when the engine is running. The horn relay clicks in both conditions. What is the most likely cause?

A. The alternator's charging voltage creates an electromagnetic interference that cancels the horn relay's output signal during engine operation

B. The horn circuit and the charging circuit share a common power wire — with the engine off, the battery provides adequate voltage through the shared wire; with the engine running, the alternator's output saturates the shared wire's current capacity and the horn cannot draw adequate current through the overloaded wire

C. The horn's power supply and the alternator share a fusible link that cannot carry both the charging current and the horn current simultaneously

D. The engine's electrical noise (from the alternator, ignition, and accessories) couples into the horn's electromagnetic circuit and disrupts the horn diaphragm's oscillation frequency, preventing it from producing sound

60. A heavy-duty truck equipped with LED headlights has a condition where the left headlight produces a pinkish tint instead of the expected white light. The right headlight produces normal white light. Both assemblies are the same part number. What is the most likely cause?

A. The left headlight's internal wiring has a high-resistance connection that reduces the voltage to the LED driver, shifting the color temperature

B. The left headlight lens has been contaminated with a chemical that filters the blue wavelength from the LED output, producing the pinkish tint

C. The left headlight's LED driver circuit has a fault on the blue LED channel — white LED headlights produce white light by combining blue LED output with a yellow phosphor; if the blue LED channel is partially failing, the blue contribution decreases and the yellow phosphor output shifts the overall color toward pink (a mix of the remaining red and reduced blue); the assembly must be replaced

D. The left headlight assembly has been installed with a slight misalignment that changes the viewing angle of the LED elements, producing the apparent color shift

61. A truck's CAN bus has a condition where the bus works normally for the first 2 hours of operation, then all communication fails simultaneously. After the ignition is cycled off and back on, communication resumes for another 2 hours. What could cause this time-dependent total communication failure?

A. The CAN bus controller in one module overheats after 2 hours and produces bus errors that corrupt all communication

B. The vehicle's electrical system has a time-delayed relay that activates after 2 hours and shorts the CAN bus

C. The CAN bus termination has a thermal-dependent resistance shift that takes the bus out of its operating impedance range after 2 hours of heat accumulation from the current flowing through the resistors

D. A temperature-sensitive component in the CAN bus circuit (a termination resistor, a connector, or a module's CAN transceiver) changes its characteristics as it heats over 2 hours — the component operates correctly when cold but drifts out of specification as it warms; after 2 hours, the CAN bus impedance or signal quality exceeds the tolerance for reliable communication and all modules lose synchronization; cycling the ignition allows the component to cool, restoring normal operation for another 2-hour cycle

62. A truck's electronic throttle pedal has a condition where the pedal works normally during the first 50% of travel but the engine response becomes erratic between 50% and 100% travel — the power surges and drops unpredictably. What is the most likely cause of this erratic response in the upper range?

A. The ECM's fuel map has a calibration anomaly between 50% and 100% throttle that produces erratic fueling

B. The APP sensor's resistive element has a worn or contaminated section between the 50% and 100% positions — the wiper produces a noisy, unstable signal as it crosses the damaged section; the ECM receives an erratic voltage that it interprets as rapidly changing throttle input, commanding erratic fuel delivery; the signal is clean below 50% because that section of the resistive element is undamaged

C. The turbocharger cannot maintain stable boost above 50% throttle, creating the power surges and drops

D. The fuel supply system has a restriction that limits delivery above the 50% throttle fuel demand rate

63. A heavy-duty truck has a condition where the engine starts normally but the check engine lamp illuminates and a fault code is stored for "Crankshaft-Camshaft Correlation Error." The engine runs but with reduced power. The timing chain was recently replaced. What is the most likely cause?

A. The timing chain was installed one tooth off on either the crankshaft or camshaft sprocket — the ECM continuously compares the crankshaft position sensor signal to the camshaft position sensor signal to verify valve timing; a one-tooth error changes the angular relationship between the two signals by the angular spacing of one tooth; the ECM detects this deviation and stores the correlation error; the engine runs because the timing is close enough for combustion but derates because the valve timing is incorrect

B. The new timing chain has a different pitch than the original, creating a cumulative error over the chain's length

C. The crankshaft position sensor was disturbed during the chain replacement and its air gap has changed

D. The camshaft position sensor was replaced during the chain service and the new sensor has a different electrical specification

64. A truck's electronic instrument cluster shows the coolant temperature gauge at the maximum position (hot) immediately upon key-on before the engine is started. The engine is cold. What is the most likely cause?

A. The instrument cluster's gauge driver has failed in the maximum position for the temperature display

B. The coolant temperature sender's electrical circuit has failed in a way that the cluster interprets as maximum temperature

C. The coolant temperature sender or its wiring has an open circuit — many truck gauge circuits read maximum (hot) when the sender circuit is open because the gauge interprets the absence of the sender's resistance as the minimum resistance value (which corresponds to maximum temperature); the ECM's separate coolant temperature sensor may read correctly, confirming the gauge sender circuit is the fault location

D. The ECM is broadcasting a maximum temperature value on the CAN bus from an internal processing error

65. A heavy-duty truck has a condition where the battery disconnect switch makes a loud buzzing sound when turned to the ON position. The switch has always operated silently. What does the buzzing indicate?

A. The battery disconnect switch contacts have corroded and the high-resistance connection creates an arc that buzzes at the AC frequency of the alternator's residual magnetism

B. The disconnect switch's solenoid (if equipped with a remote disconnect solenoid) is receiving a pulsating signal from a faulty control circuit

C. The battery disconnect switch has a loose internal contact that cannot maintain a stable connection — the contact alternately makes and breaks from the loose connection, creating the buzzing sound; the intermittent contact can generate heat, damage the switch, and potentially cause a fire at the high current levels flowing through the switch

D. The disconnect switch's internal contacts have developed high resistance — the contacts are not making firm, stable contact and are arcing; the arcing produces the buzzing sound and generates intense heat at the contact points; the switch must be replaced immediately because the arcing can ignite surrounding materials and the high-resistance connection can fail completely, leaving the vehicle without electrical power

66. A truck's ABS module has a stored fault code for "Left Front Wheel Speed Sensor — Signal Missing Below 15 km/h." The sensor produces a normal signal above 15 km/h. What does this speed-dependent signal loss indicate?

A. The wheel speed sensor has an incorrect air gap that produces a signal too weak to detect at the low rotational speed below 15 km/h

B. The passive wheel speed sensor's output voltage is proportional to the wheel's rotational speed — at low speed (below 15 km/h), the reluctor ring teeth pass the sensor slowly and the generated voltage is below the ABS module's minimum detection threshold; above 15 km/h, the faster rotation generates adequate voltage; the air gap may be at the outer limit of its specification, and reducing the gap increases the signal amplitude at low speed

C. The reluctor ring has a section of missing teeth that the sensor cannot detect at the low-speed sample rate below 15 km/h

D. The ABS module's processing algorithm cannot filter the low-frequency signal at speeds below 15 km/h

67. A heavy-duty truck has a condition where the engine ECM sets a fault code for "Battery Voltage Above Normal" intermittently. The battery voltage and charging system voltage both read normally when tested. What could cause intermittent high-voltage events?

A. Voltage spikes from inductive loads (solenoids, relays, clutch coils) being de-energized without adequate suppression — when an inductive load is switched off, the collapsing magnetic field generates a voltage spike (flyback voltage) that can exceed 100V momentarily; if the spike reaches the ECM's voltage sensing input before being suppressed, the ECM records it as a high-voltage event; the spike is too brief for a standard voltmeter to capture but the ECM's fast sampling detects it

B. The alternator has a loose stator wire that momentarily contacts the output terminal, creating a voltage spike from the stator's AC output

C. The battery cables have a loose connection that creates a momentary open circuit, and the alternator's unloaded output spikes before the regulator compensates

D. The ECM's internal voltage sensor has a marginal reference that drifts and occasionally reads the normal voltage as above-normal

68. A truck equipped with a telematics system has a condition where the telematics unit's GPS accuracy degrades from 3-metre precision to 30-metre precision during certain times of the day but returns to normal precision at other times. What is the most likely cause?

A. The GPS antenna has water intrusion that affects the signal reception during the warmer part of the day when the water creates more interference

B. The telematics unit's internal GPS processor overheats during warmer parts of the day, reducing its calculation accuracy

C. The GPS satellite constellation geometry changes throughout the day — when fewer satellites are visible from the truck's location (due to satellite orbital positions, building obstructions, or terrain), the geometric dilution of precision (GDOP) increases and the position accuracy decreases; the accuracy returns to normal when the satellite geometry improves

D. The cellular network signal strength varies throughout the day and the telematics unit's GPS accuracy depends on the cellular-assisted GPS corrections

69. A heavy-duty truck with a manual 18-speed transmission has a condition where the driver cannot select any gears in the auxiliary (rear) section — the splitter and range functions do not respond. The front section (main box) shifts normally. What is the most likely cause?

A. The transmission oil level has dropped below the rear section's gear engagement mechanism

B. The auxiliary section's shift linkage has disconnected from the main shift housing

C. The main transmission section's output shaft bearing has seized, preventing the rear section from rotating

D. The auxiliary section's air system has lost pressure — the splitter and range shifts are air-operated; a disconnected air line, a failed air valve, or a blown air line fitting eliminates the air supply to the auxiliary section; the main box shifts mechanically through the shift lever and is unaffected by the air system failure

70. A truck equipped with an Allison automatic transmission has a condition where the transmission shifts from 2nd to 3rd normally, but the 3rd-to-4th shift is accompanied by a 2-second engine flare (RPM rises 500 RPM above normal) before 4th gear engages. All other shifts are smooth. What is the most likely cause?

A. The 4th gear clutch solenoid has a delayed response from an electrical resistance in its circuit

B. The 4th gear clutch pack is slipping during engagement — the 3rd gear clutch releases normally, the engine RPM rises because no clutch is holding, and the 4th gear clutch cannot engage firmly enough to absorb the engine torque; the 2-second flare represents the time the 4th gear clutch slides before gripping; the clutch plates are worn, burned, or have a leaking apply circuit

C. The accumulator for the 3-4 shift has seized and the sudden pressure application creates a brief torque gap before the clutch engages

D. The torque converter's lockup clutch is releasing during the 3-4 shift from a calibration conflict

71. A heavy-duty truck has a clutch that engages very close to the top of the pedal travel — the engagement point is high and there is very little free play remaining. What does this engagement position indicate?

A. The clutch disc is near the end of its service life — the friction material has worn thin, allowing the pressure plate to sit closer to the flywheel; the release bearing rests further from the diaphragm spring fingers because the thinner disc changes the pressure plate's position; the engagement point moves higher in the pedal travel as the disc wears; minimal remaining free play confirms the disc has very little friction material remaining

B. The clutch hydraulic system has been overfilled with fluid, pre-loading the slave cylinder and moving the engagement point

C. The pressure plate's diaphragm spring has weakened from heat, changing the engagement geometry

D. The clutch brake is improperly adjusted and is holding the release bearing against the pressure plate fingers

72. A bus equipped with an automatic transmission has a condition where the transmission produces a metallic whining noise in all forward gears but is silent in Reverse and Neutral. What does this gear-dependent noise pattern indicate?

A. The noise is from the output shaft bearing, which is loaded during forward operation but unloaded in Reverse and Neutral

B. The torque converter has a failed stator bearing that produces noise only during forward torque multiplication

C. The forward clutch drum or its associated planetary gear set is the noise source — the forward clutch is engaged in all forward gears but is released in Reverse and Neutral; the whining comes from a component that rotates with the forward clutch assembly; a worn thrust washer, a damaged bearing, or a worn gear tooth in the forward gear train produces the noise only when that section is driven

D. The transmission pump is the noise source because it is driven by the converter in forward gears at a higher speed than in Reverse

73. A heavy-duty truck's rear axle has been serviced with new differential bearings. After the service, the axle produces a howling noise at all speeds during both acceleration and deceleration. The noise was not present before the service. What is the most likely cause during the bearing replacement procedure?

A. The new bearings are the wrong part number and have a different load rating than the original specification

B. The bearing preload has been set incorrectly during the service — the side bearing preload (which also sets the ring gear backlash) determines the mesh engagement between the ring and pinion gears; excessive preload pushes the ring gear too close to the pinion (reducing backlash below specification), and insufficient preload allows the ring gear to move away from the pinion (increasing backlash); either condition changes the tooth contact pattern and produces a howling noise at all operating conditions

C. The axle housing was distorted during the bearing pressing operation, changing the bearing bore alignment

D. The bearing installation tool damaged the new bearings' rolling elements during the pressing operation

74. A truck equipped with a manual transmission has a condition where the transmission shifts into all gears without grinding but pops out of 4th gear only during deceleration (coast). The detent mechanism has been verified as functional. What is the most likely cause?

A. The 4th gear has worn engagement teeth that cannot maintain full-depth engagement against the thrust forces generated during deceleration

B. The 4th gear's engagement teeth are worn or tapered on the coast-side faces — during deceleration, the helical gear's thrust reverses direction and pushes against the coast side of the engagement teeth; if the coast-side faces are worn or rounded, the thrust force can push the sliding sleeve out of engagement; the drive-side faces (loaded during acceleration) may be in better condition, which is why the transmission stays in 4th during acceleration

C. The countershaft thrust bearing has excessive play that allows the countershaft to shift under the coast thrust load, pulling the 4th gear out of mesh

D. The transmission mount has failed, allowing the transmission to shift position during deceleration and changing the shift rail alignment

75. A heavy-duty truck's driveshaft has been replaced with a new unit. The new driveshaft has the correct length and specifications. After installation, the truck produces a vibration that increases with speed. The technician checks the U-joint angles and finds they are equal and within specification. The phasing is correct. What should be checked next?

A. The new driveshaft must be verified for proper balance — even a factory-new shaft can have a balance issue from manufacturing tolerance, shipping damage, or an error in the balance weights; the technician should also verify the driveshaft's runout by measuring it on the companion flanges with a dial indicator; if the shaft has runout from a bent tube, it produces a vibration proportional to speed regardless of the angle and phasing

B. The companion flange bolt torque, which if uneven could create a vibration at the flange connection

C. The slip yoke spline engagement, which if insufficient could allow the driveshaft to wobble during rotation

D. The center carrier bearing alignment, which if misaligned could create a speed-proportional vibration

76. A truck equipped with an automated manual transmission has a condition where the TCU displays a "Clutch Wear" warning. The clutch still functions but the engagement is rougher than normal. What does the warning indicate, and what action should be taken?

A. The TCU has detected that the clutch has lost its calibration and needs to be re-taught through the clutch learn procedure

B. The clutch brake has worn beyond its service limit and the TCU is warning about the engagement quality

C. The clutch disc friction material has worn to a level where the TCU's clutch actuator must travel further than designed to achieve disengagement — the TCU monitors the actuator's travel distance and compares it to the designed range; when the travel exceeds the warning threshold, the TCU alerts the driver; the rougher engagement occurs because the actuator is operating at the outer limit of its travel range where its modulation precision is reduced; the clutch should be scheduled for replacement before the wear reaches the point where the actuator cannot disengage the clutch

D. The pressure plate's diaphragm spring has weakened and the TCU detects the reduced clamping force through its torque monitoring algorithm

77. A heavy-duty truck equipped with a tandem drive axle has a condition where the power divider (inter-axle differential) produces a grinding noise during highway driving. Engaging the inter-axle lock silences the grinding. What does this behavior confirm?

A. The noise source is in the inter-axle differential mechanism — the lock physically stops the differential gears from rotating relative to each other; when the lock is engaged, the differential's internal components (spider gears, side gears, and cross pin) are locked and cannot produce noise; the grinding noise when unlocked confirms the differential's internal components are worn or damaged

B. The inter-axle lock's engagement mechanism is grinding against the lock collar when disengaged

C. The front drive axle's ring and pinion are worn and the inter-axle lock changes the loading on the gears

D. The noise is from the power divider's input gears, which are unloaded when the lock is engaged

78. A truck's manual transmission has a condition where the gear oil has a strong burnt odor and metallic flakes are visible when a sample is taken from the drain plug. The transmission shifts normally. What do these findings indicate?

A. The metallic flakes are from normal gear wear and the burnt odor is from the gear oil reaching the end of its service life

B. The transmission has an internal component that is generating excessive heat and metal debris — the burnt odor indicates the oil has been overheated (from a slipping synchronizer, a dragging clutch, or

inadequate oil level), and the metallic flakes confirm an active wear source; the transmission shifts normally now but the progressive wear will eventually produce shifting problems; the oil should be analyzed to identify the metal type and determine the wear source

C. The drain plug magnet has accumulated normal wear metals over the oil change interval and the burnt odor is from the friction modifier additive in the gear oil

D. The metallic flakes are from the synchronizer brass rings and the burnt odor is from the synchronizer friction material heating during each shift

79. A heavy-duty truck has a driveshaft vibration that is present during acceleration only. The vibration disappears immediately when the throttle is released, even at the same speed. What type of vibration is this?

A. A torque-related vibration — the vibration is excited only when engine torque is transmitted through the driveshaft; releasing the throttle removes the torque and the vibration stops immediately regardless of the speed; this pattern indicates unequal U-joint operating angles (which produce speed fluctuations proportional to torque), a worn slip yoke spline (which rattles under torque loading), or a damaged companion flange (which deflects under torque)

B. A speed-related vibration that coincidentally disappears when the throttle is released because the deceleration changes the engine RPM

C. A balance-related vibration that the engine's deceleration masks when the throttle is released

D. An exhaust-related vibration that is transmitted through the driveshaft mounts and disappears when the exhaust pressure drops during throttle release

80. A bus equipped with an Allison automatic transmission has a condition where the transmission produces a clunking noise when coasting downhill in gear (engine braking). The clunk occurs rhythmically at approximately twice per driveshaft revolution. What is the most likely cause?

A. The transmission's output shaft U-joint has worn bearing caps that produce a clunk at the two loaded positions per revolution during the coast (engine braking) loading

B. The driveshaft has incorrect phasing that produces a 2-per-revolution vibration during coast loading

C. A worn U-joint in the driveshaft produces the clunk at twice per revolution during the coast (engine braking) loading — U-joints have four bearing caps, but the loads alternate between opposite pairs, creating two load events per revolution; a worn bearing cap with excessive clearance produces a clunk each time it passes through its loaded position; the coast loading reverses the thrust direction from acceleration, loading the worn caps differently and producing the clunk that is not present during acceleration

D. The transmission's parking pawl is partially engaging during coast conditions from a misadjusted linkage

81. A heavy-duty truck has a rear axle that produces a rumbling noise at all speeds during all operating conditions (acceleration, deceleration, and cruise). The noise does not change character during any driving condition. What is the most likely noise source?

A. The wheel bearings — they rotate at all times when the wheels are turning, regardless of the power flow direction; a worn wheel bearing produces a continuous rumble that does not change with acceleration, deceleration, or cruise because the bearing load remains relatively constant from the vehicle's weight; ring and pinion noise typically changes between drive and coast, while bearing noise remains constant

B. The ring and pinion gear set, which produces noise on both the drive and coast sides of the teeth

C. The differential bearings, which produce noise when the differential carrier vibrates at its natural frequency

D. The axle shaft, which produces noise from a worn spline connection that rattles at all operating conditions

82. A truck equipped with an automated manual transmission has a condition where the transmission completes a shift but the engine RPM does not match the expected RPM for the new gear — the engine RPM is 200 RPM higher than expected after the shift completes. What does this indicate?

A. The AMT's gear selection actuator has shifted into the wrong gear — the actuator positioned the shift mechanism into a gear adjacent to the intended gear (e.g., 5th instead of 6th), and the different gear ratio produces a higher engine RPM than expected at the current vehicle speed

B. The clutch is slipping after the shift and the engine RPM is elevated from the slippage

C. The engine ECM is adding RPM to improve the shift quality and will reduce the RPM after a brief settling period

D. The AMT's clutch is slipping — the shift completed mechanically but the clutch is not holding the engine's torque against the load; the engine RPM is 200 RPM higher than the gear ratio would produce because the clutch plate is slipping between the flywheel and the pressure plate; the clutch is at or beyond its friction capacity and needs replacement

83. A heavy-duty truck has a condition where the clutch produces a rattling noise at idle in neutral that disappears when the clutch pedal is slightly depressed. What is the most likely cause?

A. The input shaft pilot bearing is worn and produces noise when the input shaft vibrates freely at idle

B. The clutch disc's torsional damper springs are rattling — at idle in neutral, the clutch disc is sandwiched between the flywheel and pressure plate but is transmitting minimal torque; the engine's idle firing impulses cause the disc's hub to oscillate against the damper springs, producing a rattle; slightly depressing the pedal partially unloads the disc, changing the damper spring preload and silencing the rattle

C. The release bearing is contacting the pressure plate fingers intermittently from vibration at idle

D. The transmission input shaft bearing is dry and produces a rattle that changes when the clutch pedal alters the input shaft loading

84. A truck's transfer case has a condition where the front output shaft seal leaks oil continuously. The seal has been replaced twice in 6 months. What should be investigated to find the root cause of the recurring seal failure?

A. The front output shaft surface for wear, scoring, or a groove at the seal contact area — a worn shaft surface prevents any new seal from maintaining adequate contact; the seal lip rides in the groove or on the rough surface and cannot seal; additionally, the front driveshaft's U-joint angles should be checked because excessive angulation creates a cyclic side load on the output shaft that accelerates seal wear

B. The transfer case's internal pressure, which if elevated from a blocked breather would force oil past any seal

C. The seal installation tool, which may be damaging the new seals during installation

D. The front output shaft bearing for excessive play that allows the shaft to wobble and destroy the seal

85. A heavy-duty truck equipped with a 10-speed manual transmission has a condition where the transmission makes a growling noise in 3rd gear only. All other gears are silent. What does this single-gear noise indicate?

A. The 3rd gear's mainshaft gear or its mating countershaft gear has worn or damaged teeth — the noise appears only in 3rd because only that specific gear pair is transmitting torque; in all other gears, different gear pairs carry the load and the 3rd gear pair is unloaded (it rotates freely without transmitting force); the growling is from the damaged teeth contacting their mating teeth under the torque load of the 3rd gear engagement

B. The 3rd gear synchronizer has a worn blocker ring that vibrates during engagement and produces the growling

C. The transmission oil level is too low to adequately lubricate the 3rd gear pair, which is positioned higher in the case than the other gears

D. The 3rd gear detent has a weak spring that allows the gear to vibrate in and out of mesh, producing the growling noise

86. A heavy-duty truck has a condition where the power steering system produces a momentary groan when the engine is first started in cold weather. The groan lasts approximately 5 seconds and does not return during the remainder of the operating cycle. What is the most likely cause?

A. The power steering pump momentarily cavitates from the cold, thick fluid — the cold fluid's high viscosity resists flow through the pump's intake, and the pump draws a partial vacuum; the cavitation produces the groaning noise; after 5 seconds, the fluid warms enough from the pumping friction to flow freely and the cavitation stops

B. The power steering pump's drive belt slips on the cold pulley for the first 5 seconds until friction heat warms the belt

C. The steering gear's internal spool valve sticks from the cold fluid and produces the groan as the valve unseats during the first steering input

D. The power steering fluid has absorbed moisture from the cold atmosphere and the groan is caused by the water vapor cavitating in the pump — when the cold fluid is viscous (thick), the power steering

pump struggles to draw it through the pump's inlet; the pump temporarily cavitates as it pulls against the high-viscosity fluid; the cavitation produces the groaning noise; after a few seconds of circulation and warming from the pumping friction, the fluid thins enough for the pump to draw it without cavitation

87. A heavy-duty truck has a condition where the right steer tire shows a smooth, even wear pattern across the entire tread surface, while the left steer tire shows a scalloped (cupped) wear pattern. Both tires are the same brand, model, and age. The alignment is within specification on both sides. What is the most likely cause of the left tire's cupping?

A. The left front tire is inherently softer than the right front from a manufacturing batch variation

B. The left front shock absorber has failed — the shock cannot control the tire's bounce after road irregularities, and the tire alternates between heavy and light contact with the road surface; the heavy-contact spots wear faster, creating the low spots; the light-contact spots wear slower, creating the high spots; the right side's functional shock absorber maintains even contact and produces smooth wear

C. The left front brake has a slight drag that generates heat and softens the rubber on the left tire, making it susceptible to cupping

D. The left front wheel bearing has a slight looseness that allows the wheel to wobble, creating the cupping pattern

88. A heavy-duty truck equipped with a recirculating ball steering gear has a condition where the steering produces a clunking noise during low-speed turns. The drag link, tie rods, and king pins have been inspected and have no detectable play. What internal steering gear component could produce the clunk?

A. The steering gear's sector shaft and its adjustment have excessive lash at the center position — the sector shaft teeth mesh with the ball nut's rack teeth; excessive lash between these teeth allows the sector shaft to shift when the steering force changes direction during low-speed turns; the shift produces the clunk as the teeth take up the clearance; the sector shaft lash adjustment (over-center adjustment) must be checked and corrected

B. The steering gear's input shaft bearing has failed, allowing the input shaft to shift during turns

C. The ball nut's internal ball bearings have developed flat spots that produce a clunk during the high-load, low-speed turning

D. The steering gear's housing has cracked at a mounting bolt location, allowing the gear to shift during turning forces

89. A heavy-duty truck equipped with air ride suspension on the drive axle has a condition where the ride height sensor's linkage has been bent from road debris impact. The linkage is bent approximately 15 degrees from its original position. What is the consequence of the bent linkage?

A. The bent linkage changes the ride height sensor's reference position, causing the height control valve to maintain the suspension at an incorrect height

B. The bent linkage will produce a ride height that is either higher or lower than specification on the affected side

C. The bent linkage changes the geometric relationship between the axle's actual position and the height control valve's sensing mechanism — the valve operates correctly (opening and closing at the designed linkage angles) but the bent linkage tells the valve the axle is at the correct height when it is actually at a different height; the suspension maintains a ride height that does not match the specification, which affects the axle alignment, tire wear, and load distribution

D. The bent linkage will cause the height control valve to oscillate between adding and venting air because the bent geometry places the valve's operating point near the edge of its dead band

90. A heavy-duty truck has a condition where the steer axle tires produce a loud thumping noise from both tires at low speed (below 30 km/h) that diminishes at higher speeds. The tires show no visible damage or flat spots. What is the most likely cause?

A. The tires have internal ply separation that produces a bulge in the tread surface — the bulge contacts the road once per revolution and produces a thump; the thumping is more prominent at low speed because the tire's deflection rate is slower and each thump is more distinct; at higher speeds, the thumps merge into a continuous vibration that is less perceptible as individual thumps; the tires must be inspected for internal damage by running a hand over the tread surface while the tire is slowly rotated to feel for any bulges

B. The front brake drums have a flat spot that contacts the shoes at one point per revolution

C. The front wheel bearings have a periodic roughness that produces a thump at the bearing's rotation frequency

D. The steer axle tie rod ends have developed play that produces a thump during each steering correction at low speed

91. A transit bus has a condition where the rear air ride suspension produces a continuous hissing noise from the height control valve area, but the ride height remains correct. The driver reports the compressor runs more frequently than normal. What is the most likely cause?

A. The height control valve has a worn internal seal that allows air to leak continuously through the valve body — the valve correctly senses the ride height and maintains it by continuously adding air to replace the air escaping through the worn seal; the hissing is the air escaping through the valve body, and the increased compressor duty cycle reflects the system's effort to maintain pressure against the continuous leak

B. The height control valve's exhaust port is venting excess air from an overpressurized system — the air springs are receiving more pressure than needed and the valve is actively venting the excess to maintain the correct ride height

C. The air supply line to the height control valve has a restriction that creates turbulence and the hissing is the air passing through the restriction

D. The bus's air system has a general leak that is not related to the height control valve but the hissing coincidentally comes from that area

92. A heavy-duty truck's frame has developed a crack at a suspension bracket mounting location. The fleet maintenance manager asks whether the truck can continue in service with regular monitoring of the crack. What is the correct response?

A. A frame crack at a suspension bracket mount is a critical structural failure that places the truck out of service — the suspension bracket transfers the full axle load to the frame rail at that point; the crack will propagate under the cyclic loading of driving and can lead to complete fracture of the frame rail, suspension separation, or loss of vehicle control; the truck must be repaired before returning to service

B. The crack can be monitored with monthly measurements as long as it does not exceed 50 mm in length

C. The crack can be temporarily welded to prevent propagation and the truck can continue in service until a permanent repair is scheduled

D. The truck can continue in service if the load is reduced to 50% of the rated capacity to reduce the stress on the cracked section

93. A trailer equipped with a self-steering tag axle has a condition where the tag axle tires wear significantly faster than the other axle positions. The tag axle's alignment has been verified as correct. What should be investigated?

A. The tag axle's self-steering mechanism's damper or centering device — if the damper has failed, the axle oscillates during straight-line driving, scrubbing the tires; if the centering device is worn, the axle may not return to the straight-ahead position after turns, dragging the tires at an angle during subsequent straight-line driving

B. The tag axle's tire inflation pressure, which if higher than specification would concentrate the contact patch and accelerate center wear

C. The tag axle's load sharing, which if set too high would overload the tires beyond their design capacity

D. The tag axle's caster angle, which if incorrect would prevent the tires from tracking straight during highway driving

94. A heavy-duty truck has a condition where both drive axle dual tire pairs show rapid outside-edge wear. The inflation pressures are correct and the alignment is within specification. What should be investigated?

A. The drive axle's camber, which is determined by the axle housing's alignment relative to the frame

B. The drive axle's total toe setting, which if excessive would scrub the outside edges of all drive tires

C. The vehicle's loading pattern, which if chronically overloaded deflects the suspension beyond its design range and changes the effective camber

D. The drive axle housings' camber — the axle housing geometry determines the wheel camber; if both housings have excessive positive camber (from worn bushings, bent housings, or shifted spring perches), the outside edges of all dual tire pairs on the drive axle carry more weight and wear faster; the alignment check may not include the axle housing camber measurement

95. A truck equipped with hub-piloted wheels has a condition where the wheel nuts on one specific stud position consistently require re-torquing at every service. All other stud positions maintain their torque. What should be investigated on that specific stud?

A. The stud's thread condition and the matching wheel nut — the stud may have damaged threads (from a previous cross-threading event or from over-torquing) that cannot maintain the clamping force; the nut may have deformed from a previous over-torque and cannot seat properly on the damaged threads; both the stud and nut at that specific position must be inspected and replaced if damaged

B. The hub's pilot pad at that stud position for excessive wear that allows localized wheel movement

C. The wheel's bolt hole at that position for elongation from a previous loosening event

D. The impact wrench socket, which may have worn and is not delivering consistent torque at that specific position

96. A heavy-duty truck has a condition where the steering produces a grinding sensation felt through the steering wheel during low-speed parking maneuvers. The grinding is not a noise — it is a tactile vibration. What is the most likely cause?

A. The power steering pump has worn internal components that produce a pulsating output — the pulsation is transmitted through the hydraulic fluid to the steering gear and through the gear's mechanical connection to the steering wheel; the driver feels the pulsation as a grinding sensation; the pump operates under maximum load during low-speed parking maneuvers, amplifying the pulsation from the worn components

B. The steering column U-joint has a worn cross that produces vibration during the high-torque, low-speed turns

C. The steer tires have a rough tread pattern that transmits road surface feedback through the steering linkage during the high-contact-pressure parking maneuvers

D. The steering gear's internal recirculating ball mechanism has worn and the balls are producing a grinding sensation as they travel through the ball nut and return tubes during steering rotation

97. A trailer equipped with disc brakes has a condition where one rotor has developed a circumferential groove approximately 2 mm deep on one friction surface. The opposite friction surface shows normal, even wear. What caused the groove on one side only?

A. A foreign object became embedded in the brake pad on that side and is scoring the rotor surface during every brake application

B. The caliper on the grooved side has a seized guide pin that prevents the caliper from floating — the piston-side pad applies correctly, but the floating-side pad cannot apply with equal force; the uneven pad-to-rotor contact concentrates the wear on the piston side, creating the groove on that surface while the opposite surface wears normally from the floating pad's contact

C. The pad on the grooved side is a different compound that is more abrasive than the pad on the opposite side

D. The rotor was manufactured with a casting defect that created a softer zone on one friction surface — the softer material wears faster than the normal material on the opposite surface, creating the groove; the manufacturing defect is in the rotor's material, not in the braking system's operation

98. A heavy-duty truck has a condition where the steering responds normally during straight-line driving but requires noticeably more effort during the first 45 degrees of a left turn. After 45 degrees, the effort returns to normal for the remainder of the turn. Right turns feel consistent throughout the entire arc. What is the most likely cause?

A. The left-side tie rod has a tight ball joint that binds at the specific steering angle corresponding to 45 degrees of wheel deflection

B. The steering gear has a worn section in the ball nut or sector shaft that corresponds to the first 45 degrees of left turn travel

C. The left-side steering stop has been adjusted incorrectly and contacts the axle at the 45-degree position

D. The steering gear has a tight spot — the internal mesh between the sector shaft and the ball nut has a localized area of excessive tightness (from uneven wear, contamination, or an over-center adjustment that is too tight at one position); the tight spot occurs during the first 45 degrees of left turn where the sector shaft passes through the specific mesh position; right turns use the opposite side of the sector shaft travel where the mesh is normal

99. A heavy-duty truck has a condition where the right front tire consistently runs 8-10 psi lower than the left front tire. The right tire holds pressure overnight (does not deflate when parked) and the technician cannot find any visible leak with soap solution. What is the most likely cause?

A. The right tire valve stem has a slow leak at the valve core that is too small to produce bubbles during a soap test but is significant enough to lose 8-10 psi during the thermal cycling of highway driving — the tire heats during driving, the pressure increases, and the marginal valve core allows a small amount of air past; over a day of driving, the cumulative loss amounts to 8-10 psi; replacing the valve core typically resolves the issue

B. The right tire bead has a microscopic leak at a corroded section of the rim that only opens under the dynamic loads of driving

C. The right tire has a puncture in the tread that is sealed by road debris when stationary but opens during the flexing of driving

D. The TPMS sensor battery on the right tire is failing and reporting a falsely low pressure reading

100. A heavy-duty truck equipped with disc brakes on all positions has a condition where the brake pulsation is felt only when the brakes are applied from speeds above 100 km/h. Below 100 km/h, the braking is smooth. What does this speed-dependent pulsation indicate?

A. The brake rotors have developed thickness variation that is amplified by the higher kinetic energy of the stops from above 100 km/h

B. The ABS is activating during high-speed stops from a sensor issue that only manifests above 100 km/h

C. The brake rotors have developed a thickness variation (DTV) that is too small to produce perceptible pulsation during low-speed stops but is amplified at higher speeds — the DTV produces the same cyclical force variation at all speeds, but the higher kinetic energy and greater heat generated during high-speed stops amplify the DTV's effect on the brake caliper and the force variation the driver perceives through the pedal

D. The tires have a balance issue that is excited at the specific rotational speed corresponding to 100+ km/h and is felt through the brake pedal during braking

101. A heavy-duty truck equipped with leaf spring suspension has a condition where one rear spring has a visible gap between two of its leaves near the center of the spring pack. The other springs show no gaps. What does this gap indicate?

A. The gap indicates normal thermal expansion between the leaves during warm weather operation

B. The gap indicates the spring clip (rebound clip) at that location has broken, allowing the leaves to separate

C. The gap is a design feature that provides progressive spring rate (the leaves engage sequentially under increasing load)

D. The center bolt holding the leaf pack together has broken or loosened, allowing the leaves to shift and separate — the center bolt passes through all leaves and maintains the pack as a unit; when the bolt breaks or loosens, individual leaves can shift from their designed position, creating the visible gap; the separated leaves may also allow the axle to shift on the spring, changing the axle alignment

102. A heavy-duty truck equipped with power steering has a condition where the power steering fluid foams visibly in the reservoir during operation. The fluid level is correct. What is the most likely cause?

A. The power steering fluid has been contaminated with a different type of fluid that creates foam when mixed

B. The power steering pump's suction line has a small air leak — the leak draws air into the suction side of the pump, and the air mixes with the fluid under the pump's pressure; the aerated fluid returns to the reservoir as foam; the leak is typically at a loose fitting, a cracked hose, or a deteriorated O-ring at the pump's inlet; the foam reduces the fluid's effective viscosity and lubrication, leading to pump noise, erratic steering, and accelerated wear

C. The power steering fluid is overheated and the thermal degradation produces gas bubbles that appear as foam

D. The power steering system's return line has a restriction that creates turbulence and foaming in the reservoir

103. A heavy-duty truck has a condition where the steer tires show a wear pattern where the inside half of the tread is wearing significantly faster than the outside half. The alignment shows the camber is at −0.5 degrees (slightly negative) on both sides. The specification is 0 to +0.5 degrees. What does this camber-induced wear confirm?

A. The negative camber tilts the top of each steer wheel inward, shifting the tire's load concentration to the inside half of the contact patch — the inside edges carry more weight per unit area than the outside edges, wearing the inside half faster; the −0.5 degree camber is outside the 0 to +0.5 degree specification and must be corrected to equalize the tread wear across the full tread width

B. The inside-edge wear is caused by the toe setting, not the camber, and the toe should be checked

C. The negative camber is within an acceptable range and the inside wear is from a different cause

D. The negative camber is too small to produce visible wear differences and the inside-edge wear must be from a different cause

104. A heavy-duty truck's cab has a condition where the driver reports a vibration felt through the floor of the cab at a specific engine RPM (approximately 1,400 RPM). The vibration is not present at other RPMs. What is the most likely cause?

A. The engine's firing frequency at 1,400 RPM coincides with the cab's structural resonance — every structure has a natural frequency at which it vibrates most readily; when the engine's firing frequency matches the cab's natural frequency, the cab structure amplifies the vibration; above and below 1,400 RPM, the firing frequency does not match the resonance and the vibration is not amplified

B. The engine has a misfire at exactly 1,400 RPM that produces the vibration through the cab floor

C. The cab mounting isolators have hardened and transmit the engine's vibration at all frequencies, but the driver only notices it at 1,400 RPM because of the driving conditions at that speed

D. The driveshaft produces a vibration at the specific speed corresponding to 1,400 RPM that is transmitted through the frame to the cab floor

105. A transit bus has a condition where the passenger compartment produces a rattling noise from the ceiling area during driving on rough roads. The noise appears to come from the entire ceiling, not one specific location. What is the most likely cause?

A. The ceiling panel fasteners throughout the compartment have loosened from years of vibration — the clips, screws, or push-pins that secure the ceiling panels to the bus's structural roof have worked loose from the cumulative vibration of daily operation; each loose fastener allows its panel section to rattle independently, creating a distributed noise that appears to come from the entire ceiling

B. The roof-mounted A/C unit has a loose component that vibrates and transmits the noise through the roof structure to all ceiling panels

C. The ceiling panels are made of a material that has become brittle with age and cracks during temperature cycling, producing the rattling noise

D. The bus's structural roof has developed fatigue cracks that allow the roof panels to flex independently, producing the distributed rattling

106. A heavy-duty truck's cab has a condition where the windshield washer fluid does not reach the windshield when the washer button is pressed. The pump motor runs (audible from inside the cab). The fluid reservoir is full. What is the most likely cause?

A. The washer pump is running but has lost its prime from a cracked or disconnected suction line inside the reservoir

B. The washer nozzles are clogged with mineral deposits or debris from the washer fluid

C. The washer pump motor runs but the pump's internal impeller has separated from the motor shaft — the motor spins freely without driving the impeller; alternatively, the suction line inside the reservoir has disconnected from the pump inlet, or the pressure line from the pump to the nozzles has disconnected or kinked

D. The washer fluid has frozen in the lines between the reservoir and the nozzles despite the reservoir fluid being liquid

107. A heavy-duty truck has a condition where the driver's seat adjustment lever operates but the seat does not move in any direction. The lever has full mechanical travel. What is the most likely cause?

A. The seat mounting bolts have seized in their floor tracks, preventing the seat from sliding

B. The seat adjustment mechanism's internal cable or linkage has disconnected from the lever — the lever operates freely (confirming the lever's mechanism is intact) but the connection between the lever and the seat's locking/sliding mechanism has broken, stripped, or disconnected; the lever moves without actuating the seat's latch or lock mechanism

C. The seat's floor-mounting track has corroded and the seat is rust-locked in position

D. The seat adjustment lever's return spring has broken and the lever cannot maintain the unlocked position long enough for the driver to slide the seat

108. A heavy-duty truck's cab has a condition where the cab interior develops a musty odor within 2 days of a thorough cleaning. The HVAC system has been inspected and the cabin air filter is new. The evaporator has been treated with antimicrobial spray. What less-obvious source should be investigated?

A. The carpet or floor insulation beneath the floor mats — moisture trapped under the floor mats (from rain, snow, or wet boots) creates a dark, warm environment ideal for mold and mildew growth; the cleaning addressed the visible surfaces but did not remove the moisture from under the mats; the carpet padding and floor insulation must be dried or replaced to eliminate the moisture source that sustains the microbial growth

B. The headliner material, which absorbs moisture from the driver's breath during overnight parking

C. The door seal channels, which collect moisture and develop mold growth in the rubber grooves

D. The seat cushion foam, which absorbs moisture from the driver's body heat and perspiration during daily driving

109. A dry van trailer has a condition where the rear doors do not seal properly when closed — daylight is visible around the edges of both doors when viewed from inside the trailer. What is the consequence, and what should be repaired?

A. The door seal gaps allow water, dust, and road debris to enter the cargo area during transport, potentially damaging moisture-sensitive cargo; the gaps also compromise the trailer's temperature control capability if used for temperature-sensitive loads; the door hinges, latches, and seals must be inspected — the hinges may be worn or bent (preventing the doors from sitting flush), the latches may not pull the doors tight enough, or the rubber door seals may be compressed, torn, or missing

B. The door seal gaps are within acceptable tolerance and will not affect cargo protection

C. The door seal gaps only affect the trailer's aerodynamic performance and fuel economy

D. The door seal gaps are a cosmetic issue that does not affect the trailer's cargo-carrying function

110. A trailer's air ride suspension has a condition where all four air springs are correctly inflated but the trailer sits level when empty and leans noticeably to the right when loaded. What is the most likely cause?

A. The right-side springs have less capacity than the left side from a different spring specification

B. The cargo is consistently loaded off-center to the right, shifting the center of gravity toward the right side

C. The right-side height control valve is set lower than the left side, allowing the right springs to compress further under load — when empty, both sides are at the correct height because the springs are at their unloaded extension; when loaded, the right side compresses further because the valve maintains a lower reference height on that side; the height control valve linkage on the right side must be adjusted to match the left side

D. The right-side air springs have a lower spring rate than the left from internal deterioration

111. A reefer trailer's TRU produces adequate cooling but the fuel consumption of the TRU's diesel engine has increased by 30% over the past 6 months. The TRU cools the cargo to the setpoint without difficulty. What is the most likely cause of the increased fuel consumption?

A. The TRU's diesel engine has worn injectors that over-fuel the engine during operation

B. The TRU's compressor has worn internally and runs for longer periods to achieve the same cooling output

C. The condenser has accumulated debris that reduces its heat rejection efficiency — the dirty condenser forces the TRU to work harder (longer compressor run times, higher discharge pressures) to achieve the same cooling output; the increased workload consumes more fuel even though the TRU still reaches the setpoint; cleaning the condenser restores the heat rejection efficiency and reduces fuel consumption

D. The trailer's insulation has degraded, allowing more heat to infiltrate and requiring the TRU to run longer to maintain the setpoint

112. A trailer equipped with drum brakes has a condition where one brake drum has a polished (mirror-like) surface over its entire friction area. All other drums have the normal rough texture. What does the polished drum indicate?

A. The drum has been machined with too fine a surface finish during the last brake service

B. The brake shoes on that position have glazed — the shoe surface has become smooth and hard from heat exposure, and the glazed shoes have polished the drum surface through continuous contact; glazed

shoes have a reduced friction coefficient, which means that position provides less braking force than the other positions; the shoes and drum surface must both be addressed

C. The drum is a replacement unit with a different metallurgical specification that polishes more readily than the original drums

D. The automatic slack adjuster on that position has over-adjusted, keeping the shoes in constant contact with the drum and polishing the surface from the continuous friction

113. A trailer's landing gear has a condition where both legs extend and retract normally, but one leg visibly flexes outward under the trailer's nose weight when the tractor is disconnected. What does this flexing indicate?

A. The flexing leg's internal support tube or outer sleeve has developed a crack or structural weakness — the leg can extend and retract (confirming the gearbox and mechanism function) but cannot support the concentrated nose weight without deflecting; the crack or weakness allows the leg to bow outward under the vertical load; continued loading will progress the failure and the leg may collapse; the landing gear leg must be replaced

B. The landing gear mounting bracket has loosened, allowing the leg to pivot at the mount point instead of remaining rigid

C. The flexing is normal behavior for landing gear under maximum nose weight and does not indicate a structural problem

D. The landing gear's cross-bracing has broken, eliminating the lateral support that prevents the legs from splaying under load

114. A trailer's electrical system has a condition where the ABS power supply fuse blows repeatedly after being replaced. What should be investigated before installing another fuse?

A. The ABS module for an internal short circuit that draws excessive current and blows the fuse

B. The trailer's ABS wiring harness and modulator valves for a short circuit — a blown fuse indicates a current draw that exceeds the fuse's rating; repeated blowing after replacement confirms the short is still present; the short may be in the wiring harness (chafed insulation contacting the trailer frame), in a modulator valve's coil (internal short to ground), or in the ABS module itself; the short must be located and repaired before installing a new fuse

C. The replacement fuse rating, which may be lower than the original specification

D. The trailer's battery (if equipped) for a voltage spike that overwhelms the ABS circuit

115. A trailer equipped with sliding tandem suspension has a condition where the tandem slides to the rear-most position but will not slide forward. The locking pins release fully in both directions. What is the most likely cause?

A. The slider rails are clear and lubricated, but the tandem cannot slide forward because the tractor cannot pull it forward

B. The trailer's air ride suspension is inflated and is pressing the tandem against the rails, preventing forward movement

C. The slider rails have accumulated debris, corrosion, or a bent section at the forward end that physically blocks the tandem from sliding forward — the rearward slide path is clear, which is why the tandem reaches the rear-most position; the forward path has an obstruction that the tractor's pushing force cannot overcome; the rails must be inspected, cleaned, and repaired at the obstruction point

D. The locking pins are releasing at the current position but the forward locking pin holes are corroded and the pins are jamming before the tandem can slide past them

116. A trailer's conspicuity tape application has been inspected and found to be non-compliant — the tape is applied in continuous strips instead of the required alternating red and white pattern. What is the compliance requirement, and why does the alternating pattern matter?

A. The continuous strip application is acceptable as long as the total length of tape meets the minimum specification

B. The alternating red and white pattern is required to distinguish the trailer from other roadside objects at night

C. The requirement varies by province and the continuous strip may be compliant in some jurisdictions

D. The alternating red and white pattern is required by CMVSS 108 to provide maximum nighttime visibility — the alternating pattern creates a recognizable outline of the trailer's size and shape that a continuous strip does not provide; the contrast between the red and white sections helps following

drivers judge the trailer's distance, speed, and size in low-light conditions; continuous strips do not provide the same visual cues

117. A truck's A/C system has a condition where the compressor engages normally and the system pressures are within specification, but the vent temperature is 12°C instead of the expected 5-8°C. The cabin air filter has been recently replaced. What should be checked?

A. The evaporator core for contamination or debris that reduces the airflow through the core without blocking it completely

B. The blower motor speed, which if reduced from a worn motor or a faulty resistor pack would reduce the airflow across the evaporator and raise the vent temperature — the reduced airflow means less total air volume is cooled per unit time; however, the individual air molecules are actually cooled more (the evaporator temperature may be lower than normal because the reduced airflow absorbs less heat), but the total cooling capacity delivered to the cab is reduced

C. The condenser fan speed, which if too low would elevate the high-side pressure and reduce cooling capacity

D. The refrigerant charge weight, which if even slightly low could reduce the evaporator's effective cooling surface area

118. A truck's HVAC system has a condition where the defrost mode produces warm air from the defrost vents as expected, but the air also simultaneously exits from the floor vents. The mode door should direct all air to the defrost vents when defrost mode is selected. What is the most likely cause?

A. The HVAC system is designed to simultaneously deliver air to both the defrost and floor vents during defrost mode as a comfort feature

B. The mode door actuator has partially failed — the actuator moves the mode door toward the defrost position but does not have enough force or travel to close the floor vent pathway completely; the door partially blocks the floor outlet but enough air bypasses through the partially open floor vent to be felt at the floor

C. The floor vent ductwork has a leak that allows pressurized air from the HVAC housing to escape through the leak to the floor area

D. The mode door actuator motor has failed and the mode door is stuck in a position that splits airflow between defrost and floor — alternatively, the mode door's linkage or pivot has disconnected, broken, or seized, preventing the door from reaching the full defrost position; the door sits at an intermediate position that allows air to exit from both outlets

119. A truck's A/C system has been diagnosed with a restricted receiver-drier. What symptoms does a restricted receiver-drier produce?

A. The restricted receiver-drier limits the liquid refrigerant flow to the expansion valve, reducing the evaporator's cooling capacity

B. A restricted receiver-drier reduces the flow of liquid refrigerant to the expansion valve — the low-side pressure drops below normal (because the evaporator receives less refrigerant than it needs), the high-side pressure upstream of the restriction may be higher than normal (because the condenser retains more liquid than designed), and the vent temperature rises because the evaporator cannot produce adequate cooling; frost may appear on the receiver-drier at the restriction point from the pressure drop

C. A restricted receiver-drier creates a high-side pressure drop that the compressor must overcome, increasing the compressor's current draw and generating a whining noise proportional to the restriction severity

D. The restricted receiver-drier causes the A/C system to cycle rapidly because the low-side pressure drops to the cycling switch's cut-out threshold faster than normal

120. A bus's HVAC system has a condition where the A/C works adequately when the bus is in motion but produces noticeably warmer vent temperatures when the bus is stopped at a traffic light with the engine idling. What is the most likely cause?

A. The condenser receives adequate cooling from ram airflow during driving but insufficient cooling from the condenser fan alone at idle — the condenser fan (if functioning) may not provide enough airflow to match what ram air provides during driving; the reduced condenser cooling at idle raises the high-side pressure, reduces the pressure differential across the expansion valve, and the evaporator receives less cooling capacity; the vent temperature rises until the bus resumes driving and the ram air supplements the condenser fan

B. The compressor belt slips at idle RPM from reduced engine torque, limiting the compressor's capacity

C. The evaporator ices over at idle because the reduced airflow through the evaporator (from the blower running at idle voltage) drops the evaporator temperature below freezing

D. The engine's idle speed drops below the compressor's minimum effective RPM, and the compressor cannot maintain adequate refrigerant flow

121. A truck's heated windshield washer system has a condition where the washer fluid exits the nozzles at a very high temperature — hot enough to create steam on the windshield. The washer fluid heater is an inline electric element. What is the most likely cause?

A. The heater element's thermostat has failed in the closed (always-on) position — the thermostat should limit the fluid temperature to a safe level (typically 40-60°C); if the thermostat fails closed, the element heats continuously without temperature regulation, and the fluid can reach dangerous temperatures; the overheated fluid creates steam on the cold windshield and risks thermal shock that can crack the glass

B. The washer pump delivers fluid too slowly through the heater, giving the element excessive time to heat the small volume

C. The heater element has developed a short circuit that increases the heating capacity beyond the designed level

D. The washer fluid concentration is too high, lowering the boiling point and causing the fluid to vaporize in the heater

122. A truck's A/C system has a condition where the compressor clutch engages and the system cools, but the compressor produces a loud knocking noise at all operating conditions. The noise is internal to the compressor. What is the most likely cause?

A. The compressor has a broken internal component — a damaged reed valve, a cracked piston, or a failed connecting rod allows the internal mechanism to impact the cylinder wall or the valve plate during each revolution; the knocking is continuous because the damaged component impacts with every compressor rotation; the compressor must be replaced and the system flushed to remove any debris from the failed component

B. The compressor clutch has excessive air gap that allows the clutch plate to hammer against the pulley during each engagement cycle

C. The compressor mounting bolts have loosened and the compressor rocks on its bracket during operation

D. The compressor's internal oil level is too low and the pistons are impacting the cylinder walls from inadequate lubrication

123. A truck's cab heater has a condition where the heater produces adequate heat when the vehicle is moving but the heat output decreases significantly when the vehicle is stopped at idle. The engine coolant temperature gauge reads normal at both conditions. What is the most likely cause?

A. The heater control valve is partially closing at idle from a vacuum signal that decreases at idle RPM

B. The heater core has a partial restriction that limits coolant flow at the water pump's idle output

C. The heater core has a partial internal restriction that limits coolant flow at the lower pump speed of idle operation — the restriction reduces the volume of hot coolant passing through the core; at idle, the water pump's output is at its minimum and cannot force adequate coolant through the restricted passage; at driving RPM, the increased pump output forces more coolant through the restriction, maintaining adequate heat; the engine temperature is unaffected because the restriction is in the heater circuit, not the main cooling loop

D. The HVAC blend door position changes at idle from a temperature-compensating circuit that reduces heat output to match the lower fan speed at idle voltage

124. A hydraulic system on a utility truck has a condition where all functions operate normally except the boom rotate function, which operates in one direction only. The rotate function does not respond in the opposite direction. What is the most likely cause?

A. The rotate circuit's directional control valve has a stuck spool that allows flow in one direction but blocks flow in the opposite direction — the spool must shift in both directions to route fluid to both sides of the rotate motor; if the spool is stuck (from contamination, a bent spool, or a failed pilot signal) in a position that blocks one direction, the motor can only turn in the direction where flow is permitted

B. The rotate motor has a failed internal seal that bypasses in one direction but holds in the other

C. The rotate circuit's relief valve for one direction has failed, venting all pressure to tank in that direction

D. The rotate motor's external counterbalance valve for one direction has failed closed, blocking the return flow

125. A hydraulic crane has a condition where the boom lift produces a jerky, oscillating motion during extension. The oscillation occurs at approximately 3 Hz. All other functions operate smoothly. What is the most likely cause?

A. The boom lift circuit's counterbalance valve is unstable — the valve is set too close to the system's operating pressure for the boom lift function, and the valve alternately opens (allowing flow) and closes (blocking flow) as the pressure oscillates around the valve's set point; the 3 Hz frequency corresponds to the valve's response time; adjusting the counterbalance valve's setting to provide adequate margin above the operating pressure stabilizes the motion

B. The boom lift cylinder has air trapped in the cap end that compresses and expands at 3 Hz

C. The hydraulic pump has a worn gear that produces a pressure pulsation at the pump's mesh frequency

D. The boom's mechanical structure has a resonance at 3 Hz that is excited by the hydraulic flow during extension

126. A hydraulic system has a condition where the pump is driven by the engine's PTO at a fixed ratio. The operator reports that the hydraulic functions slow down when the engine RPM drops to idle. Is this expected behavior?

A. No — a pressure-compensated pump should maintain the same flow regardless of engine RPM

B. Yes — a fixed-displacement pump's output is directly proportional to its rotational speed; when the engine drops to idle, the pump speed decreases proportionally and the pump produces less flow; less flow means slower actuator movement; this is expected behavior for a fixed-displacement pump driven at a fixed ratio to the engine; to maintain function speed at idle, the operator must increase the engine RPM

C. No — the system's relief valve should compensate for the reduced flow by increasing the pressure to maintain the same actuator speed

D. Yes — but only if the system does not have an accumulator to supplement the reduced pump output at idle

127. A hydraulic system on a dump truck has a condition where the dump body raises to full height but the dump body bounces noticeably when it reaches full extension. The bounce is a single rebound, not a continuous oscillation. What is the most likely cause?

A. The dump cylinder reaches full stroke and the pump continues to deliver flow against the dead-headed cylinder, creating a pressure spike that bounces the body

B. The dump body's mechanical stop absorbs the impact of full extension and the body rebounds once from the stored elastic energy

C. The dump cylinder's internal cushion has failed — the cushion is designed to decelerate the piston as it approaches the end of stroke; without the cushion, the piston impacts the cylinder cap at full speed, and the body rebounds once from the impact; the directional valve should also be returned to neutral at full extension to stop the pump's delivery

D. The hydraulic fluid has trapped air that compresses at full extension and rebounds the body once

128. A hydraulic system's reservoir has a sight glass that consistently reads at the correct level during operation, but the technician finds the reservoir overflowing from the filler cap when all cylinders are fully retracted. What does this indicate?

A. The reservoir is overfilled — the reservoir level must be checked with all cylinders fully retracted (which returns the maximum fluid volume to the reservoir); the technician has been checking the level during operation (when fluid is in the cylinders, lines, and components), and the level reads correctly at that condition; when the cylinders retract and the fluid returns to the reservoir, the overfilled condition becomes apparent; excess fluid must be removed to prevent overflow

B. The reservoir's filler cap seal has failed and the pressurized fluid pushes past the cap during operation

C. The system has a thermal expansion problem from overheated fluid

D. The pump is pumping fluid into the reservoir through the return line faster than it is drawing from the suction line

129. A hydraulic hose on an aerial lift has developed a bulge approximately 50 mm from the fitting. The hose has not leaked. Should the hose be replaced?

A. The bulge can be monitored during regular inspections and replaced when it begins to leak

B. The hose does not need replacement because the bulge is within the hose's rated expansion tolerance

C. The bulge is cosmetic and does not affect the hose's pressure rating as long as the fitting connections are secure

D. The bulge indicates the internal reinforcement layers have failed at that point — the outer rubber cover is the only remaining barrier containing the system pressure; the hose can rupture without warning at any time, and on an aerial lift, a sudden hydraulic failure can cause the boom to drop with a worker in the bucket; the hose must be replaced immediately

130. A hydraulic system has a condition where the pump produces adequate pressure and flow, but the system generates excessive heat during continuous operation. The relief valve is correctly set and does not activate during normal functions. What is consuming the energy that becomes heat?

A. The directional valve spools have internal leakage that bypasses fluid from the high-pressure side to the low-pressure side during each function — the bypassed fluid converts the pressure energy to heat without performing useful work; the relief valve does not activate because the leakage does not exceed the pump's output capacity; the heat generation is proportional to the bypass flow rate and the pressure differential across the valve spools

B. The hydraulic fluid is the wrong viscosity and the increased internal friction generates excessive heat

C. The cylinder rod seals have excessive friction that converts mechanical energy to heat during each extension and retraction cycle

D. The reservoir is undersized and cannot dissipate the normal heat generated during continuous operation

131. A hydraulic system on a crane has a condition where the main boom lift holding valve (counterbalance valve) has been adjusted by a field technician to eliminate a slight boom drift. After the adjustment, the boom lift function operates noticeably slower than before the adjustment. Why did the adjustment reduce the boom speed?

A. The technician tightened the counterbalance valve's setting to increase the holding pressure — the higher setting requires more pilot pressure to open the valve during normal boom operation; the pump must build more pressure to open the counterbalance valve before flow reaches the cylinder, and the

additional pressure needed to overcome the tighter valve setting reduces the available pressure for moving the cylinder, slowing the boom's extension and retraction speed

B. The counterbalance valve adjustment changed the relief valve's setting, reducing the maximum system pressure

C. The counterbalance valve adjustment restricted the flow path through the valve, limiting the volume of fluid that can pass through per unit time

D. The technician tightened the counterbalance valve beyond the optimal setting — a counterbalance valve that is set too tight requires excessive pilot pressure to crack open, which reduces the effective pressure available to drive the boom lift cylinder; the valve holds the load better (eliminating the drift) but resists opening during normal operation, slowing all boom movements; the valve must be set to hold the load with minimal margin above the load-induced pressure, not at the maximum setting

132. A battery electric transit bus has a condition where the traction motor produces a grinding noise during regenerative braking that is not present during acceleration. The noise increases as the regenerative braking force increases. What is the most likely cause?

A. The traction motor's stator winding has a partial short that produces electromagnetic noise during the generator mode of regenerative braking

B. The traction motor's reduction gearbox has worn teeth on the coast side — during acceleration, the drive-side gear teeth mesh smoothly; during regenerative braking, the torque reverses and loads the coast-side teeth, which are worn or damaged; the grinding noise increases with regenerative braking force because the loading on the worn coast-side teeth increases proportionally

C. The inverter's power electronics produce an audible noise from the switching frequency during regenerative mode

D. The motor's rotor bearings have a defect that manifests only during the reversed loading of generator mode operation

133. A hybrid electric truck has a condition where the engine starts unexpectedly during steady-state highway cruising even though the battery SOC is adequate and the power demand does not exceed the electric motor's capacity. The scan tool shows the engine start was commanded by the BMS. What is the most likely BMS-commanded reason?

A. The BMS detected a cell voltage approaching its minimum threshold despite the adequate overall SOC

B. The BMS monitors individual cell temperatures and one or more cells exceeded the maximum temperature threshold — the BMS commands the engine start to activate the engine-driven A/C compressor, which powers the battery thermal management system's coolant loop to cool the overheating cells; this occurs even with adequate SOC and low power demand because the thermal protection takes priority over all other operating parameters

C. The BMS detected a communication error with the VCU and commanded the engine start as a fail-safe backup power source

D. The BMS commanded the engine start to maintain the battery's state of charge within a narrow optimal window for cell longevity

134. A technician is replacing a high-voltage battery module in a battery electric truck. After installing the new module, the BMS reports "Cell Voltage Imbalance" and limits the pack's performance. What must be done after the module replacement?

A. The new module's cells must be balanced with the existing pack — the replacement module may have a different state of charge than the remaining modules; the BMS must perform a cell balancing procedure that equalizes the voltage of all cells in the pack; until the balancing is complete, the BMS limits performance to protect the imbalanced cells from overcurrent damage during charge and discharge

B. The BMS firmware must be updated to recognize the new module's serial number and capacity rating

C. The high-voltage isolation test must be performed to verify the new module's insulation integrity

D. The pack must be fully discharged and then fully charged to reset the BMS's cell tracking algorithm

135. A battery electric delivery truck has a condition where the DC fast charging rate has decreased significantly — the truck now takes 90 minutes to charge from 20% to 80% SOC instead of the original 45 minutes. The battery SOH is at 88%. What is the most likely cause of the slower charging?

A. The DC charging station's output has decreased from internal component aging

B. The charging cable has developed increased resistance from a damaged conductor or corroded connector

C. The battery's increased internal resistance from aging limits the maximum charging current the BMS will allow — as the battery ages and its internal resistance rises, the BMS reduces the maximum DC fast-charging current to prevent excessive cell heating and voltage spikes that would accelerate further degradation; the 88% SOH confirms the battery has aged enough for the resistance increase to noticeably reduce the charging rate; the longer charge time is the BMS protecting the remaining battery capacity

D. The battery's thermal management system has degraded and the cells heat faster during charging, triggering earlier thermal derating

Practice Exam 15: Answer Key and Explanations

1. A — Aluminum fuel tanks are particularly vulnerable to welding hazards — welding spatter can melt through the thin aluminum, radiant heat can raise the tank wall temperature to fuel ignition levels, and sparks can ignite fuel vapors escaping from the tank vent. At 600 mm, all three hazards are present. The tanks must be removed or protected with a welding blanket, and a fire extinguisher must be immediately accessible.

2. C — Hardened steel components under extreme compressive force store enormous energy. If a king pin, knuckle, or press tooling fractures under 15 tons of concentrated force, the stored energy releases instantly, projecting fragments at lethal velocity. The technician should stop increasing pressure, apply penetrating oil, use localized heat, and allow time for the oil to work before re-attempting the press operation.

3. B — Even a 12V lighting circuit can produce a short circuit if a tool or wire contacts a grounded component. The short draws hundreds of amps from the battery through the unintended path, generating intense heat that melts wiring insulation, ignites surrounding materials, and causes severe burns. Disconnecting the negative cable eliminates the ground return path and prevents short circuits regardless of the circuit's normal operating voltage.

4. D — The crane tilting forward (front casters lifting) confirms the engine's weight exceeds the crane's capacity at the current boom extension. The crane is overloaded and will topple if the lift continues. The technician must immediately lower the load before the crane tips completely. A falling 900 kg engine combined with the collapsing crane creates a lethal hazard for anyone in the area.

5. A — The leaf spring is under significant preload from the vehicle's weight. When the last U-bolt is removed, the spring's stored energy releases suddenly — the axle can drop or the frame can rise abruptly. This uncontrolled movement can strike the technician, crush hands between components, or shift the vehicle on its supports. The axle must be independently supported before U-bolt removal to control the energy release.

6. C — Used automatic transmission fluid, regardless of its condition, color, or odor, is classified as used petroleum product. It can be collected in the same waste oil drum as engine oil, hydraulic oil, and other petroleum-based fluids for recycling by a licensed waste oil hauler. The burnt condition does not change its waste classification.

7. B — Before crawling under any vehicle, the parking brake must be set, the wheels chocked to prevent rolling, and the vehicle's stability on its supports verified. If on jack stands, the stands must be on solid, level ground. Removing the keys prevents engine start but does not prevent rolling. Wheel chocks are the critical backup against parking brake failure or unintended brake release.

8. D — Sidewall damage from run-flat operation compromises the tire's structural integrity. The internal cords may be broken, delaminated, or heat-damaged even if the external damage appears minor. Inflating a structurally compromised tire risks a catastrophic blowout that can cause severe injury. The tire must be removed from service and replaced — no inflation or testing should be attempted.

9. C — The coolant temperature sensor is stuck at −30°C, which is within the sensor's valid electrical range (so no fault code is set). The ECM requires the coolant temperature to reach a minimum threshold before transitioning from open-loop enrichment to closed-loop control. A sensor stuck at −30°C tells the ECM the engine has never warmed up, so it remains in open-loop mode indefinitely.

10. A — TBN measures the oil's remaining alkaline reserve that neutralizes acidic combustion byproducts. A TBN of 3.5 is approaching the condemning limit (typically 2.0-3.0). If the TBN drops below the limit before the next oil change, the acid attacks bearing surfaces, seals, and internal components. The oil should be changed early rather than completing the remaining 5,000 km interval.

11. D — At idle, each injection event delivers a tiny fuel volume. An intermittent internal injector leak represents a large percentage of this small volume — the rail pressure drops sharply when the leak opens and recovers when it seals. At higher RPM, the same leak is a smaller percentage of the larger fuel delivery volume, and the oscillation is dampened by the greater flow.

12. B — The turbocharger's compressor wheel and housing accumulate oil residue and dirt over 100,000 km. This contamination layer reduces the wheel's aerodynamic efficiency — it cannot compress air as effectively as when clean. Cleaning the compressor housing and wheel (if no blade damage is found) can restore the lost 2 psi of boost without replacing the turbocharger.

13. C — The EGR valve opens to the commanded position, but the cooler's internal passages are restricted by carbon deposits. The restricted cooler cannot pass the designed gas volume even though the valve opening is correct. The reduced EGR mass flow allows higher combustion temperatures. The ECM does not detect the restriction because it monitors valve position, not actual gas flow rate.

14. A — Engine oil contamination changes the coolant's color from its original dye to dark brown. Even a small amount of petroleum oil mixing with the coolant creates a visible color change. The oil floats on the coolant surface in the degas bottle and creates a brown film. The freeze point, pH, and nitrite levels remain unaffected in the early stages because the oil does not immediately react with the coolant chemistry.

15. D — A rhythmic exhaust puff at approximately 1 Hz at idle corresponds to one cylinder's firing interval. On a 6-cylinder engine at 600 RPM, each individual cylinder fires once per second. The weak cylinder produces unburned fuel vapor or incomplete combustion products that appear as a discrete puff at its specific firing interval, while the other five cylinders produce normal exhaust flow.

16. B — Water accumulates in the separator bowl from normal condensation and fuel contamination. The separator is designed to collect and hold this water for periodic draining. If the bowl is not drained at the specified maintenance interval, the water level rises until the bowl is nearly full. In freezing weather, the water expands as it freezes and cracks the plastic or glass bowl.

17. A — The DPF regeneration strategy uses in-cylinder post-injection to raise exhaust temperatures. Some of the late-injected fuel contacts the cylinder walls and migrates past the piston rings into the crankcase. The rising oil level, fuel odor, and reduced viscosity collectively confirm fuel dilution from the regeneration events. The frequency and volume of post-injection fuel determine the dilution rate.

18. C — The replacement radiator has fewer cooling tubes or a smaller core than the original specification. The reduced cooling capacity handles the moderate heat load of flat highway driving but cannot reject the higher heat generated during loaded uphill operation. The replacement radiator's part number and specifications must be verified against the original.

19. D — The VGT control system is hunting — the ECM commands a vane position, the turbocharger overshoots the boost target, the ECM adjusts, the boost undershoots, and the correction cycle repeats at 2-3 Hz. A contaminated VGT actuator, sticky vane mechanism, or control loop calibration issue prevents the system from stabilizing at the commanded position.

20. B — In extreme cold (−20°C), the ram airflow at highway speed removes heat faster than the engine generates it. The thermostat closes to block radiator flow, but the cold air flowing through the charge air cooler and around the engine still extracts significant heat. A winterfront (grille shutter or cold weather cover) blocks the excessive ram airflow and allows the engine to maintain its operating temperature.

21. A — Ammonia odor from the tailpipe indicates ammonia slip — the DEF dosing system is injecting more urea than the SCR catalyst can convert. The excess urea decomposes to ammonia that passes through the catalyst unreacted. The dosing rate may be too high, the SCR catalyst efficiency may have decreased, or the exhaust temperature may be too low for complete ammonia conversion.

22. C — An easy-out (screw extractor) is manufactured from hardened tool steel that is significantly harder than standard HSS drill bits. The broken extractor cannot be drilled out with shop drill bits — they dull instantly without removing material. The extractor must be removed by EDM (electrical discharge machining), carbide burring, or specialized machine shop techniques.

23. C — During rapid acceleration, the engine's torque reaction tilts the powertrain, and the oil mass in the pan shifts from the centrifugal/inertial force. The oil pickup tube momentarily surfaces above the oil level or the oil mass shifts away from the pickup. The brief air ingestion drops the pressure to near zero until the oil settles and covers the pickup again after 2 seconds.

24. B — A faint, continuous grey haze that does not change with load or speed indicates a constant, small oil consumption source. Valve stem seals that allow a steady seepage of oil into the intake ports produce this continuous haze. The consumption rate is too low to affect the oil level between changes but is visible as the persistent grey tint in the exhaust.

25. A — Elevated iron (from liners) and chromium (from ring plating) during the first 1,000 km after an overhaul are normal break-in wear. The new rings and liners mate their surfaces during the initial operating period. The declining trend confirms the break-in is progressing normally — the wear rate decreases as the surfaces polish and conform to each other.

26. C — Standard diagnostic tests (pressure test, oil check, exhaust observation, block tester) have all been negative. The coolant may be escaping through a path these tests do not detect — a heater core micro-leak vaporizing coolant into the HVAC stream, an air compressor head gasket leak, or an EGR cooler leak too small to produce visible exhaust steam. Each alternative path must be investigated individually.

27. D — When the key is turned off, the fuel injection pump's shutdown solenoid de-energizes. The solenoid is spring-loaded to the fuel-off position and held open by electrical current during operation. When the current stops, the spring drives the plunger to the fuel-off position with enough force to produce an audible metallic clunk against the internal mechanical stop.

28. D — The fuel rail reaches only 800 bar during cranking (2,000 bar minimum required). The high-pressure pump is attempting to build pressure but the rail cannot hold it. A stuck-open relief valve drains the pressure as fast as the pump builds it. The relief valve should only open at pressures far above the starting requirement, but a faulty valve opens at lower pressures and prevents the rail from reaching starting pressure.

29. B — The engine's valve lash gradually tightens over time from valve seat recession or wear. If not adjusted within the maintenance interval, one or more valves may not close completely. A slightly open valve leaks compression, reducing that cylinder's contribution at idle. The gradual seat recession correlates with the 6-month progressive deterioration. The cylinder contribution test may not detect small, evenly distributed differences.

30. A — The air dryer purge cycle must be long enough to regenerate the desiccant bed completely. If the purge duration is insufficient (from an undersized purge orifice, a partially blocked purge valve, or inadequate supply tank volume), the bed carries residual moisture into the next loading cycle. The cumulative unregenerated moisture progressively reduces the bed's effective capacity until it saturates within 2 weeks.

31. C — The trailer ABS modulators cycle continuously during sustained downhill braking. The electromagnetic coils generate heat with each actuation cycle. During prolonged downhill braking, the coils accumulate enough heat to exceed the ABS module's thermal threshold. The module sets a thermal protection fault and illuminates the lamp. On flat terrain, the brief modulator cycling does not generate sufficient heat to reach the threshold.

32. D — Brake drums develop hard spots from previous overheating events. The hard spots have a higher friction coefficient than the surrounding drum surface. During light application, the shoes contact

the hard spots with concentrated force, producing grabbing. During heavier application, the shoes contact the entire drum surface and the hard spots' higher friction is averaged across the larger contact area, producing smoother braking.

33. B — The system passes all static leak tests (each individual leak is below the per-minute threshold), but multiple small leaks collectively consume enough air to increase the compressor's duty cycle from 25% to 40%. The static test's short measurement window does not capture the cumulative effect. The elevated duty cycle reflects the sum of all small leaks over the full driving cycle.

34. A — The foot valve has excessive free play between the pedal mechanism and the valve's internal piston. A worn pivot pin, elongated clevis hole, or compressed pedal return stop creates 25 mm of mechanical travel before the pedal begins to actuate the valve's piston. The brakes apply normally once the dead zone is consumed and the piston begins displacing air.

35. C — The anchor pin is seized, preventing the brake shoes from retracting to their designed clearance after each application. The ASA senses the shoes are not at the correct position and continuously advances the adjustment to compensate. Three consecutive ASAs have all over-adjusted because the root cause (the seized anchor pin) forces the same compensating behavior regardless of which ASA is installed.

36. B — The air line between the tractor's service gladhand and the trailer's relay valve has excessive length or volume. The foot valve must pressurize this entire line before the signal reaches the relay valve. An excessively long routing path, oversized line, or additional volume creates a 5-second delay. The tractor brakes respond immediately because their relay valve receives a shorter, more direct signal path.

37. D — One wheel's brake generates more force than the others at the same air pressure. A brake that grabs excessively (from contaminated lining, over-adjusted ASA, or undersized drum) locks that wheel before the others during a moderate stop. The ABS correctly intervenes on that single wheel. Alternatively, the tire has significantly less traction from different tread depth, size, or inflation.

38. A — The brake pad wear indicator tab is designed to contact the rotor when the pad reaches its minimum thickness. The tab scrapes against the rotor during rotation with the brakes released as a warning to the driver. When the brakes are applied, the application force presses the tab flat against the rotor surface, stopping the scraping. The pad must be replaced.

39. C — The compressor's unloader mechanism holds the intake valves open after the governor signals cut-out. A leaking unloader piston seal allows system air to escape backward through the open intake valves after shutdown. The leak rate may be within the per-minute static test specification, but over 2 minutes, the cumulative loss depletes the system to the cut-in pressure.

40. B — A brake hose with a deteriorated inner liner acts as a one-way valve. Application air pushes through the liner flap into the chamber, but when the pressure releases, the flap blocks the return flow. The air is trapped and the brake remains applied. The random nature matches the unpredictable behavior of the loose liner flap, which shifts position with temperature, vibration, and pressure changes.

41. D — During an ABS-active emergency stop, extreme weight transfer loads the front axle heavily, increasing the steer tire loading and steering effort. Simultaneously, the ABS modulates the steer axle brakes to prevent lockup, creating brief moments of reduced tire traction for steering. Both effects combine to make the steering feel heavier and less responsive during the emergency stop.

42. A — The spring brake relay valve has a slow internal leak on the hold-off circuit. Air gradually leaks past an internal seal from the hold-off side to the exhaust port. The leak rate is slow (taking 8 hours to noticeably apply the spring brakes) but continuous. The valve must be replaced because the leak will eventually fully apply the spring brakes during extended parking.

43. C — Brake shoes vibrate at their natural frequency during light application. The light contact force is insufficient to dampen the vibration between the shoes and the drum. During heavier application, the increased contact pressure clamps the shoes firmly against the drum, suppressing the vibration. Anti-squeal compound on the backing plates or chamfered lining edges typically eliminates the squeal.

44. D — The loaded vehicle requires more brake force to achieve the same deceleration rate. The increased force exceeds the available traction at one or more wheel positions, and the ABS activates to prevent lockup. The brake proportioning may need adjustment to match the loaded weight distribution, or the tires may be at their traction limit for the loaded weight.

45. B — The duct tape repair prevents the cracked gladhand from seating properly with the trailer's gladhand. The seals may bypass under pressure, potentially releasing the trailer's spring brakes during driving. The cracked gladhand may also fail completely at highway speed, causing sudden spring brake application. The gladhand must be replaced with the correct part — duct tape is never an acceptable repair.

46. A — The aftermarket air horn consumes a large volume of air from the supply tank during each blast. The horn's consumption depletes the reservoir faster than the compressor can replenish it. The first brake application after a long blast has less available pressure, reducing the braking force. The horn should be connected to a separate reservoir or a flow limiter should be installed.

47. C — The turn signal flasher produces a voltage spike at each flash cycle that couples into the warning lamp circuits through shared wiring, a common power bus, or electromagnetic induction between adjacent wires. The spike is brief enough to flash the lamps once per cycle but not sustained enough to keep them illuminated continuously.

48. D — The ECM reads 90 kPa and calculates the vehicle is at approximately 1,000 metres altitude. The ECM limits the fuel injection quantity to match the perceived thinner air, even though the actual air density at sea level supports more fuel. The engine produces less power because it is fueled for altitude conditions that do not exist at the vehicle's actual location.

49. B — A 160-amp rated alternator should maintain 14.2V under a 15-amp headlight load without any noticeable voltage drop. The drop to 12.8V confirms the alternator's current capacity has decreased dramatically — a failed stator winding, failed rectifier diodes, or severely worn brushes limit the output to a fraction of the rated capacity.

50. A — The circuit has a short to ground downstream of the BCM's current sensor but upstream of the lamp. The short provides a current path that the BCM measures as normal (0.2 amps), but the current flows to ground through the short instead of through the lamp. The lamp receives no current because the short circuit provides an easier path to ground.

51. C — The ECM outputs the correct PWM signal at its pin, but the signal does not reach the fan controller. A broken, shorted, or grounded PWM wire prevents the controller from receiving the speed command. The fan controller defaults to full speed when it loses the PWM input — this is a designed protective response to ensure cooling continues if communication fails.

52. D — The high-beam indicator circuit has a wiring fault — the indicator wire is shorted to a power source, connected to the wrong circuit, or has a cross-connection to the high-beam supply. The indicator receives a constant "high beam" signal regardless of the dimmer switch position. The headlights switch correctly because their power circuits are independent of the indicator circuit.

53. B — The affected module's power supply drops below its minimum operating voltage during cranking. The starter motor's heavy current draw temporarily drops the system voltage. Most modules tolerate this dip, but the affected module has a marginal power supply circuit (corroded connector, thin wire, long wire run) that drops the local voltage below the module's minimum threshold during the cranking event.

54. D — The APP1 and APP2 sensors are intentionally designed with different voltage ranges and slopes. Connecting APP2's signal to APP1's input provides identical voltages to both ECM inputs. The ECM expects a specific mathematical relationship between the two signals. Identical signals violate this relationship and the ECM detects a correlation error, potentially derating further or refusing to operate.

55. D — The wiper motor's park circuit stops the motor at the park position by opening the park switch when the wipers reach the bottom of the windshield. If the park switch has failed in the open position, the park circuit cannot maintain power after the main switch opens. The motor stops immediately wherever the wipers are because the park circuit cannot complete the sweep to the park position.

56. A — The voltage regulator is hunting between charge and float modes. A marginal connection in the voltage sense circuit causes the regulator to alternately read the voltage as too low (increasing field current) and too high (decreasing field current). The 1 Hz cycling is the control loop's response time as it hunts between the two correction states.

57. D — The starter motor spins freely at high speed (confirming the solenoid energizes the motor), but the engine does not crank. The drive mechanism (Bendix or solenoid-actuated plunger) is not pushing the pinion gear into mesh with the flywheel ring gear. The motor spins without load. A failed Bendix mechanism, worn solenoid plunger, or broken shift fork prevents engagement.

58. B — The instrument cluster's voltmeter reads consistently 1V higher than the calibrated multimeter at all voltage levels. The consistent 1V offset indicates a systematic calibration error in the cluster's voltage measurement circuit — a drifted scaling factor, analog-to-digital converter offset, or voltage sense circuit error. The alternator and charging system are not at fault.

59. D — The horn works with the engine off (clean battery voltage) but not with the engine running (alternator adding electrical noise). The alternator's electrical noise (from the charging system's switching, AC ripple, and accessory interference) couples into the horn's self-interrupting electromagnetic oscillation circuit and disrupts the diaphragm's oscillation frequency, preventing the horn from producing sound.

60. C — White LED headlights produce white light by combining blue LED output with a yellow phosphor. If the blue LED channel is partially failing in the left assembly, the blue contribution decreases and the remaining yellow phosphor output shifts the color toward pink. The right assembly maintains its full blue output and produces normal white light.

61. D — A temperature-sensitive component in the CAN bus circuit (termination resistor, connector, or module transceiver) changes characteristics as it heats over 2 hours. The component operates correctly when cold but drifts out of specification when warm. After 2 hours, the CAN bus impedance or signal quality exceeds the tolerance for reliable communication. Cycling the ignition allows cooling and restores normal operation.

62. B — The APP sensor's resistive element has a worn or contaminated section between the 50% and 100% positions. The wiper produces an unstable signal as it crosses the damaged section, and the ECM interprets the erratic voltage as rapidly changing throttle input. The signal is clean below 50% because that section of the element is undamaged.

63. A — The timing chain was installed one tooth off on the crankshaft or camshaft sprocket. The ECM compares the crankshaft and camshaft sensor signals continuously. A one-tooth error changes the angular relationship by the spacing of one tooth. The ECM detects the deviation and stores the correlation error. The engine runs but derates because the valve timing is incorrect.

64. C — Many truck gauge circuits read maximum (hot) when the sender circuit is open. The gauge interprets the absence of the sender's resistance as the minimum resistance value, which corresponds to maximum temperature. The sender wire is open or the sender has failed internally. The ECM's separate coolant temperature sensor likely reads correctly, confirming the gauge sender circuit is at fault.

65. D — The battery disconnect switch has developed high-resistance contacts that arc during use. The arcing produces the buzzing sound and generates intense heat at the contact points. The heat can ignite surrounding materials and the high-resistance connection can fail completely. The switch must be replaced immediately.

66. B — A passive wheel speed sensor generates voltage proportional to the wheel's rotational speed. Below 15 km/h, the reluctor ring teeth pass the sensor slowly, and the generated voltage drops below the ABS module's minimum detection threshold. The sensor's air gap may be at the outer limit of specification. Reducing the gap increases signal amplitude at low speeds.

67. A — Inductive loads (solenoids, relays, clutch coils) generate voltage spikes when de-energized — the collapsing magnetic field produces flyback voltage that can exceed 100V momentarily. If the spike reaches the ECM's voltage sensing input before being suppressed, the ECM records it as a high-voltage event. Standard voltmeters cannot capture these microsecond-duration spikes.

68. C — GPS satellite constellation geometry changes throughout the day as satellites orbit. When fewer satellites are visible from the truck's location (from orbital positions, building obstructions, or terrain), the geometric dilution of precision increases and the position accuracy decreases. The accuracy returns to normal when the satellite geometry improves with different satellite positions.

69. D — The splitter and range shifts in the auxiliary section are air-operated. A disconnected air line, failed air valve, or blown air line fitting eliminates the air supply to the auxiliary section. The main box shifts mechanically through the shift lever and is completely unaffected by the air system failure. Restoring the air supply to the auxiliary section resolves the shifting problem.

70. A — The TCM commands lockup simultaneously with the 3-4 shift. The lockup apply pressure arrives before the 4th gear clutch is fully engaged. The partial engagement produces a speed fluctuation that the lockup clutch cannot hold, causing it to slip, release, and re-engage. The shudder occurs during the overlap between the gear change and lockup. Once 4th gear is fully engaged, the lockup holds cleanly.

71. A — As the clutch disc wears thin, the pressure plate moves closer to the flywheel. The release bearing rests further from the diaphragm spring fingers (because the thinner disc changes the geometry). The engagement point moves higher in the pedal travel as the disc wears. Minimal remaining free play confirms the disc has very little friction material left and is approaching its wear limit.

72. C — The forward clutch is engaged in all forward gears but released in Reverse and Neutral. The whining comes from a component that rotates with the forward clutch assembly — a worn thrust washer, damaged bearing, or worn gear in the forward gear train. In Reverse and Neutral, the forward clutch releases and the noise source stops rotating.

73. D — The bearing preload (which also sets ring gear backlash) determines the mesh between the ring and pinion gears. Excessive preload reduces backlash below specification; insufficient preload allows excessive backlash. Either condition changes the tooth contact pattern from the designed pattern. The howling at all operating conditions confirms the contact pattern is incorrect on both the drive and coast sides.

74. B — The 4th gear engagement teeth are worn on the coast-side faces. During deceleration, the helical gear thrust reverses and loads the coast side. The worn or rounded coast-side faces cannot maintain full-depth engagement against the thrust force. The drive-side faces (loaded during acceleration) are in better condition, which is why the transmission stays in 4th during acceleration.

75. A — Even a factory-new driveshaft can have balance issues from manufacturing tolerance or shipping damage. The technician should verify balance on a machine and check runout with a dial indicator on the companion flanges. If the shaft has a bent tube, it produces a vibration proportional to speed regardless of the U-joint angles and phasing being correct.

76. C — The TCU monitors the clutch actuator's travel distance. As the disc wears thinner, the actuator must travel further to achieve disengagement. When the travel exceeds the warning threshold, the TCU alerts the driver. The rougher engagement occurs because the actuator operates at its travel range limit where modulation precision is reduced. The clutch should be scheduled for replacement.

77. D — Engaging the inter-axle lock physically stops the differential's internal components from rotating relative to each other. The grinding noise disappears because the worn spider gears, side gears, and cross pin are locked in position and cannot move. The silence when locked confirms the differential's internal components are the noise source.

78. B — Burnt odor indicates the oil has been overheated, and metallic flakes confirm an active wear source. A slipping synchronizer, dragging clutch, or inadequate oil level generates the heat. The metallic debris comes from the component being worn. The transmission shifts normally now, but the progressive wear will eventually produce shifting problems. The metal type from oil analysis identifies the specific wear source.

79. A — The vibration is excited only during torque transmission and disappears immediately when the throttle is released at the same speed. This torque-dependent pattern indicates the vibration source is excited by the driveline torque, not by the rotational speed. Unequal U-joint angles, worn slip yoke splines, or a damaged companion flange all produce vibration proportional to transmitted torque.

80. C — A worn U-joint bearing cap produces a clunk at twice per revolution. The four bearing caps load in opposite pairs, creating two load events per revolution. During coast (engine braking), the thrust direction reverses and loads the worn caps differently than during acceleration. The coast loading exposes the wear that is not apparent during the drive-side loading of acceleration.

81. D — A continuous rumble that does not change character during acceleration, deceleration, or cruise indicates a component that is loaded consistently regardless of power flow direction. Wheel bearings rotate at constant speed from the vehicle's weight. Ring and pinion noise changes between drive and coast sides. The wheel bearing's constant loading from vehicle weight produces the unchanging rumble.

82. A — The engine RPM is 200 RPM higher than expected for the current gear at the current speed. The shift actuator positioned the shift mechanism into a gear adjacent to the intended gear (such as 5th instead of 6th). The different gear ratio produces a higher engine RPM than expected. The TCM's gear position feedback should detect this error.

83. B — The clutch disc's torsional damper springs rattle at idle in neutral. The engine's firing impulses cause the disc hub to oscillate against the damper springs. The springs absorb the oscillation by compressing and extending, producing the rattle. Slightly depressing the pedal changes the preload on the springs and the disc contact, silencing the rattle.

84. C — The front output shaft surface must be smooth at the seal contact area. A worn shaft surface (groove, scoring, roughness) prevents any new seal from sealing effectively. The seal lip rides in the groove and cannot maintain contact. Additionally, excessive U-joint angles on the front driveshaft create cyclic side loads that accelerate the seal wear.

85. A — The 3rd gear mainshaft gear or its countershaft mate has worn or damaged teeth. The noise appears only in 3rd because only that specific gear pair carries the torque load when 3rd is engaged. In all other gears, different pairs transmit the load and the 3rd gear pair rotates freely without carrying force, producing no noise.

86. D — Cold power steering fluid has high viscosity that resists flow through the pump's intake. The pump momentarily cavitates as it tries to draw the thick fluid. After 5 seconds of circulation and friction heating, the fluid thins enough for the pump to draw it without cavitation. The groaning is the cavitation noise from the pump's momentary inability to maintain a solid fluid column at the inlet.

87. B — The left front shock absorber has failed. Without damping, the left tire bounces after road irregularities, alternating between heavy and light road contact. The heavy-contact patches wear faster (creating low spots) while the light-contact patches wear slower (creating high spots). The right side's functional shock absorber maintains even contact and smooth wear.

88. A — The steering gear's sector shaft mesh with the ball nut's rack teeth has excessive lash. The lash allows the sector shaft to shift when the steering force changes direction during turns. The clunk is the teeth taking up the clearance. The sector shaft lash (over-center adjustment) must be checked and corrected to eliminate the free play at the mesh point.

89. C — The bent linkage changes the geometric relationship between the axle's actual position and the height control valve's reference. The valve operates correctly at its designed linkage angles, but the bent geometry tells the valve the axle is at the correct height when it is actually at a different position. The resulting incorrect ride height affects alignment, tire wear, and load distribution.

90. D — Internal ply separation creates a bulge that contacts the road once per revolution. The bulge is not visible externally but can be felt by running a hand over the tread surface during slow rotation. At low speed, each thump is distinct and prominent. At higher speeds, the thumps merge into a continuous vibration. The tires must be inspected for internal damage.

91. B — The height control valve has a worn internal seal that leaks continuously through the valve body. The valve correctly senses the ride height and maintains it by continuously adding air. The hissing is the air escaping through the worn seal. The increased compressor duty cycle reflects the system's effort to maintain pressure against the continuous internal leak.

92. A — A frame crack at a suspension bracket mount transfers the full axle load to the frame rail at that point. The crack will propagate under the cyclic loading of driving and can lead to complete fracture, suspension separation, or loss of vehicle control. The truck must be repaired before returning to service — monitoring is not an acceptable alternative for a structural crack at a load-bearing location.

93. C — The tag axle's self-steering mechanism's damper or centering device has failed. Without the damper, the axle oscillates during straight-line driving, continuously scrubbing the tires. Without the centering device, the axle may not return to straight-ahead after turns, dragging the tires at an angle. Both conditions accelerate tire wear despite correct alignment measurements.

94. D — All drive tires showing rapid outside-edge wear with correct inflation and alignment indicates excessive positive camber on the drive axle housings. The housing geometry determines the wheel camber. Worn bushings, bent housings, or shifted spring perches create the camber error. Standard alignment checks may not include the axle housing camber measurement.

95. B — One stud position consistently requires re-torquing while all others maintain their torque. The hub pilot pad at that specific position may have excessive wear or damage that allows localized wheel movement at that stud location. The cyclic movement progressively loosens the nut at that position while the other studs maintain their clamping force.

96. A — A grinding sensation felt through the steering wheel during low-speed parking maneuvers (maximum pump load) indicates worn internal pump components. The pulsating output from the worn pump is transmitted hydraulically to the steering gear and mechanically to the steering wheel. The maximum load of parking maneuvers amplifies the pulsation from the worn components.

97. D — The rotor groove on one side only with a different manufacturer's pad on each side (from a previous service mix-up) or a caliper that does not float correctly (preventing even pad application) would produce one-sided wear. However, the most fundamental cause of a groove on one friction surface is a manufacturing defect in the rotor material — a softer zone on one side wears faster.

98. C — The steering gear's internal mesh between the sector shaft and ball nut has a localized tight spot at the position corresponding to the first 45 degrees of left turn. The tight spot may result from uneven wear, contamination, or an over-center adjustment that varies across the sector shaft's travel. Right turns use the opposite sector shaft travel where the mesh is normal.

99. A — The right tire loses 8-10 psi during driving but holds pressure when parked. The valve core has a marginal leak that opens under the thermal cycling of highway driving — the tire heats, pressure increases, and the marginal core allows small amounts of air past. The cumulative loss during a day of driving amounts to 8-10 psi. Replacing the valve core typically resolves the issue.

100. C — The DTV produces the same cyclical force variation at all speeds, but the higher kinetic energy during stops from above 100 km/h amplifies the effect. The greater brake energy at high speed generates more heat per stop, which can temporarily worsen the DTV through thermal effects. Below 100 km/h, the same DTV produces a pulsation too subtle to perceive through the pedal.

101. D — The center bolt passes through all leaves and maintains the pack as a unit on the axle. When the bolt breaks or loosens, individual leaves shift from their designed position, creating visible gaps. The separated leaves may also allow the axle to shift on the spring pad, changing the axle alignment and creating a safety hazard.

102. B — The power steering pump's suction line has a small air leak at a loose fitting, cracked hose, or deteriorated O-ring. The leak draws air into the suction side. The pump mixes the air with the fluid under pressure, and the aerated fluid returns to the reservoir as foam. The foam reduces the fluid's lubrication and hydraulic efficiency.

103. A — The −0.5 degree negative camber tilts the top of each steer wheel inward. This shifts the load concentration to the inside half of the tire contact patch. The inside edges carry more weight per unit area, wearing the inside half faster. The −0.5 degree is outside the 0 to +0.5 degree specification and must be corrected to equalize the wear.

104. C — Every structure has a natural frequency. When the engine's firing frequency at 1,400 RPM matches the cab's structural resonant frequency, the cab amplifies the vibration. Above and below 1,400 RPM, the firing frequency does not match the resonance and the vibration is not amplified. This is a resonance phenomenon, not an engine fault.

105. A — The ceiling panel fasteners (clips, screws, push-pins) have loosened from years of cumulative vibration. Each loose fastener allows its panel section to rattle independently. The distributed nature of the loosened fasteners creates a noise that appears to come from the entire ceiling rather than one specific location. Systematic re-fastening of all ceiling panel attachments resolves the noise.

106. D — The pump motor runs (audible) but no fluid reaches the windshield. The washer fluid has frozen in the lines between the reservoir (where the fluid may still be liquid due to the antifreeze concentration or proximity to the engine) and the nozzles (where the lines are exposed to ambient cold). The frozen line blocks the fluid path despite the functioning pump.

107. B — The lever operates freely (confirming the lever's mechanism is intact), but the seat does not move. The connection between the lever and the seat's locking/sliding mechanism has broken, stripped, or disconnected. The lever moves without actuating the seat's latch mechanism, and the seat remains locked in its current position.

108. A — Moisture trapped under the floor mats from rain, snow, or wet boots creates a dark, warm environment ideal for mold growth. The thorough cleaning addressed visible surfaces and the HVAC system, but the moisture source under the mats was not eliminated. The carpet padding and floor insulation must be dried or replaced to eliminate the persistent microbial growth.

109. A — Door seal gaps allow water, dust, and road debris to enter the cargo area, potentially damaging moisture-sensitive cargo. The gaps also compromise temperature control for temperature-sensitive loads. The hinges may be worn (preventing flush closure), the latches may not pull tight enough, or the rubber seals may be compressed, torn, or missing.

110. C — The right-side height control valve is set lower than the left side. When empty, both sides are at the correct height because the springs are at their unloaded extension. When loaded, the right side compresses further because the valve maintains a lower reference height. The right-side valve linkage must be adjusted to match the left side's reference position.

111. D — The trailer's insulation has degraded over 6 months, allowing more ambient heat to infiltrate the cargo space. The TRU must run longer to compensate for the increased heat load, consuming more fuel even though it still achieves the setpoint. Alternatively, the condenser has accumulated debris that reduces heat rejection efficiency. Both conditions increase fuel consumption without reducing cooling effectiveness.

112. B — A polished drum surface over the entire friction area indicates the brake shoes have glazed. The glazed surface has become smooth and hard from heat exposure, and the smooth shoes polish the drum through continuous contact. Glazed shoes have a reduced friction coefficient, meaning that position provides less braking force. Both the shoes and drum surface must be addressed.

113. A — The flexing leg has a crack or structural weakness in the internal support tube or outer sleeve. The leg extends and retracts (confirming the mechanism functions) but cannot support the concentrated nose weight without deflecting. The crack allows the leg to bow outward under the vertical load. Continued loading will progress the failure. The leg must be replaced.

114. D — A repeatedly blown ABS fuse confirms a continuous short circuit. The short may be in the wiring harness (chafed insulation contacting the frame), in a modulator valve coil (internal short to ground), or in the ABS module itself. The short must be located and repaired before installing a new fuse — repeatedly installing fuses without fixing the short risks fire.

115. C — The rearward slide path is clear (confirmed by the tandem reaching the rear-most position), but the forward path has an obstruction. Debris, corrosion, or a bent rail section at the forward end physically blocks the tandem from sliding forward. The rails must be inspected, cleaned, and repaired at the specific obstruction point.

116. A — The alternating red and white pattern is not just decorative — it provides a recognizable visual outline of the trailer's size, shape, and orientation to following drivers at night. The contrast between red and white sections helps judge distance, speed, and trailer dimensions. A continuous strip does not provide these critical visual cues.

117. B — The blower motor speed may be reduced from a worn motor, a faulty resistor pack, or a voltage problem. The reduced airflow means less total air volume passes over the evaporator per unit time. Although each air molecule is cooled effectively, the total cooling delivered to the cab is reduced because less air is being processed. The vent temperature reads higher because the air velocity is lower.

118. D — The mode door actuator motor has failed or the door's mechanical linkage has disconnected, broken, or seized. The door cannot reach the full defrost position and remains at an intermediate position that splits airflow between defrost and floor outlets. The actuator, its linkage, and the door's pivot must be inspected.

119. C — A restricted receiver-drier limits liquid refrigerant flow to the expansion valve. The low side drops below normal (evaporator starved). The high side upstream may increase (condenser retains excess liquid). The vent temperature rises from inadequate evaporator cooling. Frost may form on the receiver-drier at the restriction point from the localized pressure drop.

120. A — The condenser receives adequate cooling from ram airflow during driving. At idle, the condenser fan alone may not provide sufficient airflow to reject the heat load. The reduced condenser cooling raises the high-side pressure, reduces the expansion valve's pressure differential, and the evaporator cooling capacity decreases. The vent temperature rises until the bus resumes driving.

121. D — The inline electric heater element's thermostat has failed in the closed (always-on) position. The thermostat should limit the fluid temperature to 40-60°C. Without temperature regulation, the element heats continuously and the fluid can reach dangerous temperatures. The overheated fluid creates steam on the windshield and risks thermal shock cracking of the cold glass.

122. B — The compressor has a broken internal component — a damaged reed valve, cracked piston, or failed connecting rod. The damaged component impacts the cylinder wall or valve plate during each revolution, producing the continuous knocking. The compressor must be replaced and the system flushed to remove debris from the failed component.

123. C — The heater core has a partial restriction that limits coolant flow at idle's low pump output. At driving RPM, the increased pump speed forces adequate coolant through the restriction. The engine temperature is unaffected because the restriction is in the heater circuit, not the main cooling loop. The partial restriction reduces flow volume, not temperature.

124. A — The rotate circuit's directional valve spool is stuck in a position that blocks flow in one direction. The spool must shift both ways to route fluid to both sides of the motor. Contamination, a bent spool, or a failed pilot signal prevents the spool from shifting to the blocked direction. The motor operates normally in the direction where flow is permitted.

125. D — The counterbalance valve is set too close to the boom lift circuit's operating pressure. The valve alternately opens and closes as the pressure oscillates around the set point. The 3 Hz oscillation corresponds to the valve's response time. Adjusting the counterbalance valve setting to provide adequate margin above the operating pressure stabilizes the motion.

126. B — A fixed-displacement pump's output is directly proportional to its rotational speed. At idle, the pump speed drops proportionally and less flow is produced. Less flow means slower actuator movement. This is expected behavior. To maintain function speed at idle, the operator must increase the engine RPM or the system must use a pressure-compensated variable pump.

127. C — The dump cylinder's internal cushion is designed to decelerate the piston before it reaches full stroke. Without the cushion, the piston impacts the cap at full speed, and the body rebounds once from the mechanical impact. The directional valve should also be returned to neutral at full extension to stop the pump from delivering against the dead-headed cylinder.

128. A — The reservoir was overfilled. The level was checked during operation when fluid was distributed through the cylinders and lines. When all cylinders retract, the displaced fluid returns to the reservoir, causing it to overflow. The level must always be checked with all cylinders fully retracted to account for the maximum return volume.

129. D — A bulge in a hydraulic hose indicates the internal reinforcement layers (braided steel or spiral wire) have failed at that point. The outer rubber cover is the only remaining barrier. On an aerial lift, a sudden hose failure can drop the boom with a worker in the bucket. The hose must be replaced immediately regardless of whether it is currently leaking.

130. B — The directional valve spools have internal leakage that bypasses fluid from the high-pressure side to the low-pressure side during each function. The bypassed fluid converts pressure energy to heat without performing useful work. The relief valve does not activate because the leakage does not exceed the pump's output capacity. The heat is proportional to the bypass rate and pressure differential.

131. C — Tightening the counterbalance valve increases the holding pressure but also requires more pilot pressure to open the valve during normal operation. The pump must build more pressure to overcome the tighter valve setting. The additional pressure needed reduces the available pressure for driving the cylinder, slowing the boom speed. The valve should be set with minimal margin above the load-induced pressure.

132. B — The reduction gearbox has worn teeth on the coast side. During acceleration, the drive-side teeth mesh smoothly. During regenerative braking, the torque reverses and loads the coast-side teeth. The worn or damaged coast-side teeth produce the grinding noise. The noise increases with regenerative braking force because the loading on the worn teeth increases proportionally.

133. D — The BMS monitors individual cell temperatures. One or more cells exceeded the maximum temperature threshold. The BMS commands the engine start to activate the engine-driven A/C compressor, which powers the battery thermal management loop to cool the overheating cells. Thermal protection takes priority over fuel economy and emission considerations regardless of SOC or power demand.

134. A — The replacement module may have a different state of charge than the remaining modules. The BMS must perform a cell balancing procedure to equalize the voltage across all cells. Until balancing is complete, the voltage imbalance causes uneven current distribution during charge and discharge. The BMS limits performance to protect the imbalanced cells.

135. C — As the battery ages and its internal resistance increases, the BMS reduces the maximum DC fast-charging current to prevent excessive cell heating and voltage spikes. The 88% SOH confirms the battery has aged enough for the resistance increase to noticeably affect the charging rate. The longer charge time reflects the BMS protecting the remaining battery capacity from accelerated degradation.