

# PRACTICE EXAM 11: RED SEAL 310T SIMULATION (135 QUESTIONS)

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1. A technician is using an oxy-acetylene torch to heat a seized exhaust manifold bolt. During the heating process, the technician notices the flame has changed from a neutral cone to a long, feathery, luminous orange flame. What does this flame change indicate, and what should the technician do?
- A. The flame has shifted to an oxidizing mixture that is adding oxygen to the heated bolt and increasing the risk of the bolt cracking from rapid oxidation
  - B. The flame change is normal and indicates the torch tip has reached its optimal operating temperature for heavy heating applications
  - C. The flame has shifted to a carburizing (fuel-rich) mixture from a partially blocked oxygen orifice or a changed gas setting — the excess acetylene produces soot that can contaminate the heated surface; the technician should readjust the torch valves to restore a neutral flame before continuing
  - D. The orange flame indicates the acetylene tank is nearly empty and the reduced gas pressure is causing an unstable mixture that should be monitored but does not require immediate action
2. A shop is equipped with a centralized exhaust extraction system that connects hoses to each vehicle's tailpipe during indoor running. A technician starts a diesel truck for a diagnostic procedure but does not connect the exhaust hose because the test will take "only a few minutes." What is the hazard?
- A. Diesel exhaust contains carbon monoxide, nitrogen oxides, and particulate matter that accumulate rapidly in an enclosed shop — CO is odorless and can reach dangerous concentrations within minutes in a poorly ventilated space; the exhaust extraction must be connected for every indoor engine operation regardless of the expected duration
  - B. The diesel exhaust will trigger the shop's fire suppression system from the heat of the exhaust gases contacting the overhead sensors
  - C. The particulate matter from the diesel exhaust will contaminate the shop's compressed air system through the open bay doors
  - D. The diesel exhaust will damage the paint on adjacent vehicles from the acidic compounds in the exhaust gas condensate

3. A technician is removing a tire from a multi-piece rim assembly on a heavy-duty truck. What specific hazard is associated with multi-piece rim assemblies that does not exist with single-piece rims?

A. Multi-piece rims generate more heat during driving and the residual heat can cause burns during tire removal

B. Multi-piece rims use a different bead seat angle that makes the tire more difficult to break from the bead seat

C. Multi-piece rims are heavier than single-piece rims and require additional lifting equipment during handling

D. The locking ring, side ring, or flange on a multi-piece rim can separate explosively if the tire retains residual air pressure or if the rim components are corroded, cracked, or incorrectly assembled — the ring can project from the rim with lethal force; the tire must be fully deflated and the rim components inspected for damage before any disassembly

4. A technician needs to lift a heavy-duty alternator weighing approximately 25 kg from a workbench and carry it 10 metres to the truck being serviced. What is the correct manual lifting technique?

A. Bend at the waist with straight legs to pick up the alternator, then walk quickly to minimize the carrying time

B. Bend at the knees with a straight back, grip the alternator firmly with both hands close to the body, lift using leg muscles, and walk at a controlled pace while maintaining the load close to the body's center of gravity to minimize back strain

C. Have a coworker lift one end of the alternator while the technician lifts the other end to split the 25 kg weight equally

D. Place the alternator in a five-gallon bucket with handles for easier carrying over the 10-metre distance

5. A technician is servicing a truck's air conditioning system and must recover the refrigerant before opening the system. The recovery machine has a digital scale that shows the amount of refrigerant recovered. After recovery, the machine's gauge reads 0 psi. Is the system fully evacuated and safe to open?

A. A gauge reading of 0 psi indicates the system pressure equals atmospheric pressure, but the system may still contain refrigerant in liquid or vapor form at atmospheric pressure — the system is not under vacuum and is not fully evacuated; the technician must perform a proper vacuum evacuation before opening the system to ensure all refrigerant and moisture have been removed

B. The system is fully evacuated because the gauge shows zero pressure and no refrigerant remains

C. The system is safe to open but the technician should wait 5 minutes for any remaining refrigerant to settle to the bottom of the system before disconnecting

D. The gauge reading confirms the system is empty, but the technician must verify by weighing the recovered refrigerant against the system's rated charge capacity

6. A shop has recently installed new LED shop lighting. Several technicians report that the LED lights create a strobing effect on rotating components — such as alternator pulleys, fan blades, and drill press chucks — making them appear stationary when they are actually spinning. What is the safety concern?

A. The LED lights produce ultraviolet radiation that can damage the technician's vision when reflected from rotating metallic surfaces

B. The LED strobing causes headaches and eye fatigue that reduce the technician's ability to focus on detailed repair work

C. The strobing effect creates a dangerous illusion where a spinning component appears stationary — a technician who reaches for a component that appears still but is actually rotating at high speed can suffer severe entanglement or laceration injuries; anti-strobe LED fixtures or guards on rotating equipment must be used

D. The LED lighting frequency interferes with the shop's electronic diagnostic equipment and causes false readings on scan tools

7. A technician is performing a road test on a heavy-duty truck after a brake repair. During the road test, the technician notices that the truck pulls sharply to the left during a moderate brake application at 60 km/h. What is the immediate safety concern?

A. The sharp pull indicates the right rear tire has significantly lower inflation pressure than the left rear

B. The pull indicates the power steering pump has momentarily lost pressure during the brake application

C. The pull is caused by a loaded cargo shift that has moved the vehicle's center of gravity to the left during braking

D. The brake imbalance creates a directional control hazard — the vehicle deviates from its intended path during braking, and on a road with opposing traffic or adjacent vehicles, the deviation could cause a collision; the truck must not be returned to service until the brake imbalance is diagnosed and corrected

8. A technician is working on a truck equipped with a natural gas fuel system (CNG or LNG). What unique fire and explosion hazard does a natural gas fuel system present compared to a diesel fuel system?

A. Natural gas is heavier than air and accumulates in pits, trenches, and low areas of the shop floor where it can reach ignition concentration without being detected

B. Natural gas (methane) is lighter than air and rises to the ceiling — in an enclosed shop, the gas can accumulate at the ceiling level and reach an explosive concentration; unlike diesel, which has a high flash point and is difficult to ignite at room temperature, natural gas is flammable at room temperature and requires only a spark for ignition; the shop must have ceiling-level gas detectors and adequate roof ventilation

C. Natural gas fuel systems operate at extremely high pressures (up to 3,600 psi for CNG) that create a burst hazard if a line or fitting is disturbed

D. Natural gas produces more carbon monoxide per unit of fuel burned than diesel, requiring more powerful exhaust extraction systems

9. A heavy-duty diesel engine has a condition where the exhaust produces a continuous light blue haze at all operating conditions — idle, cruise, and full load. The haze does not change with load or throttle position. Crankcase pressure is within specification. What is the most likely cause?

A. The valve stem seals on the intake valves have hardened and are no longer preventing oil from being drawn into the cylinders during the intake stroke — the constant oil consumption across all operating conditions produces the continuous blue haze regardless of load, and the crankcase pressure remains normal because the ring-to-liner seal is intact

- B. The turbocharger oil seals have failed on both the compressor and turbine sides simultaneously
- C. The piston rings are worn and allowing oil to bypass into the combustion chambers during all four strokes
- D. The engine oil has been overfilled and the crankshaft is windage-whipping oil into the cylinders through the breather

10. A diesel engine equipped with a common rail fuel system has a fault code for "Fuel Rail Pressure — Above Commanded." The engine runs but is in a derate. The scan tool shows the actual rail pressure is 2,000 bar while the commanded pressure is 1,200 bar at the current operating condition. What component is the most likely cause?

- A. The fuel rail pressure sensor has drifted and is reading higher than the actual pressure in the rail
- B. The high-pressure fuel pump has a stuck metering valve that is delivering maximum fuel volume regardless of the ECM's command
- C. The fuel return line from the rail is kinked, preventing excess fuel from returning to the tank
- D. The fuel rail pressure control valve (pressure regulator or metering valve) is stuck in the maximum delivery position — the valve that regulates how much fuel the high-pressure pump delivers to the rail is not responding to the ECM's command to reduce delivery; the pump sends maximum volume to the rail, exceeding the commanded pressure

11. A heavy-duty diesel engine has been in service for 600,000 km. The engine's power output has gradually decreased by approximately 15% from its original rating. There are no fault codes, all sensors read correctly, and the boost pressure matches the commanded value. An in-chassis dynamometer test confirms the power loss. What mechanical condition is the most likely cause?

- A. The engine's camshaft lobes have worn from 600,000 km of operation, reducing the valve lift and duration below the designed values
- B. Gradual internal wear — the piston rings and cylinder liners have worn enough to reduce the cylinder's sealing efficiency; each cylinder loses a small percentage of its compression charge past the rings, and the cumulative effect across all cylinders reduces the engine's volumetric efficiency and power output by 15% without triggering fault codes or visibly affecting sensor readings

C. The turbocharger's compressor wheel has eroded from ingesting fine particles over 600,000 km, reducing its aerodynamic efficiency

D. The engine's fuel injectors have all gradually drifted from their calibration over the 600,000 km service life

12. A diesel engine has a condition where the coolant temperature gauge reads normal but the engine oil temperature (measured by the scan tool) is 15°C higher than the coolant temperature. The manufacturer's specification states oil temperature should be within 10°C of coolant temperature. What does the elevated oil temperature indicate?

A. The oil viscosity is too low for the application, causing the oil to heat faster than the coolant

B. The engine's bearing clearances have enlarged from wear, generating more friction heat than normal in the oil circuit

C. The engine oil cooler has a partial restriction or is undersized — the oil cooler's function is to transfer heat from the oil to the coolant; if the cooler is restricted internally, has a failed bypass thermostat that diverts oil around the cooler, or has inadequate capacity for the engine's heat load, the oil retains more heat than the cooling system can absorb

D. The oil filter is creating excessive backpressure that generates friction heat in the oil as it passes through the filter

13. A heavy-duty diesel engine's air filter restriction indicator shows the filter is at its maximum restriction limit. The filter was replaced only 5,000 km ago. What could cause premature filter loading?

A. The engine is operating in an environment with abnormally high dust concentration — construction sites, gravel roads, agricultural operations, or mining areas produce airborne particulate levels that can load an air filter to its maximum restriction limit in a fraction of the normal interval; the filter must be replaced and the operating environment assessed to determine if a pre-cleaner or a higher-capacity filter system is needed

B. The filter restriction indicator is faulty and has tripped prematurely due to a weak internal spring

C. The intake ducting upstream of the filter has a leak that is drawing in unfiltered air and depositing debris on the clean side of the filter

D. The engine's increased blow-by is pressurizing the intake tract through the crankcase ventilation system and triggering the restriction indicator

14. A diesel engine has a condition where the coolant level drops gradually but no external leak can be found, the oil appears normal (no milky appearance), and there is no visible white exhaust smoke. The technician performs a combustion gas test on the cooling system using a block tester (chemical test that detects combustion gas in the coolant). The test fluid changes color, indicating combustion gas is present. What does this confirm?

A. The catalytic converter is leaking exhaust gas into the engine's coolant jacket through a shared heat exchanger

B. The EGR cooler has failed internally and is introducing exhaust gas into the coolant circuit at a rate too low to produce visible symptoms

C. The coolant is contaminated with a cleaning chemical that causes a false positive on the block tester

D. An internal head gasket leak, a cracked cylinder head, or a cracked liner is allowing combustion gas to enter the cooling system — the combustion gas pressure (which exceeds coolant system pressure) pushes gas into the coolant and simultaneously pushes coolant into the cylinder where it vaporizes; the leak is small enough that the coolant loss is gradual, the oil contamination is undetectable, and the vaporized coolant is invisible in the exhaust

15. A heavy-duty diesel engine has a condition where the engine develops a metallic ticking noise that increases with engine speed. The noise is coming from the valve cover area. An injector cut-out test does not change the noise. The valve lash was recently adjusted. What should be rechecked?

A. The valve adjustment procedure, which may have been performed on the wrong firing order or at the wrong engine position

B. The valve lash settings — if one or more valves were set with too much clearance (too loose), the rocker arm tip strikes the valve stem with a metallic tick at each cam lobe lift; the noise increases with engine speed because the impact frequency increases; the injector cut-out test does not affect the noise because the noise is mechanical (valve train), not combustion-related

C. The injector hold-down clamp torque, which if insufficient would allow the injector to vibrate and produce a ticking noise

D. The rocker arm shaft for a crack that allows the shaft to flex and produce a ticking noise at each rocker arm actuation

16. A diesel engine equipped with a wastegate turbocharger has a condition where the boost pressure exceeds the specification by 5 psi under full load. No fault codes are present. What could cause over-boost on a wastegate turbocharger?

A. The turbocharger bearing has excessive play that allows the compressor wheel to move closer to the housing, increasing its efficiency

B. The air filter is excessively clean (recently replaced), allowing too much airflow to the compressor inlet

C. The wastegate actuator diaphragm has ruptured, the wastegate linkage has disconnected, or the wastegate valve is stuck closed — any of these conditions prevents the wastegate from opening to bypass excess exhaust around the turbine; without the bypass, all exhaust energy drives the turbine, and the turbo produces more boost than the system is designed for

D. The charge air cooler is too efficient and is cooling the intake air below the designed temperature, increasing its density beyond the boost specification

17. A technician discovers that a heavy-duty diesel engine's coolant reservoir (overflow tank) is empty and the pressure cap on the radiator hisses briefly when loosened. The engine temperature gauge reads normal. What should the technician investigate?

A. The cooling system has lost enough coolant to empty the reservoir, and the hissing cap indicates the system was under normal pressure — the coolant must be replenished and the system pressure-tested to locate the leak; the leak may be external (hoses, clamps, water pump, freeze plugs) or internal (head gasket, EGR cooler, oil cooler); the temperature reading may appear normal because the remaining coolant is still circulating, but the reduced coolant volume limits the system's heat rejection capacity

B. The reservoir cap is the wrong pressure rating for the application and is venting coolant during normal operation

C. The engine thermostat is stuck open and the coolant is bypassing the reservoir through the overflow tube during cold operation

D. The reservoir itself has a crack that is draining the coolant before it can be drawn back into the radiator during cool-down

18. A heavy-duty diesel engine produces a deep, rhythmic knocking noise from the bottom end that is most prominent at idle and decreases at higher RPM. The noise becomes louder when the cylinder above the affected bearing is loaded (by grounding the injector wire on that cylinder). What does this load-responsive behavior confirm?

A. The noise is from a worn wrist pin that is loaded more heavily when the cylinder fires and produces the knock

B. The noise source is in the upper end of the engine (valve train) and the perceived bottom-end location is an acoustic illusion caused by the engine block's resonance characteristics

C. The affected cylinder's fuel injector is misfiring and the noise is the unburned fuel detonating in the exhaust manifold

D. A worn connecting rod bearing — the bearing has excessive clearance that allows the rod to shift on the crankshaft journal; grounding the injector for that cylinder increases the combustion load on the rod, pushing it harder against the journal and amplifying the knock; the noise is most prominent at idle because the oil film is thinnest at low RPM and the rod has the most time to shift during each revolution

19. A diesel engine's scan tool data shows that the fuel rail pressure undershoots the commanded pressure by 200 bar during rapid acceleration (tip-in). The pressure recovers to the commanded value within 2 seconds. What component should be investigated?

A. The fuel rail pressure relief valve, which may be opening prematurely during the pressure spike of rapid acceleration

B. The fuel transfer pump or the fuel supply system — the undershoot during rapid acceleration indicates the high-pressure pump is momentarily starved of fuel; the transfer pump may not respond quickly enough to the sudden increase in fuel demand, or a restriction in the supply line, filter, or pickup tube limits the fuel volume available to the high-pressure pump during the transient demand spike

C. The common rail itself, which may have developed a micro-crack that opens under the thermal expansion of rapid acceleration

D. The fuel injector return orifices, which may be too large and allowing excessive fuel to return to the tank during the tip-in event

20. A heavy-duty diesel engine's EGR system has a condition where the EGR valve operates correctly but the EGR cooler has developed an internal coolant leak. The leak is small — approximately 100 ml per day. What is the consequence of continuing to operate with this small leak?

A. The small leak has no operational consequence because the coolant is vaporized by the exhaust gas and exits through the tailpipe harmlessly

B. The leaked coolant enters the combustion chambers through the intake manifold and is burned, producing harmless water vapor in the exhaust

C. The leaked coolant introduces moisture and contaminants into the intake system, can cause white smoke, may accelerate corrosion of intake components, and progressively deposits mineral and additive residue on the EGR valve and intake manifold surfaces — the deposits accumulate over time and restrict EGR flow and intake port flow; the coolant loss also gradually depletes the cooling system's capacity

D. The leaked coolant will immediately damage the turbocharger compressor wheel from liquid ingestion during boost conditions

21. A diesel engine has a condition where the engine starts normally when cold but cranks for an extended period (15+ seconds) when restarted within 10 minutes of shutdown. Once running, the engine operates normally. What is this symptom pattern called, and what is the most likely cause?

A. This is a "hot restart" problem — the most likely cause is fuel drainback from the high-pressure fuel system during the hot-soak period; a leaking check valve, worn injector seats, or a high-pressure pump with worn seals allows fuel to drain from the rail back to the tank while the engine sits hot; the engine must re-prime the system during the extended cranking before adequate rail pressure is achieved for starting

B. This is a "vapor lock" condition caused by the fuel boiling in the fuel lines during the hot-soak period after shutdown

C. This is a "heat soak" condition caused by the starter motor's reduced efficiency when hot from the first start event

D. This is a "thermal expansion" condition where the hot engine's expanded cylinder bores create too much ring-to-liner clearance for effective compression

22. A heavy-duty diesel engine equipped with a DOC and DPF has a condition where the DOC inlet temperature and outlet temperature are identical during all operating conditions — there is no temperature rise across the DOC. What does the absence of a temperature rise (exotherm) indicate?

A. The DOC is functioning normally because a temperature rise only occurs during active DPF regeneration, not during normal driving

B. The engine's combustion is so clean that the DOC has no hydrocarbons or CO to oxidize, confirming optimal engine performance

C. The DOC temperature sensors are mounted in the wrong locations and are reading the same exhaust gas at the same point

D. The DOC catalyst has failed — a functioning DOC produces a measurable exotherm (temperature rise) from the oxidation of hydrocarbons and CO in the exhaust; the absence of any temperature rise confirms the DOC is no longer catalytically active and cannot support passive DPF regeneration or generate heat for active regeneration; the DOC must be replaced

23. A technician is performing an overhead adjustment on a heavy-duty diesel engine equipped with an engine brake (Jake Brake). The engine brake uses slave pistons that are integral to the valve train. During the overhead, what additional adjustment must be performed beyond the standard intake and exhaust valve lash?

A. The engine brake actuator solenoid gap must be measured and shimmed to the correct air gap specification

B. The engine brake slave piston lash must be adjusted to the manufacturer's specification — the slave piston clearance determines how far the exhaust valve opens during the engine brake event; incorrect lash affects braking performance and can damage the valve train if set too tight (holding the exhaust valve open during combustion) or reduce braking effectiveness if set too loose (insufficient exhaust valve opening during the braking event)

C. The engine brake housing oil supply check valve must be tested for proper seating pressure at each cylinder

D. The engine brake control solenoid circuit must be tested for proper response time using the scan tool during the overhead procedure

24. A diesel engine has a condition where the engine's idle speed gradually increases from the normal 650 RPM to 800 RPM over a period of 10 minutes after startup. No fault codes are present. The accelerator pedal is fully released. What is the most likely cause?

A. The engine is compensating for increasing alternator load as the batteries charge and the voltage regulator increases the field current demand

B. The idle speed increase is a normal warm-up strategy programmed into the ECM — some engines increase idle speed slightly as the coolant temperature rises to promote faster catalyst light-off and reduce emissions during warm-up

C. The ECM is increasing idle speed in response to a gradually rising coolant temperature — as the coolant temperature sensor reports the engine warming from cold-start temperature toward operating temperature, the ECM adjusts the idle speed according to its programmed warm-up idle schedule; this progressive increase is designed into the engine's control strategy

D. The turbocharger is spooling gradually at idle and adding unwanted boost that increases the engine's air charge and causes the ECM to add fuel proportionally

25. A diesel engine's exhaust manifold gasket between the manifold and the turbocharger has developed a leak. What operational symptoms would this exhaust leak produce?

A. Reduced turbocharger performance — the exhaust gas that leaks through the failed gasket bypasses the turbine, reducing the energy available to spin the turbine wheel; the compressor produces less boost because it receives less drive energy; the engine may produce less power under load, increased smoke from the reduced air supply, and the leak produces an audible hiss or whistle that varies with engine speed and load

B. The exhaust leak will cause the turbocharger to overspeed because the reduced backpressure allows the turbine to spin with less resistance

C. The exhaust leak will increase the boost pressure because the escaping exhaust gas creates a venturi effect that accelerates the remaining gas through the turbine

D. The exhaust leak will only produce noise and has no effect on turbocharger performance or engine operation

26. A diesel engine has a condition where the crankcase ventilation system's oil separator is plugged with solidified oil residue. What caused the oil to solidify inside the separator?

A. The engine oil was mixed with an incompatible additive that reacted with the separator's material and created a solid residue

B. The engine was operated with the wrong viscosity oil that gelled at the separator's operating temperature

C. The oil separator screen has corroded and the corrosion products have mixed with oil to create the blockage

D. The engine has been operating predominantly at idle or low-load conditions — the low exhaust temperatures prevent the crankcase ventilation system from reaching a temperature that keeps the oil in liquid form; the oil vapors in the blow-by gas condense and solidify inside the separator from the cold operating conditions, progressively building a blockage that restricts ventilation

27. A technician is testing a diesel engine's cooling system with a pressure tester. The system holds the rated pressure (15 psi) for 10 minutes without any drop. However, the engine still overheats during loaded driving. What cooling system fault would pass a static pressure test but cause overheating during operation?

A. A leaking head gasket that only opens under the higher cylinder pressures of loaded combustion

B. A water pump with an eroded or loose impeller — the pump's shaft seals hold the static pressure (no external leak), but the eroded impeller cannot move adequate coolant volume at the flow rates needed for loaded operation; the pump maintains the system's static integrity (passes the pressure test) but fails to circulate coolant effectively when the engine generates maximum heat

C. A thermostat stuck in the closed position that holds pressure but blocks coolant circulation to the radiator

D. An internally restricted radiator that holds pressure but cannot pass adequate coolant volume through its tubes during loaded conditions

28. A heavy-duty diesel engine equipped with a common rail fuel system has all six injectors replaced with remanufactured units. After installation, each injector's unique calibration code (IMA or trim code) must be programmed into the ECM. What happens if the calibration codes are not entered?

A. The engine will not start because the ECM requires the calibration codes before it will activate the fuel injection system

B. The ECM uses default fueling values that do not account for the individual manufacturing variations of each injector — this results in cylinder-to-cylinder fuel delivery imbalances that produce rough idle, increased emissions, reduced fuel economy, and potential power imbalance; the ECM cannot optimize each injector's performance without its specific calibration data

C. The engine will start but will enter a permanent derate mode until the codes are entered through the scan tool

D. The calibration codes are only needed for warranty tracking purposes and have no effect on engine performance

29. A diesel engine's turbocharger has been removed for inspection. The technician rotates the turbine shaft by hand and feels a slight roughness that was not present when the turbocharger was new. The shaft has no perceptible radial or axial play. Should the turbocharger be reinstalled?

A. The turbocharger is acceptable for reinstallation because some roughness develops normally over the turbocharger's service life

B. The turbocharger should be rebuilt or replaced because any roughness indicates bearing wear

C. The roughness is caused by carbon deposits on the turbine wheel that will burn off during the first few minutes of operation

D. The slight roughness without play indicates early bearing surface degradation — while the bearings have not yet developed measurable clearance (no play), the surface damage will progress; the turbocharger should be scheduled for rebuild or replacement at the next planned maintenance rather than being immediately condemned, but it must be monitored through oil analysis and boost pressure trending

30. A heavy-duty truck's air brake system has a condition where the compressor runs continuously — it never unloads. The system pressure on both gauges reads 125 psi (the normal cut-out pressure). What is the most likely cause?

A. The governor is not signaling the compressor to unload — the governor may have a faulty sensing port, a plugged signal line to the compressor's unloader mechanism, or an internal spring failure that prevents it from sending the unload signal at the cut-out pressure; the compressor pumps against the closed system, the safety valve maintains the pressure at or near its setting, and the compressor runs without relief

B. The compressor has a seized unloader piston that remains in the loaded position regardless of the governor signal

C. The air dryer is venting all the compressed air during a continuous purge cycle, and the compressor runs continuously to replace the vented air

D. The check valve between the compressor discharge and the wet tank is stuck closed, causing the compressor to pump against a dead head

31. A tractor-trailer combination has a condition where the trailer brakes release very slowly after each brake application. The tractor brakes release normally. What trailer-specific component should be investigated?

A. The trailer's ABS modulator valves, which may be restricting the exhaust air during the release cycle

B. The tractor's foot valve, which may be holding residual signal pressure in the trailer control line after the pedal is released

C. The trailer's relay valve exhaust function — the relay valve must quickly vent the application air from the brake chambers when the signal pressure drops; if the relay valve's exhaust port is restricted (from contamination, corrosion, or a stuck internal component), the application air cannot escape quickly and the brakes release slowly

D. The trailer's air tank volume, which may be oversized and taking longer to depressurize during the release

32. A heavy-duty truck equipped with automatic slack adjusters has a condition where one rear brake's pushrod stroke is within specification during the daily pre-trip measurement, but the driver reports that

the brake on that wheel smokes and smells hot during driving. What could explain adequate stroke with a dragging brake?

A. The brake drum on that wheel is undersized (turned too small), and the shoes maintain full contact even when the slack adjuster retracts

B. The automatic slack adjuster has over-adjusted — it has advanced beyond the correct setting, holding the shoes against the drum even when the pushrod appears to be at the correct stroke measurement; the stroke measurement looks correct because the pushrod starts from a position that is already too close to the drum, but the shoes never fully release from the drum surface

C. The S-cam has worn flat on its lift profile, causing the shoes to remain in partial contact after the cam returns to the released position

D. The return spring on the trailing shoe has broken, allowing that shoe to remain in contact with the drum while the leading shoe retracts

33. A transit bus equipped with hydraulic disc brakes has a condition where the brake fluid in the master cylinder reservoir has turned dark brown and has a burnt smell. The fluid was clear and amber 6 months ago. What does this deteriorated fluid condition indicate?

A. The brake fluid has been contaminated with petroleum-based product that has caused the fluid to darken

B. The brake fluid reservoir cap seal has failed, allowing atmospheric moisture to contaminate the fluid and cause discoloration

C. The brake fluid has absorbed dirt and debris from the reservoir's venting system, discoloring the fluid without affecting its performance

D. The brake fluid has thermally degraded from exposure to excessive heat — the fluid has been overheated repeatedly (from caliper heat transferring through the hydraulic circuit), which breaks down the fluid's chemical structure, reduces its boiling point, and compromises its moisture resistance; the dark color and burnt smell confirm the fluid has exceeded its thermal limits and must be flushed and replaced

34. A heavy-duty truck has a condition where the low-air-pressure warning buzzer activates at 55 psi. The regulation requires the warning to activate before pressure drops below 60 psi. Does this truck pass or fail the inspection for low-pressure warning?

A. The truck fails — the warning activated at 55 psi, which is below the 60 psi threshold; the regulation requires the warning to activate before the pressure reaches 60 psi, meaning the buzzer must sound while the pressure is still above 60 psi; activating at 55 psi means the pressure dropped to 55 before the warning sounded, which is below the required threshold

B. The truck passes because the warning is within 5 psi of the required threshold and the regulation allows a 10% tolerance

C. The truck passes because the regulation specifies "at or below 60 psi" and 55 psi meets this criterion

D. The test must be repeated because the first test may have been affected by the gauge's response time

35. A heavy-duty truck's air disc brake caliper has a condition where the outboard pad is significantly more worn than the inboard pad on the same caliper. What is the most likely cause?

A. The inboard pad is a harder friction compound than the outboard pad from a mixed pad installation

B. The rotor has excessive lateral runout that pushes the outboard pad away from the rotor surface on each revolution

C. The caliper slide mechanism (guide pins or slider rails) is not allowing the caliper body to float freely — when the brakes are applied, the piston pushes the inboard pad against the rotor, and the caliper body should slide on its guides to pull the outboard pad against the opposite rotor face with equal force; if the guides are seized, corroded, or binding, the caliper body cannot move freely, and the outboard pad does not apply with the same force as the piston-driven inboard pad

D. The caliper piston is over-extended, pushing the inboard pad too far and reducing the force available for the outboard pad

36. A technician discovers that a truck's air brake system has a condition where the front brakes apply noticeably later than the rear brakes during every stop. The air pressure builds at the same rate in both circuits. What should be investigated?

- A. The front brake chambers for a larger displacement volume that takes longer to fill to application pressure
- B. The front axle relay valve or quick-release valve for a higher crack pressure than the rear — if the valve serving the front brakes requires more signal pressure to open than the rear relay valve, the rear brakes begin applying at a lower signal pressure while the front brakes wait for the higher threshold; this creates a noticeable delay in front brake engagement relative to the rear
- C. The front brake shoe return springs for excessive tension that resists the initial application until the air pressure overcomes the spring force
- D. The ABS system for a programmed front-axle delay that is intended to prevent front wheel lockup during initial application

37. A heavy-duty truck has a condition where the parking brake holds the vehicle on a level surface but will not hold on a moderate grade. The spring brake chambers have been tested and the springs apply full force. The brake adjustment is correct. What is the most likely cause?

- A. The parking brake valve is not fully exhausting the hold-off air, leaving residual pressure that partially compresses the springs and reduces the applied brake force
- B. The brake drums are glazed from extended highway driving, and the reduced friction coefficient is insufficient to hold the vehicle on a grade despite full spring force and correct adjustment
- C. The foundation brake components have reached their wear limit — the shoes may have insufficient lining area remaining, or the drums may be at their maximum diameter, reducing the mechanical advantage even though the stroke measurement appears within specification
- D. The spring brake chambers have corroded internally, reducing the available spring force despite the initial test showing adequate force; the corrosion is progressive and the springs have weakened since the test

38. A school bus has a condition where the ABS activates during normal stops on dry pavement when the bus is empty (no passengers). The ABS does not activate when the bus has a normal passenger load. What explains this load-dependent ABS behavior?

- A. The empty bus has significantly less weight on the rear axle, reducing the tire-to-road friction available before lockup — with the reduced weight, the tires reach their lockup threshold at lower brake

forces, and the ABS activates to prevent the lightly loaded tires from skidding; with passengers, the additional weight increases the normal force on the tires, raising the lockup threshold and allowing the brakes to apply more force before the ABS needs to intervene

B. The ABS module has a load-sensing algorithm that activates at a lower threshold when the vehicle weight sensor detects an empty condition

C. The empty bus generates more vibration that interferes with the ABS wheel speed sensors and triggers false lockup detection

D. The brake proportioning system is incorrectly biased and applies too much rear brake force for the empty vehicle weight

39. A heavy-duty truck's air compressor has been recently rebuilt. After the rebuild, the technician notices that the compressor produces a significant amount of oil in the discharge air, causing the air dryer desiccant to become oil-saturated within 2 weeks. What is the most likely cause of the excessive oil pass-by?

A. The rebuilt compressor was not properly broken in before returning to full-duty operation

B. The compressor was assembled with the wrong piston ring type or the rings were installed incorrectly (upside down, gaps aligned, or wrong ring in wrong groove)

C. The oil supply line to the compressor has a restriction that is preventing adequate lubrication and causing the rings to overheat and lose their sealing ability

D. The engine oil viscosity has changed since the rebuild and the thinner oil is passing the compressor rings more easily

40. A tractor-trailer combination has a condition where the trailer service brakes work correctly when the foot valve is applied, but the trailer hand valve (trolley valve) produces no trailer braking at all. The air system pressure is adequate. What is the most likely cause?

A. The trailer's relay valve has failed and responds only to the foot valve signal, not the hand valve signal

B. The trailer hand valve has failed — the internal piston, seal, or linkage has failed and the valve cannot generate output pressure when the handle is applied; since the foot valve uses a different path to signal

the trailer relay valve (through the tractor protection valve and service gladhand), the trailer brakes respond to the foot valve but not to the failed hand valve

C. The tractor protection valve is blocking the hand valve's signal to the trailer supply circuit

D. The trailer ABS module is filtering out the hand valve signal because it detects the signal source as inconsistent with normal braking

41. A heavy-duty truck has a condition where the air system builds pressure to cut-out normally, but after the engine is shut off for 1 hour, the system pressure has dropped to 80 psi without any brake applications. The leak rate passes the regulation's brake-released static test (under 2 psi/minute for a single vehicle). How is this possible?

A. The regulation's static test is limited to a specific time window (typically 1-2 minutes), and a leak that passes the per-minute rate test can still drain a significant volume of air over an extended 1-hour period — a leak of 1.5 psi/minute (which passes the 2 psi/min test) drains approximately 90 psi over 1 hour; the truck passes the regulation but has a leak that should be repaired

B. The pressure loss is not from a leak but from thermal contraction of the air inside the tanks as the system cools after shutdown

C. The compressor discharge check valve is stuck open, allowing the stored air to slowly bleed back through the compressor cylinders and escape through the intake

D. The air dryer purge valve has a slow leak that drains the supply tank over the 1-hour period — the leak rate is below the regulation's per-minute threshold but is sufficient to deplete the system over an extended parking period

42. A technician discovers that a truck's brake chambers have different manufacturers on the left and right sides of the same axle — both are Type 30/30, but one is Brand A and the other is Brand B. Is this a concern?

A. Different manufacturers' chambers with the same Type rating (30/30) should produce identical force at the same air pressure — the Type designation standardizes the effective diaphragm area; however, variations in internal spring force, pushrod length, and diaphragm compliance between manufacturers can create subtle differences in application characteristics that may produce a detectable brake imbalance; matching brands on the same axle is the best practice

B. The chambers are fully interchangeable and there is no concern as long as the Type designation matches

C. The chambers must be replaced with matching brands because the Type designation only specifies the mounting bolt pattern

D. Different manufacturers' chambers have different maximum stroke specifications that make the pushrod stroke measurement invalid

43. A heavy-duty truck has a condition where the spring brakes apply with a noticeable time delay after the parking brake valve is pulled — approximately 3-4 seconds pass before the brakes engage. What is the most likely cause?

A. The parking brake valve has a slow-acting exhaust that takes 3-4 seconds to vent the hold-off air from the spring brake circuit

B. The air dryer is interfering with the spring brake release signal by partially recharging the spring brake circuit during the exhaust event

C. The spring brake relay valve or the air line between the relay valve and the spring brake chambers has a restriction that limits the exhaust flow rate — the hold-off air cannot escape quickly enough through the restricted path, and the springs require 3-4 seconds to progressively extend as the air slowly vents; the restriction may be a kinked line, a contaminated valve exhaust port, or a undersized air line

D. The spring brake power springs have weakened and require more time to extend against the residual air pressure

44. A trailer equipped with drum brakes has a condition where all four brakes on the tandem axle are out of adjustment — all pushrod strokes exceed the maximum limit. The automatic slack adjusters have been recently replaced. What should the technician investigate?

A. The trailer ABS module, which may be sending a signal that prevents the ASAs from adjusting during brake applications

B. The brake drums for oversized diameter — drums that have been turned too large or have worn beyond the ASAs' compensation range cannot be held in adjustment by any slack adjuster; the increased drum diameter requires more pushrod travel than the ASA's maximum adjustment range can accommodate

C. The foundation brake anchor pins, which if frozen would prevent the shoes from expanding fully and cause the ASA to over-compensate

D. The trailer's air supply pressure, which if below specification would not provide enough force for the ASA's internal mechanism to advance

45. A technician is diagnosing a truck's air disc brake system. The pads have been replaced, but the brakes squeal loudly during light brake applications. The squeal disappears during hard braking. What is the most likely cause?

A. The replacement pads are missing their anti-squeal shim (dampening layer) or the shim was not installed during the pad replacement — the shim absorbs the high-frequency vibration between the pad backing plate and the caliper piston; without the shim, the pad vibrates at its natural frequency during light application (when the clamping force is low), producing the squeal; hard braking clamps the pad firmly enough to dampen the vibration

B. The rotor surface has developed a hard spot from a previous overheating event that excites the pad's resonance during light contact

C. The caliper mounting bracket bolts have not been torqued to specification, allowing micro-movement that produces the squeal

D. The brake dust generated by the new pads has not yet been worn to the fine particle size needed to dampen the pad-to-rotor interface vibration

46. A heavy-duty truck's air system has a condition where the system passes all static leak tests but the compressor duty cycle (the percentage of time the compressor is loaded) is 40%. The manufacturer's specification for duty cycle is a maximum of 25%. What does the elevated duty cycle indicate?

A. The compressor is undersized for the vehicle's air demand and should be replaced with a higher-capacity unit

B. The governor's cut-in pressure is set too high, causing the compressor to cycle more frequently than necessary

C. The compressor's internal efficiency has decreased from wear, requiring more pumping time to replace the air consumed by each brake application

D. The system has a leak that passes the per-minute static test but consumes enough air to increase the compressor's on-time from 25% to 40% — the leak rate is below the regulation's per-minute threshold, but the cumulative air loss over the driving cycle forces the compressor to run 40% of the time instead of the designed 25%; the leak source must be found and corrected to reduce the duty cycle and extend compressor life

47. A heavy-duty truck has a condition where the engine cranks at normal speed but will not start. The technician connects the scan tool and finds no communication with the engine ECM — the scan tool displays "No ECM Detected." All other modules communicate normally. What should the technician check?

A. The scan tool's communication protocol settings, which may not be compatible with this engine's ECM

B. The CAN bus backbone for a break that isolates the ECM from the diagnostic connector while leaving other modules accessible

C. The ECM's power supply and ground circuits — the ECM requires both adequate voltage and a solid ground to power up and communicate on the CAN bus; if the ECM has no power (blown fuse, open power wire, corroded connector) or no ground (open ground wire, corroded ground bolt), it cannot initialize and does not appear on the bus; all other modules communicate because they have independent power and ground circuits

D. The engine's crankshaft position sensor, which provides the wake-up signal for the ECM to begin communication

48. A truck's battery disconnect switch is located on the frame rail near the batteries. The switch is turned off to isolate the batteries during extended parking. When the switch is turned back on, the truck's electronic modules undergo a power-up cycle, and several systems require re-initialization (radio presets cleared, clock reset, seat memory lost). What would prevent this data loss?

A. A memory-keep-alive (parasitic) circuit should maintain a continuous low-current power supply to the modules' memory circuits even when the main disconnect is open — this is typically accomplished by wiring the keep-alive circuit directly from the battery to the modules' memory power input, bypassing the main disconnect switch; if this circuit is not present or is not wired correctly, the modules lose all stored data when the disconnect is opened

- B. The modules should retain their settings in non-volatile memory that does not require continuous power
- C. The battery disconnect switch should have a built-in timer that provides 30 seconds of warning before fully disconnecting
- D. An auxiliary battery should be connected to the modules during the disconnection period to maintain power

49. A technician is diagnosing a truck with a CAN bus communication fault. The scan tool communicates with modules on the J1939 CAN bus but cannot communicate with the instrument cluster. The cluster appears dead — no gauges, no warning lamps, no display. The technician measures voltage at the cluster's power connector and reads 12.4V. What should be checked next?

- A. The CAN bus wiring between the cluster and the nearest CAN bus junction point
- B. The cluster's power supply fuse, which may be the correct voltage but with a blown internal element
- C. The instrument cluster's firmware version, which may be incompatible with the vehicle's CAN bus protocol
- D. The instrument cluster's ground circuit — the cluster has voltage at its power input (12.4V confirmed), but if the ground circuit is open, no current can flow through the cluster's electronics; the cluster appears completely dead because it cannot complete any circuit without a ground return path; measuring the ground pin to battery negative will confirm whether the ground is intact or open

50. A heavy-duty truck has a condition where the headlights dim noticeably when the driver applies the brakes. The dimming occurs only during brake application and the headlights return to normal brightness when the brakes are released. What is the most likely cause?

- A. The brake light circuit and the headlight circuit share a fuse, and the additional current draw of the brake lights is overloading the shared fuse
- B. The headlight and brake light circuits share a common ground point that has high resistance — when the brake lights activate, the combined current of both circuits flows through the high-resistance ground; the voltage drop across the resistance increases with the added brake light current, reducing the voltage available to the headlights; this is a classic shared-ground voltage-drop symptom

C. The brake light switch has an internal contact that short-circuits the headlight circuit momentarily during each brake application

D. The body controller module reduces headlight power during brake applications to prioritize visibility of the brake lights

51. A truck's scan tool retrieves a fault code from the engine ECM for "Intake Manifold Pressure Sensor — Rationality Error." The sensor voltage is within its normal range. What does a "rationality error" mean?

A. The sensor's response time is too slow for the ECM's control algorithm requirements

B. The sensor's voltage is physically within its operating range, but the value does not make logical sense when compared to other related sensor data

C. The sensor has exceeded its maximum operating life and the ECM is flagging it for preventive replacement

D. The sensor produces a valid voltage signal, but the ECM has compared the sensor's data against other correlated data sources (such as barometric pressure, turbocharger boost, engine RPM, and throttle position) and determined that the manifold pressure reading is not consistent with what the other sensors indicate it should be — the sensor reads a value that is physically possible but logically inconsistent with the engine's current operating conditions

52. A truck's alternator has been tested and produces the correct output voltage (14.2V) and adequate current output (within specification). However, the batteries are consistently undercharged. The parasitic draw is normal. What else could prevent the batteries from reaching full charge?

A. The charging circuit has excessive voltage drop between the alternator output terminal and the battery positive terminal — the alternator produces adequate voltage at its output, but by the time the current reaches the batteries, the voltage has dropped below the effective charging level; the batteries receive insufficient charging voltage despite the alternator's adequate output

B. The battery temperature is too high for the voltage regulator to command full charging current

C. The batteries have been sulfated from previous deep discharge events and cannot accept a full charge regardless of the charging system's output

D. The voltage regulator is cycling the field current too rapidly, preventing the alternator from maintaining a consistent output

53. A heavy-duty truck has a condition where the turn signal flasher operates at the correct rate with the ignition on and the engine off, but the flash rate becomes erratic (alternating fast and slow) when the engine is running. What is the most likely cause?

A. The alternator's AC ripple is superimposed on the turn signal circuit's power supply, causing the flasher's timing circuit to respond to the ripple as if it were a voltage fluctuation

B. The engine's vibration is physically affecting the flasher module's internal components

C. The voltage regulator is cycling between charge and float modes, creating a voltage fluctuation that affects the flasher's timing

D. The alternator's AC ripple is interfering with the flasher module's timing circuit — the rectifier diodes in the alternator have a fault (open or shorted) that allows more AC component than normal to pass through to the DC system; this AC ripple modulates the voltage at the flasher module, causing the flasher's timing to vary with the ripple pattern

54. A truck's scan tool retrieves a fault code for "Battery Voltage — Below Normal" from the engine ECM. The technician measures the battery voltage at rest and reads 12.6V (fully charged). With the engine running, the voltage reads 14.1V (normal charging). Why did the ECM set this code?

A. The ECM monitors battery voltage continuously and the code was set during a brief voltage dip — this could occur during a high-current event (starter cranking, PTO engagement, multiple accessory activation) or from an intermittent loose battery connection that momentarily dropped the voltage below the ECM's minimum threshold; the voltage has since recovered, but the stored code documents the event

B. The ECM's internal voltage sensor has a calibration error that causes it to read lower than the actual battery voltage

C. The ECM uses a separate voltage sensing circuit that is connected to a different point in the wiring than the technician's meter

D. The fault code was set by a previous ECM that was replaced, and the code transferred from the old module's memory

55. A heavy-duty truck has a condition where the marker lights on the right side of the vehicle turn off when the right turn signal is activated. When the turn signal is deactivated, the marker lights come back on. What is the most likely cause?

A. The right-side marker light circuit and the right turn signal circuit share a common power wire with insufficient ampacity — when the turn signal activates and draws additional current through the shared wire, the voltage drop across the wire increases enough to extinguish the marker lights; the turn signal bulbs, being designed for higher current, remain lit while the lower-wattage marker bulbs cannot operate at the reduced voltage

B. The body controller module is programmed to disable the marker lights during turn signal operation to increase the visibility of the turn signal

C. The right turn signal relay has an internal contact that opens the marker light circuit when the turn signal relay energizes

D. The turn signal bulbs are the wrong wattage and are backfeeding voltage through the marker light circuit

56. A truck equipped with a telematics system has a condition where the telematics unit reports the engine's fuel consumption as 20% higher than the actual consumption measured by fuel tank dipping over a 1,000 km test period. What is the most likely cause of the discrepancy?

A. The telematics unit is calculating fuel consumption from the engine ECM's fuel rate data, which is an estimate based on injection pulse width and fuel pressure

B. The engine's fuel temperature sensor is reading lower than actual, causing the ECM to report a higher fuel volume consumption than what was physically consumed

C. The telematics unit's software algorithm applies a correction factor for altitude that is incorrectly configured for the vehicle's operating elevation

D. The ECM's fuel consumption data broadcast on the CAN bus is based on calculated injection volume, not actual measured fuel flow — the calculated values can deviate from actual consumption due to injector calibration tolerance, fuel temperature variations, and return fuel volume; the fuel tank dipping method measures actual physical consumption, which is more accurate than the ECM's calculated estimate

57. A heavy-duty truck has a condition where the electric horn sounds weak — the volume is noticeably lower than normal. The horn relay clicks when the horn button is pressed. What is the most likely cause?

A. The horn's power supply circuit has excessive voltage drop from corroded connections, reducing the voltage reaching the horn

B. The horn diaphragm has developed a crack or the horn's electromagnetic coil has a partial short that reduces the vibration amplitude — the horn produces sound by vibrating a diaphragm electromagnetically; a cracked diaphragm cannot vibrate at full amplitude, and a partially shorted coil produces a weaker magnetic field that drives the diaphragm with less force; either condition reduces the horn's acoustic output

C. The horn relay contacts have developed resistance that limits the current flowing to the horn circuit

D. The horn button switch has a high-resistance contact that reduces the coil current to the horn relay

58. A truck's electronic instrument cluster has a condition where the speedometer needle bounces erratically between 0 and the actual speed at random intervals during driving. All other gauges are stable. The scan tool shows the correct, stable vehicle speed from the ECM. What is the most likely cause?

A. The vehicle speed sensor is producing an erratic signal that the ECM filters out but the cluster displays raw

B. The CAN bus has a noise issue that specifically affects the speed data message

C. The instrument cluster's internal speedometer stepper motor or its driver circuit is failing — the stepper motor that positions the speedometer needle is either electrically malfunctioning (a degraded driver transistor) or mechanically failing (a worn gear in the stepper mechanism); since the scan tool shows stable speed data from the ECM, the data source is correct and the fault is in the cluster's display hardware

D. The wheel speed sensor's reluctor ring has a damaged tooth that creates an intermittent speed calculation error at random intervals

59. A truck's body controller module (BCM) has a stored fault code: "Trailer Detection — No Trailer Detected." The tractor is currently connected to a trailer with all lights functioning. What does this code indicate?

A. The BCM uses current draw on the trailer lighting circuit to detect whether a trailer is connected — the BCM monitors the current consumed by the trailer's lamps and compares it to a threshold; if the trailer's LED lamps draw less current than the BCM's detection threshold (which may have been set for higher-current incandescent lamps), the BCM incorrectly determines that no trailer is connected

B. The trailer's ABS ECU is not communicating with the tractor's BCM through the CAN bus auxiliary channel

C. The J560 connector's trailer detection pin (pin 7) has an open circuit that prevents the BCM from sensing the trailer's presence

D. The trailer's license plate lamp is burned out, and the BCM uses the license plate circuit as its primary trailer detection circuit

60. A truck has a condition where the battery cables become noticeably warm to the touch during normal driving. The charging system output is correct and the electrical loads are within the vehicle's designed capacity. What is the most likely cause?

A. The batteries have developed a high internal resistance that generates heat in the cables from the resistance-limited current flow

B. The cable insulation is a darker color that absorbs more radiant heat from the engine compartment

C. The battery cable gauge (wire cross-section) is adequate for the vehicle's electrical system under normal conditions

D. The battery cable terminals or the cable-to-terminal crimps have developed high resistance from corrosion, looseness, or poor crimping — the resistance at the connection points generates heat as current flows through them; the heat transfers along the cable, making it warm to the touch; the connection resistance must be identified and corrected to prevent progressive terminal damage, potential cable failure, and fire hazard

61. A truck's electronic throttle pedal has a fault code for "Throttle Position Sensor 1 — Signal Voltage High." The scan tool reads APP1 at 4.8V with the pedal fully released. The normal released voltage should be 0.5-0.8V. What is the most likely cause?

A. The APP1 sensor's signal wire has an open circuit that allows the voltage to float near the reference voltage

B. The APP1 sensor's signal wire is shorted to the 5V reference voltage supply wire — the short circuit bypasses the sensor's variable resistance and delivers the reference voltage directly to the ECM's input pin; the ECM reads near-5V regardless of pedal position because the signal wire is connected directly to the 5V source instead of through the sensor

C. The pedal mechanism is mechanically stuck at the full-throttle position, which produces 4.8V at APP1

D. The ECM's internal pull-up resistor on the APP1 input has failed, pulling the signal voltage to the reference level

62. A heavy-duty truck has a condition where the starter motor makes a rapid clicking sound (10-15 clicks per second) when the ignition key is turned to the start position. The engine does not crank. What does the rapid clicking indicate?

A. The starter solenoid's hold-in winding has failed, and the solenoid pulls in briefly on the pull-in winding but releases immediately when the contacts close and the pull-in winding is de-energized

B. The neutral safety switch is making and breaking contact rapidly from a misadjusted position

C. The batteries have insufficient voltage or capacity to maintain the solenoid energized under the starter motor's current draw — the solenoid pulls in (click), the contacts close, and the heavy current draw of the starter motor pulls the battery voltage below the solenoid's hold-in threshold; the solenoid drops out (releasing the contacts), the voltage recovers without the load, the solenoid pulls in again, and the cycle repeats rapidly

D. The starter motor's armature is locked from a hydro-locked cylinder and the solenoid engages and disengages as it tries to overcome the locked motor

63. A truck's scan tool shows that the transmission ECM is broadcasting two different vehicle speed values on the CAN bus — one from its dedicated speed sensor and one that it receives from the ABS module. The two values differ by 8 km/h. What is the consequence of this speed discrepancy?

A. The conflicting speed values can cause the transmission ECM to make incorrect shift decisions — the TCM may use one speed source for shift scheduling and the other for lockup clutch control; the 8 km/h discrepancy causes shifts at incorrect speeds, lockup clutch engagement at incorrect times, and may trigger a diagnostic fault code for speed sensor correlation

- B. The ABS module will disable the ABS function because it detects a speed difference between its wheel speed calculation and the transmission's speed
- C. The ECM ignores the TCM's speed and uses only the ABS speed for all vehicle functions
- D. The 8 km/h difference is within the normal tolerance for CAN bus data transmission and requires no attention

64. A truck has a condition where the left tail light, left stop light, and left turn signal all share the same dual-filament bulb. When the tail light is on and the left turn signal is activated, the tail light on the left side goes out while the turn signal flashes. When the turn signal is deactivated, the tail light comes back on. What is the most likely cause?

- A. The turn signal switch has a faulty cancellation mechanism that interrupts the tail light circuit during turn signal operation
- B. The dual-filament bulb socket has an incorrect ground configuration that creates a backfeed between the two filaments
- C. The BCM is programmed to extinguish the tail light during turn signal operation to improve the visibility of the flashing signal
- D. The lamp socket has a bad ground — the turn signal filament (higher wattage) and the tail light filament (lower wattage) share the same ground return; when the ground is compromised, the turn signal current backfeeds through the tail light filament to find ground through the tail light circuit; this extinguishes the tail light because the current is flowing in the wrong direction through that filament while the turn signal uses the tail light filament as its ground path

65. A truck's electronic engine control has a condition where the engine derate decreases (power increases) when the scan tool is connected. The engine operates at a 15% derate without the scan tool connected, but returns to full power when the scan tool communicates with the ECM. What is causing this behavior?

- A. The scan tool's communication polling is preventing the ECM from processing the derate command
- B. The scan tool is providing a ground path through its cable that the ECM uses to bypass a high-resistance ground connection — the ECM's ground circuit has excessive resistance that causes a voltage offset on its sensor inputs, which the ECM interprets as a fault condition and applies a derate; when the

scan tool's ground wire provides a parallel path to ground, the resistance drops, the voltage offset disappears, the sensor readings normalize, and the ECM removes the derate

C. The scan tool's USB power supply is supplementing the ECM's voltage during communication, raising the voltage above the derate threshold

D. The scan tool is overwriting the derate parameters in the ECM's memory during the communication session

66. A truck equipped with a J1939 CAN bus has a condition where the engine fan runs at full speed whenever the ABS warning lamp is illuminated. The fan operates normally when the ABS lamp is off. What is the connection between the ABS fault and the fan speed?

A. The ABS module provides the vehicle speed data that the ECM uses to modulate the fan speed — when the ABS module goes offline (ABS lamp on), the ECM loses the vehicle speed input and defaults the fan to full speed as a protective measure because it cannot determine whether the vehicle is moving and needs cooling or is parked and needs no cooling

B. The ABS module directly controls the cooling fan through a dedicated power output

C. The ABS module's power consumption drops when it goes into fault mode, and the excess current is redirected to the cooling fan circuit

D. The CAN bus error from the ABS fault creates electrical noise that the fan controller interprets as a full-speed command

67. A truck has a condition where the backup alarm activates when the headlights are turned on, regardless of whether the transmission is in reverse. The backup alarm does not activate when the headlights are off and the transmission is in reverse. What is the most likely cause?

A. The headlight switch has an internal contact that is cross-connected to the backup alarm circuit

B. The body controller module has a programming error that links the headlight output to the backup alarm output

C. A wiring fault has connected the headlight power feed to the backup alarm trigger circuit — when the headlights are turned on, the headlight power feed energizes the backup alarm through the unintended connection; the reverse switch circuit may be open (which is why the alarm does not sound in reverse

without headlights) or the alarm may have two trigger paths and the headlight connection provides an alternate activation

D. The backup alarm has been replaced with a unit that has a photosensor that activates in low-light conditions (when headlights would be on)

68. A truck's scan tool retrieves an active fault code from the engine ECM for "Crankshaft Position Sensor — Signal Intermittent." The engine occasionally stumbles during driving and has difficulty restarting when warm. What does an intermittent crankshaft position sensor signal cause?

A. The intermittent signal causes the ECM to momentarily derate the engine to protect the camshaft from over-advancement

B. The intermittent signal causes the fuel pressure regulator to oscillate between minimum and maximum delivery settings

C. The intermittent signal causes the transmission to downshift unexpectedly because the TCM interprets the missing engine speed data as a sudden deceleration

D. The crankshaft position sensor provides the ECM with the fundamental timing reference for fuel injection and engine speed — an intermittent signal causes momentary loss of injection timing that produces the stumble during driving, and during hot restart, the intermittent signal may not provide consistent enough data for the ECM to establish the injection timing needed to start the engine

69. A heavy-duty truck with a manual transmission has a condition where the transmission grinds when downshifting from 4th to 3rd gear. All other upshifts and downshifts are smooth. What is the most likely cause?

A. The 4th gear mainshaft bearing is worn, causing excessive free play that prevents clean gear engagement during the downshift

B. The 3rd gear synchronizer's friction cone or blocker ring is worn — the synchronizer cannot match the input shaft speed to the mainshaft speed quickly enough during the higher-speed-differential downshift from 4th to 3rd; upshifts into 3rd work because the speed differential is smaller and easier for the worn synchronizer to match

C. The clutch is not fully disengaging during the downshift, and the spinning input shaft prevents smooth engagement

D. The transmission oil has degraded and lost its synchronizer-compatible friction characteristics

70. A truck equipped with an Allison automatic transmission has a condition where the transmission produces a whining noise that varies with output shaft speed — the pitch increases with vehicle speed regardless of which gear is engaged. What is the most likely source of the noise?

A. The torque converter's stator one-way clutch is slipping intermittently and producing a speed-proportional whine

B. The planetary gear set in the currently-engaged gear is producing the noise from a damaged sun or ring gear

C. The transmission's pump gears are worn and producing a whine proportional to pump speed, which varies with engine RPM

D. The output shaft bearing or the transfer gear set that drives the output shaft is worn — these components rotate at output shaft speed regardless of which gear is engaged; the speed-proportional noise confirms the source is in the output path rather than the input path (which would vary with engine RPM) or a specific gear set (which would be present only in one gear)

71. A heavy-duty truck's clutch has a condition where the clutch pedal vibrates or pulsates when the clutch is partially engaged (during the initial engagement zone). The vibration is not present when the clutch is fully engaged or fully released. What is the most likely cause?

A. The flywheel has developed runout (warping or high spots) that causes the pressure plate to load and unload at different points during each revolution — when the clutch is partially engaged, the varying contact pressure from the runout creates a pulsation felt through the pedal; once fully engaged, the full clamping force holds the disc regardless of the runout; when fully released, there is no contact to transmit the pulsation

B. The clutch disc's torsional damper springs have broken and the hub rattles inside the disc

C. The release bearing has a rough spot that produces vibration during the partial-engagement zone

D. The pressure plate's diaphragm spring has a cracked finger that flexes differently from the others during partial engagement

72. A truck equipped with an automated manual transmission (AMT) has a condition where the transmission will not shift into gear from neutral. The scan tool shows "Clutch Actuator — Position Error." What does this code indicate?

- A. The AMT's shift fork actuator motor has failed and cannot move the gears into engagement
- B. The AMT's clutch actuator servo is commanding a position that it cannot achieve — the clutch actuator (either a hydraulic servo or an electric motor that replaces the manual clutch pedal) cannot move to the position the TCU commands; this may be caused by a failed actuator motor, a hydraulic leak in the actuator circuit, a seized clutch mechanism, or a worn clutch that has pushed the actuator beyond its travel limit
- C. The clutch actuator's position sensor has failed and the TCU can move the clutch but cannot verify its position — the TCU will not shift until it confirms the clutch is fully disengaged, and without position feedback, it refuses to command a gear change
- D. The transmission's shift actuator has detected a neutral-start interlock fault and is preventing any gear engagement

73. A heavy-duty truck's rear axle produces a grinding noise during right turns only. The noise is not present during left turns or straight-line driving. What is the most likely cause?

- A. The right rear wheel bearing is worn and produces noise when loaded during right turns
- B. The ABS wheel speed sensor on the right rear is contacting the reluctor ring during the suspension travel associated with right turns
- C. The right brake shoe is contacting the drum at a specific suspension angle that occurs only during right turns
- D. The differential's side gear and spider gear on the right side are worn — during a right turn, the right wheel slows relative to the left wheel, and the spider gears must rotate on their cross pin to accommodate the speed difference; worn spider gear teeth or worn cross pin bores produce the grinding noise only when the differential action is engaged during right turns

74. A truck equipped with a manual transmission has a condition where the transmission makes a squealing noise when the clutch pedal is depressed. The noise stops immediately when the pedal is released. What is the most likely cause?

A. The pilot bearing has failed and the transmission input shaft is riding on the dry, worn bearing surface when the clutch releases the input shaft

B. The release bearing is dry or damaged — when the clutch pedal is depressed, the release bearing contacts the pressure plate's release mechanism and rotates under load; a dry or damaged bearing produces a squeal from the metal-to-metal contact between the bearing race and the pressure plate fingers; releasing the pedal lifts the bearing off the fingers and the noise stops

C. The clutch disc facing material has worn through to the rivets and the exposed rivets squeal against the flywheel during release

D. The transmission input shaft pilot bearing is rattling inside the flywheel bore when the clutch is disengaged

75. A fleet of identical trucks has one vehicle that consistently achieves 5% worse fuel economy than the rest of the fleet. The engine, tires, and driving patterns are identical. The truck's differential gear ratio has been verified as correct. What drivetrain component should be investigated?

A. The wheel bearings on one or more axle positions — excessively tight bearing preload creates friction that the engine must overcome, consuming additional fuel proportional to the increased resistance; the cumulative effect of tight bearings on multiple axle positions can account for a 5% fuel economy penalty

B. The driveshaft balance, which if incorrect would create a vibration that reduces the drivetrain's efficiency

C. The transmission gear ratios, which may have been changed during a previous repair without updating the ECM

D. The transfer case oil viscosity, which if too heavy would create parasitic drag on the drivetrain

76. A truck's automated manual transmission has a "limp home" mode where the transmission allows only 3rd gear and reverse. The scan tool shows a fault code for "Gear Position Sensor — Range Error." What does this code indicate?

A. The transmission's gear position sensor has detected a position that does not correspond to any valid gear — the sensor cannot determine which gear is engaged, so the TCU cannot verify that the shift command was executed correctly; the TCU defaults to the known-good 3rd gear (which is where the

transmission was when the fault was detected or a default safe gear) to prevent engaging a gear that conflicts with the road speed

B. The gear position sensor needs recalibration after the transmission has been in service for an extended period

C. The gear position sensor's mounting has shifted from vibration, causing a consistent offset in its position reading that the TCU cannot compensate for

D. The transmission's shift actuator has a mechanical fault that prevents it from reaching the 3rd gear position, and the sensor correctly reports that the actuator is out of range

77. A heavy-duty truck equipped with a tandem drive axle has a condition where one axle produces a clicking noise at low speed during parking lot maneuvers. The clicking is rhythmic and corresponds to wheel rotation. The differential lock is not engaged. What is the most likely cause?

A. The axle shaft splines are worn and clicking as they load and unload during the low-speed maneuvering

B. A chipped tooth on either the ring gear or the pinion gear produces a click once per revolution as the damaged tooth contacts its mating gear — the clicking is rhythmic because it occurs at the same point in each revolution; the noise is most audible at low speed in parking lots because road noise masks it at highway speed

C. The differential spider gears are chattering on their cross pin from dry lubrication during the low-speed differential action

D. The wheel bearing retaining ring has come loose and is clicking against the axle housing once per revolution

78. A truck's transfer case has a condition where it will not shift out of 4WD High into 2WD. The shift motor activates and the indicator light attempts to change, but the transfer case remains in 4WD. What is the most likely cause?

A. The transfer case's shift fork has bent from engagement under load and is now mechanically wedged in the 4WD position

B. The shift motor does not have adequate force to move the shift mechanism back to the 2WD position against the internal resistance

C. The transfer case's 4WD indicator switch has failed and is sending a false signal that the case is still in 4WD when it has actually shifted to 2WD

D. The shift collar inside the transfer case is bound from driveline torque — the collar engaged the 4WD gears while the vehicle was under torque, and the torque load is holding the collar in the engaged position; releasing the torque (stopping the vehicle, shifting the transmission to neutral, or rocking the vehicle slightly) relieves the binding force and allows the shift motor to disengage the collar

79. A heavy-duty truck has a condition where the driveshaft has a vibration that is present during acceleration in all gears, disappears during cruise (steady speed), and returns during deceleration. The vibration intensity is proportional to the torque applied, not to the speed. What does this torque-dependent behavior indicate?

A. The driveshaft U-joint operating angles are unequal — the angle mismatch produces a vibration that is proportional to the applied torque because the speed fluctuation inherent to the Cardan U-joint design is amplified when torque is transmitted through the unequal angles; during cruise with minimal torque transfer, the vibration is not excited; during acceleration and deceleration (both transmitting torque), the vibration returns

B. The driveshaft is balanced for a no-load condition and becomes imbalanced under torque from torsional deflection

C. The transmission output bearing shifts position under torque, changing the driveshaft alignment

D. The engine mounts allow the transmission to shift under torque, altering the front U-joint angle

80. A truck equipped with an Allison automatic transmission has a condition where the transmission shifts normally in Drive but will not downshift when the driver manually selects a lower gear range. The manual range selection on the shift lever moves freely. What is the most likely cause?

A. The manual valve linkage between the shift lever and the transmission's internal manual valve is disconnected or misadjusted

B. The TCM has disabled manual range selection due to an active fault code that restricts the transmission to automatic operation only

C. The transmission's governor valve (on older hydraulic units) is stuck and overriding the manual downshift command with its speed-based signal — on electronically controlled transmissions, the TCM may be rejecting the manual downshift command because the current vehicle speed or engine RPM exceeds the safe limit for the requested lower gear; this is a protective interlock, not a fault

D. The shift lever position sensor is reporting the manual range selection to the TCM, but the TCM is rejecting the request because the engine speed would exceed the maximum limit if the requested gear were engaged at the current vehicle speed — this is a safety interlock designed to prevent over-revving the engine from an inappropriate manual downshift

81. A heavy-duty truck has a condition where the clutch cannot be disengaged — the pedal goes to the floor with no resistance, and the clutch stays fully engaged. The clutch hydraulic system uses DOT 3 fluid. What is the most likely cause?

A. The clutch disc has welded to the flywheel from extreme heat and cannot be separated by the release bearing's force

B. The pressure plate's diaphragm spring has broken and the release bearing cannot actuate the spring fingers

C. The clutch cable has stretched beyond its effective range and cannot pull the release lever far enough to disengage the clutch

D. The clutch master cylinder or a hydraulic line has failed — the pedal goes to the floor with no resistance, indicating a complete loss of hydraulic pressure in the clutch circuit; the master cylinder piston seal has blown through, a hydraulic line has ruptured, or the slave cylinder has catastrophically leaked; without hydraulic pressure, the release bearing cannot be actuated and the clutch remains engaged

82. A truck's ring and pinion gear set produces a humming noise during acceleration between 50 and 70 km/h. The noise disappears above 70 km/h and below 50 km/h. The noise is not present during deceleration at any speed. What does this speed-range-specific, load-dependent pattern indicate?

A. The differential bearings are worn and produce noise only in the speed range where their natural frequency is excited

B. The wheel bearings have a speed-dependent resonance that coincides with the 50-70 km/h range

C. The ring and pinion gear set has a wear pattern that produces noise only on the drive side of the teeth at specific mesh frequencies — the noise is present only during acceleration (drive side loaded) and absent during deceleration (coast side loaded); the speed-specific range corresponds to the RPM where the gear mesh frequency excites a resonance in the axle housing, amplifying the noise at that frequency

D. The driveshaft is approaching its critical speed in the 50-70 km/h range and producing a sympathetic vibration in the axle housing

83. A heavy-duty truck's PTO has a condition where it engages normally but produces a rhythmic clunking noise during operation. The clunking frequency corresponds to the PTO shaft rotation speed. What is the most likely cause?

A. The PTO gear has a chipped or broken tooth — the damaged tooth produces a clunk once per PTO shaft revolution as the damaged section meshes with its mating gear in the transmission; the clunking frequency corresponds exactly to the PTO shaft rotation speed because the damage is at one specific point on the gear's circumference

B. The PTO mounting gasket is too thick, causing the gear mesh to be too loose and produce a clunk at each tooth engagement

C. The PTO's driven equipment (hydraulic pump) has a damaged internal component that transmits vibration back through the PTO shaft

D. The PTO engagement mechanism is cycling between engaged and disengaged once per revolution due to a worn engagement collar

84. A truck equipped with an automatic transmission and a torque converter has a condition where the torque converter does not lock up during highway cruising. The scan tool shows the TCM commanding lockup but the actual turbine speed remains approximately 50 RPM lower than the engine speed (indicating the converter is not locking). What is the most likely cause?

A. The lockup clutch solenoid valve is stuck in the release position and cannot direct fluid to the lockup clutch apply circuit

B. The lockup clutch friction surface is worn or contaminated and cannot hold against the engine's torque — the solenoid commands lockup and fluid pressure reaches the clutch, but the clutch slips because the friction material cannot generate adequate holding force; the 50 RPM speed difference represents the clutch's continuous slip under load

C. The torque converter stator one-way clutch has failed, preventing the fluid coupling from reaching a 1:1 ratio

D. The transmission oil temperature is below the minimum threshold for lockup engagement and the TCM is rejecting the lockup despite commanding it

85. A heavy-duty truck equipped with a two-speed rear axle has a condition where the axle shifts from low range to high range normally during driving, but when the driver selects low range while cruising in high range at highway speed, the axle immediately downshifts with a loud bang. Is this normal?

A. The bang indicates the axle shift mechanism has a worn synchronizer that cannot match speeds during the high-speed downshift

B. The two-speed axle does not have a synchronizer — the axle should only be shifted to low range at reduced vehicle speed or when stopped; shifting to low range at highway speed forces the shift collar to engage the low-range gears at a significant speed mismatch, producing the bang from the impact of the mismatched teeth; repeated high-speed downshifts will damage the shift mechanism and gears

C. The bang is normal for a two-speed axle downshift at highway speed and is caused by the gear teeth meshing under the dynamic load

D. The shift motor has excessive force that slams the shift collar into engagement without the normal cushioning action

86. A heavy-duty truck has a condition where the steering wheel oscillates rapidly (shakes) at 90-100 km/h. The oscillation is not present at lower or higher speeds. The front tires are balanced and the steering linkage is tight. What is the most likely cause?

A. The front tires are balanced with clip-on weights that have shifted to a different position on the rim from road vibration

B. The steering damper (stabilizer) is worn and the harmonic balancer on the crankshaft is exciting the steering frequency

C. The front wheel and tire assemblies have a harmonic imbalance that is excited at the specific rotational frequency corresponding to 90-100 km/h — the balancing machine balanced the tires at a single speed, but the wheel/tire assembly has a resonant frequency that is excited only within the 90-100 km/h range; the resonance amplifies a small imbalance that is not detectable at other speeds

D. The front hub bearings have developed play that allows the wheel to oscillate at the natural frequency of the steering system within the 90-100 km/h speed range

87. A heavy-duty truck has a power steering system that produces a knocking noise from the steering gear area during slow-speed turns. The noise occurs once per steering wheel revolution. What is the most likely cause?

A. The steering gear's input shaft has a worn bearing or a damaged internal coupling that produces a knock once per revolution of the input shaft — the knock corresponds to the steering wheel's rotational frequency because the input shaft turns at the same rate; the worn bearing or damaged coupling creates a mechanical impact at one specific point in each revolution

B. The power steering pump's vanes are worn and produce a pressure pulse once per pump revolution that is transmitted to the gear as a knock

C. The steering column U-joints have a binding condition at one specific rotational position that produces a knock

D. The drag link ball joint has play that produces a knock during each steering wheel revolution from the oscillating input

88. A truck's steer axle alignment shows the following: left caster  $+3.0^\circ$ , right caster  $+4.5^\circ$ . The specification is  $+3.0^\circ$  to  $+4.5^\circ$ . Both readings are within specification individually. However, the vehicle pulls to the left during straight-line driving. What is the alignment-related cause?

A. The total caster (sum of both sides) exceeds the specification maximum and creates a left-pulling bias

B. The camber measurements must also be considered because caster alone cannot cause a pull condition

C. The toe setting is the primary cause of the pull, and the caster difference is coincidental

D. The caster difference of  $1.5^\circ$  between left and right causes the vehicle to pull toward the side with less caster — the left side has  $+3.0^\circ$  (less caster) and the right side has  $+4.5^\circ$  (more caster); the vehicle pulls toward the side with less positive caster because that side has less self-centering force and less directional stability; equalizing the caster side-to-side eliminates the pull

89. A truck equipped with air ride suspension on the drive axles has a condition where the right-side ride height is correct when measured at the axle, but the right rear tires show excessive inside-edge wear. The alignment has been checked and the total toe is within specification. What additional measurement should be taken?

A. The toe angle should be measured as individual wheel angles rather than total toe — the total toe may be within specification but the individual wheel angles may be unequal; if the right wheel has more toe-in than the left, the right tires will wear on the inside edge while the left tires wear normally; the ride height is correct because the air suspension maintains the designed height regardless of the wheel angle

B. The camber should be measured because inside-edge wear is typically caused by excessive negative camber on the right side

C. The thrust angle should be measured to verify the rear axle is square to the frame centerline

D. The axle spacing should be measured to verify the tandem axles are at the correct distance from each other

90. A transit bus has a condition where the front suspension produces a metallic popping noise when the steering is turned from full lock in one direction to full lock in the other. The noise occurs once during the transition through center. What is the most likely cause?

A. The stabilizer bar bushings are dry and pop as the bar rotates through its center position during the lock-to-lock transition

B. The steering gear sector shaft adjustment is too loose, allowing the sector teeth to disengage and re-engage with a pop during the lock-to-lock sweep

C. The upper strut mount bearing (on strut-type front suspensions) is binding and releasing during the steering transition — the bearing allows the strut to rotate with the steering; when the bearing binds from corrosion or dry lubrication, it stores energy from the steering force until the force overcomes the binding, releasing with a metallic pop

D. The tie rod end ball joint has play that produces a pop when the steering force direction reverses at the center position during the lock-to-lock sweep

91. A heavy-duty truck has both drive axle tires on one side showing excessive wear on the outside edges. The other side's tires show normal wear. The inflation pressures are equal on both sides. What alignment condition would produce this one-sided outside-edge wear pattern?

A. The affected side's axle has excessive positive camber — the wheel tilts outward at the top, loading the outside edge of the tire more heavily; the opposite side's camber is within specification, producing normal wear; camber-induced wear affects only the side with the excessive angle

B. The total toe on the drive axle is set to excessive toe-in, which would affect both sides equally

C. The drive axle has a thrust angle error that causes one side to scrub during straight-line driving

D. The affected side's shock absorber has failed, causing bouncing that wears the outside edge during the suspension's rebound cycle

92. A heavy-duty truck's frame has been inspected and shows evidence of previous unauthorized welding — a welded repair on the upper flange of the right frame rail. The weld appears to be a general-purpose MIG weld with no evidence of pre-heating or post-heating. What is the concern?

A. The unauthorized weld may have aesthetically altered the frame's appearance in a way that does not match the original factory finish

B. The weld introduces additional weight to the frame rail that may affect the vehicle's gross weight compliance

C. The frame rail's paint has been damaged by the welding heat and is now susceptible to surface corrosion at the weld location

D. The unauthorized weld may have compromised the frame rail's structural integrity — heavy-duty truck frame rails are manufactured from specific high-strength steel alloys that require controlled welding procedures (specific filler metal, pre-heat, post-heat, interpass temperatures) to maintain the material's properties; a general-purpose MIG weld on high-strength steel can create a brittle heat-affected zone that is weaker than the original material and prone to cracking under the dynamic loads of vehicle operation

93. A trailer equipped with a spread tandem suspension has a condition where both axles track straight and the alignment is correct, but the trailer experiences excessive tire wear on all positions. The tires are the correct specification and inflation pressure. What else should be checked?

A. The trailer's suspension height, which if set incorrectly could change the effective scrub radius during steering

B. The axle spacing — spread tandem trailers have a specific axle spacing that is part of the suspension geometry; if the spacing has changed (from a shifted mounting bracket, a bent torque arm, or an incorrect component replacement), the geometric relationship between the axles produces tire scrub even though each axle individually measures as correctly aligned

C. The trailer's kingpin offset, which affects the tire wear pattern during tight turns

D. The trailer's fifth wheel position, which if too far forward could overload the tandem and accelerate tire wear from excessive contact pressure

94. A heavy-duty truck has a condition where the steer tires produce a loud humming noise that increases with vehicle speed. The noise is present regardless of whether the brakes are applied or the steering is turned. The tires are a common highway tread pattern and are properly inflated. What is the most likely cause?

A. The steer tires have developed irregular wear (cupping, feathering, or flat spots) that produces the humming noise as each irregularity contacts the road surface — the noise increases with speed because the contact frequency increases; the specific wear pattern determines the noise character (hum, growl, or thump); rotating the tires to a non-steer position confirms whether the noise follows the tires or stays with the axle

B. The front wheel bearings are worn and producing a speed-dependent hum that is transmitted through the hub and tire to the cabin

C. The power steering fluid is cavitating inside the steering gear at higher vehicle speeds, producing the humming noise

D. The front brake shoes are lightly contacting the drums at all times, producing a speed-dependent hum from the continuous friction

95. A truck equipped with hub-piloted disc wheels has had a wheel come loose despite the nuts being torqued to specification during the last service. Upon inspection, the technician finds that the hub pilot pads are heavily corroded. How does corrosion on the hub pilot pads cause wheel loosening?

- A. The corrosion reduces the pilot pad diameter, preventing the wheel from centering properly and causing it to oscillate during rotation
- B. The corrosion creates an uneven surface that prevents the wheel from seating flat — the corroded surface has high and low spots that compress unevenly under the clamping force of the nuts; as the high spots crush and the corrosion breaks down under the wheel's weight and the dynamic loads of driving, the clamping force decreases and the nuts loosen
- C. The corrosion on the pilot pads acts as a lubricant between the hub and the wheel, allowing the wheel to rotate on the hub under driving forces
- D. The corrosion produces iron oxide particles that interfere with the nut threads, preventing the nuts from achieving adequate clamping force during torquing

96. A heavy-duty truck has a condition where the steering becomes very stiff and difficult to turn for the first 30 seconds after a cold start. After 30 seconds, the steering effort returns to normal. What is the most likely cause?

- A. The steering gear's internal spool valve is sticking from cold, thickened power steering fluid and requires 30 seconds for the fluid to warm enough to flow freely through the valve's metering orifices
- B. The power steering pump belt slips on the cold, contracted pulley for the first 30 seconds until the belt and pulley warm and expand to their operating dimensions
- C. The power steering pump's pressure relief valve is stuck closed from cold and opens after the fluid warms and dissolves the varnish holding the valve closed
- D. The power steering fluid is cold and thick — the high viscosity of the cold fluid resists flow through the pump, hoses, gear, and metering orifices; the pump must work harder to move the thick fluid, and the metering orifices in the steering gear cannot pass adequate flow for responsive assist; after 30 seconds of circulation, the fluid warms enough to flow freely and the steering effort normalizes

97. A trailer has a condition where one wheel position consistently has tire valve stem failures — the stems crack and leak within 3 months of installation. The stems are the correct specification for the rim. What could cause this premature valve stem failure?

- A. The rim hole for the valve stem has a rough edge or a burr from corrosion or damage that cuts into the stem's rubber base during rotation

B. The valve stems are failing from fatigue caused by centrifugal force bending the stems outward during highway-speed rotation — the stems on this position may be exposed to higher centrifugal force from a slightly larger-diameter wheel or a higher-speed rating requirement; alternatively, the rim's valve stem hole has a rough edge or a burr that cuts into the rubber base of the stem during each revolution, creating a progressive cut that cracks the stem

C. The tire mounting machine's bead breaker has been damaging the valve stems during tire changes on this position

D. The tire pressure monitoring sensor is applying lateral force to the stem from inside the tire

98. A truck's front suspension uses maintenance-free sealed king pin bearings that do not require periodic greasing. After 200,000 km, the technician measures king pin play and finds it exceeds the maximum specification. What is the correct action?

A. The sealed king pins must be replaced — unlike traditional greaseable king pins that can have their bushings replaced independently, maintenance-free sealed king pin assemblies are a complete unit that is replaced as an assembly when the internal bearing surfaces wear beyond the specification

B. The seals can be removed and the bearings packed with grease to extend their service life beyond the current wear level

C. Maintenance-free king pin assemblies are designed to operate beyond the measured play specification and do not require replacement until visible looseness is detected during a road test

D. The king pin assembly can be rebuilt by pressing out the worn bearing races and pressing in new races

99. A truck has a condition where one rear drive tire consistently runs at a lower temperature than the other rear drive tire on the same axle. Both tires are the same specification and inflation pressure. What should be investigated?

A. The tire rubber compound variation between the two tires from different manufacturing batches

B. The brake on the side with the warmer tire for a slight drag condition that generates friction heat

C. The differential, which may be biasing more torque to the warmer side through worn spider gears

D. The cooler tire's brake — a brake that is not applying on one side means that side's tire does not receive the friction heat generated during braking that the other side receives; the warmer tire is on the side with the properly functioning brake, and the cooler tire's brake must be inspected for a disconnected air line, failed chamber, or non-functioning slack adjuster

100. A heavy-duty truck equipped with a walking beam tandem suspension has a condition where the vehicle handles poorly during cornering — the rear of the truck feels like it is "walking" or shifting laterally during turns. The equalizer beam bushings and center pivots have been recently replaced. What else should be inspected?

- A. The tire inflation pressures on the tandem axles, which if uneven could create a cornering instability
- B. The torque arms (torque rods) and their bushings — the torque arms locate the axles longitudinally and laterally relative to the frame; if the torque arm bushings are worn or the arms themselves are bent, the axles can shift laterally during cornering forces, creating the "walking" sensation; the equalizer beam system handles the load distribution, but the torque arms handle the axle location
- C. The equalizer beam itself for a crack that allows it to flex laterally under cornering loads
- D. The frame crossmember above the equalizer beam pivot for looseness that allows the entire suspension mounting to shift during turns

101. A truck has a condition where the front tires show a wear pattern that is smooth on one half of the tread and rough (feathered) on the other half, with a clear dividing line across the middle of the tread. What alignment condition produces this specific half-and-half wear pattern?

- A. A combination of toe and camber that produces scrubbing on one half of the contact patch while the other half tracks cleanly
- B. A bent tie rod that produces a toe change during steering that affects one half of the tread more than the other
- C. A worn king pin that allows the wheel to shift between positive and negative camber during driving, alternately loading each half of the tread
- D. Incorrect toe — the feathered half is the side of the tread that scrubs against the road surface from the toe angle; on a toe-in condition, the outside edges of both tires feather, and on toe-out, the inside edges feather; the clear dividing line at the tread center separates the scrubbing zone from the tracking zone

102. A truck's steer axle has a tie rod that has been recently replaced. After the replacement, the driver reports that the steering is now more responsive (quicker) than before. The alignment has been set to specification. What could explain the increased responsiveness?

A. The replacement tie rod is a different part number with a different arm length that changes the steering geometry's ratio between steering wheel input and road wheel output — a shorter tie rod increases the steering's quickness by translating each degree of steering wheel rotation into more degrees of road wheel rotation; the alignment settings may read correctly but the steering ratio has changed

B. The new tie rod end has tighter ball joints that reduce the free play in the steering system, making it feel more responsive

C. The alignment was set with the vehicle on a lift, and the loaded alignment on the ground produces a different steering ratio

D. The power steering system's flow rate has increased coincidentally during the repair, providing faster response to steering inputs

103. A heavy-duty truck's frame has developed a crack at a suspension bracket weld joint. The fleet manager asks whether the frame can be safely repaired. What factors determine whether the repair is appropriate?

A. The frame can always be repaired with a simple weld if the crack is less than 100 mm in length

B. The frame cannot be repaired at all and the entire frame rail must be replaced

C. The repair decision depends only on the cost comparison between welding and replacing the frame rail

D. The repair must follow the frame manufacturer's approved procedure — the repairability depends on the crack location (flange, web, or radius), the crack length and direction, the frame rail material (mild steel, high-strength low-alloy, or heat-treated), and the availability of an approved repair procedure; some frame materials cannot be welded without destroying their heat-treated properties, and some crack locations require section replacement rather than welding

104. A heavy-duty truck's cab has developed a water leak that appears during heavy rain but not during light rain or car-wash pressure. The leak drips from the headliner near the center of the cab roof. What is the most likely entry point?

- A. The windshield seal has a gap at the top center that only opens under the heavy rain's water pressure
- B. A cab-mounted accessory (roof-mounted antenna, clearance light, or grab handle) has a failed gasket or mounting seal
- C. A roof seam, a clearance light mounting gasket, or a cab-mounted accessory gasket at the top of the cab has failed — heavy rain produces enough water volume and pressure to penetrate the weakened seal that light rain and car-wash spray cannot overcome; the water enters at the roof level and travels along the headliner to drip at the center, which may not be directly below the entry point
- D. The HVAC fresh air intake drain has clogged and the backup water is entering the cab through the blower housing

105. A transit bus has a condition where the driver's seat produces an air leak hissing sound continuously. The seat rides at the correct height and the height adjustment functions normally. What is the most likely cause?

- A. The seat's air ride system has a minor leak at a fitting, air line, or the air spring itself that continuously vents air
- B. The seat's height control valve is cycling rapidly between add and vent, creating a continuous hissing sound from the alternating air flow — the valve is trying to maintain the set height but a marginal sensor, a worn valve, or a slow leak forces it to continuously add and vent small amounts of air; the seat maintains its height because the valve compensates, but the continuous cycling produces the audible hiss
- C. The seat's lumbar support air bladder has a leak that sounds like it comes from the air ride system
- D. The shop air supply line to the seat has a restriction that creates turbulence noise as air passes through the narrow section

106. A heavy-duty truck's cab tilt hydraulic system has a condition where the cab tilts forward normally but will not lower back to the latched position under its own weight. The technician must manually push the cab down. What is the most likely cause?

- A. The cab tilt hinge pins have seized from corrosion, preventing the cab from pivoting freely under its weight

B. The cab tilt safety prop (the bar that holds the cab tilted) is not fully retracting and is physically blocking the cab's return

C. The HVAC lines, electrical harnesses, or other components routed between the cab and the frame are preventing the cab from lowering fully

D. The cab tilt cylinder has a failed internal check valve or the lowering circuit has a restriction that prevents the oil from returning to the reservoir as the cab weight pushes the cylinder's piston — the oil cannot exit the cylinder fast enough for the cab to lower under its own weight; manually pushing the cab overcomes the restriction with additional force

107. A truck's windshield wiper motor operates at only one speed — high. The low and intermediate speed settings produce no change in wiper speed. What is the most likely cause?

A. The wiper motor's internal brush plate has worn, shorting the speed selection resistors and defaulting to full speed

B. The wiper motor's speed control module or the park/speed resistor assembly has failed — many wiper motors use internal resistors or an external module to provide reduced speeds; if the resistor or module fails, the motor defaults to the high-speed direct-power path that bypasses the speed control components

C. The wiper motor itself has failed and can only operate at full voltage regardless of the control input

D. The wiper control switch on the dash has a shorted contact that sends full voltage to the motor regardless of the selected speed position

108. A heavy-duty truck's driver-side mirror produces a blurred image that cannot be corrected by adjusting the mirror angle. The mirror glass is not cracked. What is the most likely cause?

A. The mirror's anti-glare coating has degraded from UV exposure, creating a haze on the glass surface

B. The mirror glass surface has been damaged by road chemicals, solvents, or abrasive cleaning — chemical etching from de-icing spray, solvent overspray, or aggressive cleaning with abrasive pads creates microscopic surface damage that scatters the reflected light and produces a permanently blurred image

C. The mirror's heating element has melted the adhesive behind the glass, causing the glass to warp slightly on its backing

D. Moisture has penetrated between the mirror glass and its reflective coating, creating internal condensation that blurs the reflected image

109. A dry freight van trailer has a condition where the roof panel has developed multiple small dents and depressions. The dents are concentrated in the center of the roof between the roof bows. What caused this damage, and what is the consequence?

A. The dents were caused by walking on the roof during inspections or repairs — the roof skin is thin sheet aluminum or fiberglass that cannot support a person's concentrated weight between the structural roof bows; the depressions collect water, snow, and ice that accelerate corrosion, add weight, and can leak into the cargo area; roof-top walking platforms or planks must be used to distribute the load during any roof-top work

B. The dents were caused by hail damage during a severe weather event

C. The dents were caused by cargo stacked too high inside the trailer pressing against the roof skin from the inside

D. The dents are manufacturing variations in the roof skin that are cosmetic and do not affect the trailer's structural integrity

110. A trailer equipped with disc brakes has a condition where the brake pads on all wheel positions have worn to the minimum thickness indicator within 40,000 km. The previous set of pads lasted 100,000 km. What could cause this dramatically accelerated pad wear?

A. The replacement pads are a softer compound than the original specification, wearing faster under normal braking conditions

B. The driver has changed their driving technique and is using the brakes more aggressively than before

C. The trailer's ABS system is activating excessively and the rapid cycling is wearing the pads faster than normal

D. The caliper pistons on all positions are not fully retracting after each brake application — the pistons remain partially extended, keeping the pads in light contact with the rotors; the continuous light friction generates heat and wears the pads at several times the normal rate; the most common cause of universal non-retraction is contamination in the brake fluid that has swollen the caliper piston seals, preventing them from pulling the pistons back into the bore

111. A trailer's structural inspection reveals that the main longitudinal I-beams have surface corrosion on the bottom flanges. The corrosion has reduced the flange thickness by approximately 15% as measured with an ultrasonic thickness gauge. What is the structural significance of this material loss?

- A. A 15% reduction in bottom flange thickness is within the normal service tolerance for a trailer I-beam and does not require action
- B. The bottom flange of an I-beam carries the tensile load when the beam is loaded from above — a 15% reduction in thickness reduces the flange's cross-sectional area proportionally, decreasing the beam's load-carrying capacity; the trailer's rated payload must be reassessed based on the reduced flange dimensions, and the corrosion must be addressed to prevent further material loss
- C. The bottom flange corrosion only affects the trailer's resale value and does not impact its load-carrying capacity
- D. The corrosion can be repaired by welding a reinforcing plate to the bottom flange to restore the original thickness

112. A reefer trailer's TRU has a condition where the compressor short-cycles — it runs for 30 seconds, then stops for 60 seconds, then runs again. The cargo temperature is not reaching the setpoint. What is the most likely cause?

- A. The TRU's high-pressure switch is tripping — the condenser may be dirty, the condenser fan may have failed, or the refrigerant charge is excessive; any of these conditions causes the discharge pressure to rise rapidly to the high-pressure switch's trip point, shutting the compressor down; the pressure drops during the 60-second off cycle, the switch resets, and the compressor restarts
- B. The TRU's diesel engine is overheating and the engine protection circuit is shutting the compressor down
- C. The TRU's defrost cycle is activating every 90 seconds due to a faulty defrost timer
- D. The evaporator blower motors have failed and the TRU's freeze protection circuit is cycling the compressor to prevent the evaporator from icing

113. A flatbed trailer has a condition where the rub rails (side rails) have been bent outward from contact with loading dock structures. The rails extend approximately 50 mm beyond the trailer's legal width. What is the consequence?

- A. The bent rub rails are cosmetic damage that affects the trailer's appearance but does not create a legal or safety issue
- B. The trailer is too narrow for legal operation and the bent rails must be bent inward to restore the designed width
- C. The bent rub rails extend the trailer beyond its legal maximum width — overwidth vehicles require special permits for operation on public roads; the rails must be straightened or replaced to bring the trailer within its legal width; additionally, the protruding rails create a side-swipe hazard to adjacent vehicles and infrastructure
- D. The bent rails only create a problem during loading dock operations and do not affect roadway safety

114. A trailer's landing gear has been found with both legs fully retracted even though the trailer is disconnected from the tractor and resting on the ground. The landing gear should have been fully extended before disconnection. What is the immediate concern?

- A. The trailer's nose is resting on the ground, and the impact may have damaged the front crossmember, the king pin area, and the trailer's brake and electrical connections at the nose
- B. The retracted landing gear has placed the trailer's full nose weight on the king pin and the front crossmember, which are not designed to support the trailer's weight without the tractor or the landing gear
- C. The landing gear gearbox has been damaged by the weight of the trailer resting on the retracted legs
- D. The trailer's front cargo may have shifted forward and is pressing against the bulkhead, creating a load balance issue

115. A trailer equipped with a sliding tandem suspension has a condition where the tandem will not slide — the locking pins are released but the suspension does not move when the tractor attempts to push or pull the trailer. What is the most likely cause?

- A. The tandem slider rails are corroded and the friction between the corroded rail surfaces and the tandem's slide pads prevents movement
- B. The tandem slider rails are corroded, debris-laden, or dry, creating friction that prevents the tandem from sliding — the slider rails must be clean and lubricated for the tandem to slide freely; corrosion

buildup, accumulated road debris, and lack of lubrication increase the friction to the point where the tractor cannot overcome the resistance; cleaning and lubricating the rails, and verifying the locking pins are fully retracted, restores slide function

C. The trailer's air ride suspension is inflated and the ride height is pressing the tandem against the slider rails too tightly

D. The tandem locking pin air cylinder has a slow leak that is gradually re-engaging the pins after they are released

116. A trailer's conspicuity tape (retroreflective tape) on the rear has faded significantly — the red and white alternating pattern is barely visible. The tape has not been physically damaged. What is the cause of the fading, and what action is required?

A. The tape has been covered with road grime and cleaning the surface will restore its reflectivity

B. The conspicuity tape's retroreflective elements have degraded from UV exposure and weathering over time — the microscopic glass beads or prismatic elements that reflect light back to its source have deteriorated, reducing the tape's reflective performance below the minimum standard; the faded tape must be replaced with new tape that meets CMVSS 108 reflectivity requirements to maintain the trailer's nighttime visibility

C. The tape's adhesive has failed and the tape is lifting from the surface, reducing its visible area but maintaining its reflective performance

D. The trailer's rear surface has corroded under the tape, pushing the tape away from the surface and reducing its reflective angle

117. A truck's A/C system has a condition where the compressor engages and the system cools, but the cooling performance is noticeably better during highway driving than during city stop-and-go driving. The condenser fan operates at both conditions. What is the most likely cause?

A. The evaporator is partially iced over during city driving from the frequent compressor cycling, reducing airflow

B. The condenser fan is undersized for the application and cannot reject heat as effectively at idle as the ram air does at highway speed

C. The condenser fins are partially blocked with debris — at highway speed, the increased ram airflow forces enough air through the partially blocked condenser to provide adequate heat rejection; at city speeds, the reduced ram airflow combined with the debris blockage limits the condenser's ability to reject heat, raising the high-side pressure and reducing cooling performance

D. The compressor belt slips at idle RPM from inadequate tension and cannot drive the compressor at full capacity

118. A truck's heater produces a strong sweet odor in the cab when the heater is turned on. No visible coolant leak is present under the dashboard or on the cab floor. What does the sweet odor indicate?

A. The heater core's internal passages are contaminated with bacterial growth that produces a sweet-smelling compound

B. The heater core has developed a micro-leak that vaporizes a small amount of coolant into the airstream — the sweet smell is the characteristic odor of ethylene glycol coolant; the leak is too small to produce visible dripping but large enough to release coolant vapor that the HVAC blower distributes through the cab; this is an early warning of an impending heater core failure

C. The coolant's supplemental additive package has expired and is producing a sweet decomposition odor

D. The cabin air filter has absorbed coolant vapor from an external leak and is releasing the odor when the blower forces air through it

119. A truck's A/C system has been evacuated to 500 microns and the vacuum has been held for 30 minutes. During the vacuum hold, the technician notices the vacuum gauge slowly rises from 500 microns to 1,500 microns over the 30-minute period. What does this rising vacuum reading indicate?

A. Normal outgassing of residual moisture and refrigerant oil from the system's internal surfaces, which is expected and does not indicate a leak

B. The vacuum pump has a worn internal seal that is allowing atmospheric air to leak into the evacuated system through the pump

C. The rising vacuum reading is caused by the temperature of the system equalizing with the ambient temperature, which changes the gas behavior inside the system

D. The system has a leak that is allowing atmospheric air to enter — a proper vacuum hold should maintain the vacuum level at or near the achieved level for the entire test period; a rising reading from 500 to 1,500 microns over 30 minutes indicates air is entering the system through a leak; the leak must be located and repaired before the system is recharged

120. A bus's HVAC system has a condition where the defroster clears the windshield effectively but the side windows remain fogged. What adjustment or repair could correct this?

A. The HVAC system's mode door or duct configuration needs adjustment to direct more heated air toward the side windows — the defroster ductwork may not include dedicated outlets for the side windows, or the outlets may be blocked or disconnected; adding or repairing side-window defrost outlets, or adjusting the mode door to deliver air to these outlets, clears the side window fog

B. The side windows need a hydrophobic coating applied to prevent moisture from adhering to the glass surface

C. The side window glass has a different thermal conductivity than the windshield glass and requires a separate heating element

D. The HVAC blower speed must be increased to maximum to force air around the cab corners to reach the side windows

121. A truck's A/C system has been diagnosed with a restricted expansion valve. The technician replaces the expansion valve and the receiver-drier. After evacuation and recharging with the specified refrigerant amount, the system produces vent temperatures of 3°C — colder than the expected 5-8°C range. What could cause the below-normal vent temperature?

A. The system is performing optimally and the 3°C reading is within an acceptable range for the current ambient conditions

B. The system has been overcharged despite the technician measuring the correct weight — the scale may be inaccurate

C. The new expansion valve has a lower flow rating than the original, starving the evaporator and causing it to superheat excessively — the low flow reduces the evaporator temperature but also reduces the system's total cooling capacity

D. The receiver-drier's desiccant is absorbing residual moisture from the system and the exothermic drying reaction is temporarily lowering the evaporator temperature

122. A truck's heated exterior mirror has a condition where the mirror heating works but the heat is concentrated in one area — one corner of the mirror is very hot while the rest is barely warm. What is the most likely cause?

A. The mirror glass has a thermal conductivity defect that prevents even heat distribution from the element

B. The heating element behind the mirror glass has a partial open circuit — the element is a resistance wire grid or printed circuit that should distribute heat evenly across the entire mirror surface; a break in the element at one location forces all the current through a shorter path, concentrating the heat in the remaining functional section while the disconnected section receives no heat

C. The mirror's heating relay is providing pulsating power that causes uneven heating across the mirror surface

D. The mirror glass adhesive has created an insulating air gap between the element and the glass on the cool side

123. A transit bus's passenger compartment air conditioning has a condition where the system cools effectively near the evaporator unit but the far end of the bus is warm. The blower motors throughout the bus are operating. What is the most likely cause?

A. The far end of the bus is receiving direct sunlight through the rear window that overwhelms the A/C system's capacity

B. The bus's insulation has degraded at the far end, allowing ambient heat to infiltrate faster than the A/C can remove it

C. The condenser is undersized for the bus's interior volume and cannot reject enough heat for the entire passenger compartment

D. The distribution ductwork has a leak, collapse, or disconnection between the evaporator and the far end of the bus — the cooled air escapes or is blocked before reaching the distant passengers; the passengers near the evaporator receive adequate cooling because they are upstream of the ductwork fault; inspecting the duct system for integrity along its entire length identifies the failure point

124. A hydraulic system on a truck-mounted aerial lift has a condition where the boom extends smoothly but retracts with a jerky, stick-slip motion. The extend circuit and the retract circuit use separate directional valve spools. What is the most likely cause?

A. The retract circuit's directional valve spool is contaminated — particles or varnish on the spool surface create areas of increased friction that cause the spool to stick momentarily, then break free and move abruptly; the stick-slip cycle produces the jerky retraction; the extend circuit's spool is clean and operates smoothly

B. The boom cylinder has different internal bore finishes on the cap end and rod end that produce different friction characteristics

C. Air trapped in the rod end of the cylinder compresses during retraction, causing intermittent piston movement

D. The retract circuit's relief valve is chattering from a contaminated seat, producing pressure fluctuations that cause jerky motion

125. A hydraulic system has a condition where the pump produces adequate flow and pressure, but the system overheats within 30 minutes of operation even when no functions are being used (system in standby). What is the most likely cause?

A. The pump's compensator has failed in the full-flow position, continuously pumping fluid through the system at maximum flow even in standby

B. The directional valve has a stuck spool that continuously routes fluid through a restriction

C. The system's relief valve is set at or near the standby pressure — the pump continuously pushes fluid over the relief, converting hydraulic energy to heat; alternatively, the pump's internal bypass is excessive from wear, generating heat inside the pump during standby

D. The reservoir's fluid level is too low, reducing the fluid volume available for heat dissipation

126. A hydraulic crane has a condition where the boom telescope cylinder drifts out (extends slowly) when the system is in standby with a load suspended. The boom should hold its position. What is the most likely cause?

A. The counterbalance valve in the telescope circuit has a seal leak that allows pressure to bypass and slowly extend the cylinder

B. The pilot-operated check valve in the retract circuit is leaking, allowing fluid to flow into the extend side of the cylinder from the return line — the load's weight creates pressure on the retract side of the cylinder, and this pressure pushes fluid through the leaking pilot check valve into the extend side, causing the slow drift outward

C. The directional valve spool for the telescope circuit is leaking internally from the pressure port to the extend port

D. The boom's mechanical weight is pushing against the telescope cylinder's rod end and forcing it to extend by compressing the fluid on the retract side through the leaking counterbalance valve or the leaking directional valve spool — the drift outward means fluid is being displaced from the rod end to the cap end through an internal leak path; the counterbalance valve, the pilot-operated check valve, or the directional valve spool must be tested individually to identify the specific leak source

127. A hydraulic system uses a heat exchanger (oil cooler) to maintain the fluid temperature below 80°C. The technician measures the fluid temperature at 95°C during normal operation. The heat exchanger appears clean externally. What should be checked?

A. The heat exchanger bypass thermostat, which may be stuck in the bypass position and routing fluid around the cooler instead of through it

B. The system's relief valve setting, which if too low would generate excessive heat from continuous bypass

C. The pump speed, which if set too high would generate more heat than the cooler can reject

D. The heat exchanger's bypass valve or thermostat — many hydraulic oil coolers have a bypass valve that routes fluid around the cooler when the fluid is cold (to allow faster warm-up) and directs it through the cooler when the fluid reaches operating temperature; if the bypass is stuck open, the fluid continuously routes around the cooler regardless of temperature, and the system overheats because no cooling occurs

128. A technician is performing a hydraulic pump efficiency test. The test requires measuring the pump's flow at no load (low pressure) and at full load (relief valve pressure). The pump produces 20 GPM at no load and 14 GPM at relief pressure. The pump is rated at 20 GPM. What is the pump's volumetric efficiency?

A. The volumetric efficiency is calculated as  $(\text{flow at load} / \text{flow at no load}) \times 100 = (14/20) \times 100 = 70\%$  — this means 30% of the pump's output is being lost to internal leakage under load; most manufacturers specify a minimum acceptable efficiency of 80-85%, so this pump has significant internal wear and should be rebuilt or replaced

B. The volumetric efficiency is 93% because the no-load flow matches the rated capacity

C. The volumetric efficiency cannot be calculated from these measurements alone — the pump must be tested at multiple pressure points

D. The volumetric efficiency is 100% minus the pressure drop percentage, which is approximately 85%

129. A hydraulic system on a refuse truck has a condition where one specific function (the packer blade extend) operates normally for the first 10 cycles, then slows progressively with each subsequent cycle. After a 5-minute rest, the function operates at normal speed again for another 10 cycles. What is the most likely cause?

A. The directional valve spool for the packer extend circuit has a thermal expansion issue — the spool expands from the heat of repeated cycling and begins to bind in the valve body, restricting flow; the 5-minute rest allows the spool to cool and contract, restoring normal clearance and flow

B. The pump is overheating from the repeated cycling and losing efficiency as the fluid temperature rises

C. The packer extend cylinder has an internal leak that worsens as the cylinder heats from repeated operation — the heated seals expand and temporarily improve the seal, but the underlying leak path re-opens as the seal material fatigues with each cycle; the rest period allows the seals to cool and temporarily reseal

D. The hydraulic filter is clogging from debris generated during the packer operation and the restriction increases with each cycle

130. A hydraulic system has been drained for maintenance. During the refill, the technician adds fluid directly to the pump inlet port to "prime" the pump before starting the system. Is this practice recommended?

A. This practice is not recommended — the fluid added through the inlet port does not fill the pump's internal chambers adequately; the correct practice is to fill the reservoir to the proper level, then briefly

jog the electric motor (if applicable) or bump the engine starter in short bursts while monitoring the pump for output; this allows the pump to draw fluid from the reservoir through its normal suction path and self-prime without running dry

B. Priming the pump through the inlet port is the correct practice and ensures the pump has fluid in its chambers before the first revolution — running a hydraulic pump dry, even briefly, can cause immediate and severe damage to the pump's internal surfaces; however, the pump must also have its case drain port filled if it is a piston-type pump, and the reservoir must be at the correct level before starting

C. Priming is unnecessary because modern hydraulic pumps are designed to self-prime from a dry start without damage

D. The pump should be filled through its case drain port rather than the inlet port to ensure the bearings are lubricated before the shaft rotates

131. A hydraulic system on a utility truck has a condition where the outrigger cylinder extends to its full stroke but cannot support the vehicle's weight — the outrigger slowly retracts under the vehicle's load. The control valve is in the hold (neutral) position. What is the most likely cause?

A. The outrigger cylinder's piston seal has failed, allowing fluid to bypass from the cap end to the rod end under the vehicle's weight

B. The holding valve (pilot-operated check valve or counterbalance valve) in the outrigger circuit has a leak that allows fluid to drain from the cylinder under load

C. The system's relief valve is set too low, preventing adequate pressure from reaching the outrigger cylinder to support the load

D. The outrigger cylinder is leaking internally (piston seal bypass) or the holding valve in the outrigger circuit is leaking — fluid is escaping from the pressurized side of the cylinder through an internal leak path; the most dangerous consequence is the vehicle losing its outrigger support during aerial work, which can cause the vehicle to tip; the exact leak source must be isolated by testing the cylinder and the holding valve separately

132. A battery electric transit bus has a condition where the traction motor produces reduced torque during acceleration, and the scan tool shows a fault code for "Inverter — Phase U Current Imbalance." What does this fault indicate?

- A. The inverter has a fault in one of its three power phases — the three-phase inverter converts DC battery voltage to AC for the traction motor; if one phase (Phase U) is producing a different current level than the other two phases, the motor receives an unbalanced power supply that reduces its total torque output and can cause vibration; the inverter's power module, gate driver, or current sensor for Phase U must be diagnosed
- B. The traction motor has a shorted winding on Phase U that is drawing excessive current and overheating the inverter
- C. The battery pack has a cell imbalance that is reducing the available voltage on the Phase U DC bus
- D. The motor's Phase U connector has a loose terminal that is creating intermittent contact under the vibration of acceleration

133. A hybrid electric truck uses regenerative braking to recover kinetic energy during deceleration. The driver reports that the regenerative braking force has decreased noticeably compared to when the truck was new. The battery SOH is 90%. What is the most likely cause of the reduced regenerative force?

- A. The traction motor's permanent magnets have partially demagnetized from sustained high-temperature operation over the vehicle's life
- B. The friction brakes have worn and the blended braking algorithm is commanding less regenerative torque to compensate
- C. The battery's reduced capacity (90% SOH) limits the maximum charging current it can accept during regeneration — as the battery ages, its internal resistance increases and its capacity decreases; the BMS reduces the maximum allowable regenerative charging current to protect the degraded cells from overcurrent damage, which directly reduces the regenerative braking force available
- D. The inverter's software has been updated to a version that limits regenerative torque for improved passenger comfort

134. A technician discovers that a hybrid bus's high-voltage battery cooling system has a low coolant level. The coolant is a dielectric (non-conductive) type. Can the technician top up the system with standard automotive coolant?

- A. Standard automotive coolant can be used temporarily until the correct dielectric coolant is ordered from the dealer

B. Standard automotive coolant must never be added to the high-voltage battery cooling circuit — standard coolant contains dissolved ions from its corrosion inhibitor additives that make it electrically conductive; adding conductive coolant to a dielectric cooling circuit compromises the electrical isolation between the high-voltage system and the vehicle chassis, creating a shock hazard; only the specified dielectric coolant may be used

C. Standard coolant can be mixed with dielectric coolant as long as the mixture does not exceed 25% standard coolant

D. The coolant type is not critical for the cooling function and any automotive coolant will work as long as the cooling capacity is adequate

135. A battery electric truck has a condition where the vehicle's maximum speed is limited to 50 km/h even though the motor and inverter are capable of much higher speeds. The battery SOC is at 20%. What is the most likely cause of the speed limitation?

A. The motor controller limits maximum speed at low SOC to prevent damage to the motor's permanent magnets from overspeed

B. The inverter enters a thermal protection mode at low SOC that limits the switching frequency and therefore the motor speed

C. The traction motor's winding temperature has exceeded its maximum threshold and the controller limits speed to reduce the heating rate

D. The VCU limits the maximum power output at low battery SOC to extend the remaining range and protect the battery cells from damage — at 20% SOC, the battery's voltage sags under high current draw and the cells are more susceptible to damage from deep discharge; the VCU reduces maximum motor power (which limits speed) to prevent the battery voltage from dropping below the minimum safe cell voltage threshold

## Practice Exam 11: Answer Key and Explanations

1. C — A neutral oxy-acetylene flame has a distinct inner cone with a sharp, well-defined outline. A long, feathery, luminous orange flame indicates a carburizing (acetylene-rich) mixture caused by a partially blocked oxygen orifice or a shifted gas setting. The excess acetylene produces soot that contaminates heated surfaces and the incomplete combustion is less efficient for heating. The technician must readjust the torch valves to restore a neutral flame before continuing.

2. A — Diesel exhaust contains carbon monoxide (CO), nitrogen oxides (NOx), and fine particulate matter — all of which are hazardous to health. CO is odorless and colorless, and can reach dangerous concentrations in an enclosed shop within minutes, causing impaired judgment, unconsciousness, and death. The exhaust extraction hose must be connected for every indoor engine operation regardless of the expected duration — there is no safe minimum time for running an engine indoors without extraction.

3. D — Multi-piece rim assemblies use separate locking rings, side rings, or flanges that are held in place by air pressure and mechanical engagement. If the tire retains residual air pressure or the rim components are corroded, cracked, or improperly assembled, these rings can separate explosively during tire service with lethal force. The tire must be fully deflated, the rim components inspected for damage, and the disassembly performed inside a safety cage or with restraining devices.

4. B — Proper manual lifting technique requires bending at the knees (not the waist), maintaining a straight back, gripping the load firmly with both hands, keeping the load close to the body's center of gravity, and lifting with the leg muscles — not the back muscles. Walking at a controlled pace while maintaining the load close to the body minimizes the leverage effect that causes back strain. A 25 kg alternator is within the recommended manual lifting limit for a single person.

5. A — A recovery machine gauge reading of 0 psi means the system pressure equals atmospheric pressure — not that the system is empty. Refrigerant can still exist as liquid or vapor at atmospheric pressure inside the system. The system has been depressurized but not evacuated. A proper vacuum evacuation (pulling the system below atmospheric pressure to approximately 500 microns) must be performed before opening the system to ensure all remaining refrigerant and moisture have been removed.

6. C — LED lighting operates by switching on and off at a frequency determined by its power supply driver. If this frequency aligns with the rotational frequency of a spinning component, the strobing effect makes the component appear stationary (the stroboscopic effect). A technician who reaches for a component that appears still but is spinning at thousands of RPM can suffer severe entanglement, laceration, or amputation injuries. Anti-strobe LED fixtures or physical guards on rotating equipment must be used.

7. D — A sharp directional pull during braking means the vehicle deviates from its intended path — on a road with opposing traffic, adjacent vehicles, cyclists, or pedestrians, this deviation can cause a collision. The brake imbalance creates a safety hazard at any speed, and the severity increases with speed because the deviation distance increases proportionally. The truck must not be returned to service until the brake imbalance is diagnosed and corrected.

8. B — Natural gas (methane) is lighter than air and rises to the ceiling in an enclosed shop. Unlike diesel fuel, which requires significant heat to ignite, natural gas is flammable at room temperature and can form an explosive mixture at concentrations of 5-15% in air. A spark, open flame, or electrical arc at ceiling level can ignite the accumulated gas. Shops servicing natural gas vehicles must have ceiling-level gas detectors, adequate roof ventilation, and explosion-proof electrical fixtures.

9. A — A continuous light blue haze at all operating conditions (idle, cruise, and full load) that does not change with load indicates a constant oil consumption path. Valve stem seals that have hardened from age and heat exposure cannot flex to maintain their seal against the valve stems. Oil seeps past the hardened seals during the intake stroke's negative pressure pulse and is drawn into the cylinders. The crankcase pressure is normal because the piston ring-to-liner seal is intact.

10. D — The actual rail pressure (2,000 bar) exceeds the commanded pressure (1,200 bar) by 800 bar. The fuel rail pressure control valve or metering valve regulates how much fuel the high-pressure pump delivers to the rail. If this valve is stuck in the maximum delivery position (from contamination, a failed solenoid, or a seized spool), the pump sends maximum volume to the rail regardless of the ECM's command to reduce delivery. The ECM derates because the uncontrolled pressure risks damage.

11. B — At 600,000 km with no fault codes, correct sensor readings, and matching boost/fuel rail values, the electronic systems are functioning as designed. The 15% power loss must come from reduced mechanical efficiency. Over 600,000 km, the piston rings and cylinder liners wear enough to reduce each cylinder's sealing efficiency — a small percentage of each cylinder's compression charge leaks past the rings, reducing the engine's volumetric efficiency and power output across all cylinders.

12. C — The engine oil cooler transfers heat from the oil to the coolant. If the cooler is partially restricted internally (from deposits or sludge), has a failed bypass thermostat (routing oil around the cooler), or has insufficient capacity for the engine's heat load, the oil retains more heat than the cooling system can absorb. The 15°C differential exceeding the 10°C specification confirms inadequate heat transfer between the oil and coolant circuits.

13. A — An air filter that loads to its maximum restriction in 5,000 km instead of the normal interval is being exposed to abnormally high particulate concentrations. Construction sites, gravel roads, agricultural environments, and mining operations produce airborne dust levels many times higher than highway conditions. The filter is functioning correctly — it is simply capturing more material per kilometre. A pre-cleaner or higher-capacity filtration system may be needed for the operating environment.

14. D — The combustion gas test (block tester) confirms that combustion products are present in the cooling system. Combustion gas can only enter the cooling system through a breach between a combustion chamber and a coolant passage — a failed head gasket, a cracked cylinder head, or a cracked liner. The breach allows combustion pressure to push gas into the coolant and simultaneously push coolant into the cylinder where it vaporizes. The gradual coolant loss, normal-appearing oil, and invisible exhaust steam confirm a small leak.

15. B — A metallic ticking from the valve cover area that increases with engine speed and does not change during an injector cut-out test is mechanical, not combustion-related. If the valve lash was recently adjusted and excessive clearance was set on one or more valves, the rocker arm tip strikes the valve stem with a metallic tick at each cam lobe lift. The injector cut-out test does not affect the noise because the valve train operates mechanically regardless of whether the cylinder fires.

16. C — The wastegate controls boost pressure by diverting exhaust gas around the turbine when the desired boost is reached. A ruptured actuator diaphragm, a disconnected linkage, or a stuck-closed wastegate valve prevents the wastegate from opening. Without the bypass, all exhaust energy drives the turbine wheel, and the turbocharger produces more boost than the system's design specification. Over-boost can damage engine components and cause detonation.

17. A — An empty coolant reservoir and a hissing pressure cap confirm the system has lost coolant but is still pressurized from normal operation. The coolant loss must be located through a pressure test — the leak may be external (visible at hoses, clamps, water pump, or freeze plugs) or internal (head gasket, EGR cooler, or oil cooler leaks produce no external evidence). The temperature gauge may read normally because the remaining coolant still circulates, but the reduced volume limits the system's heat rejection reserve.

18. D — A deep, rhythmic bottom-end knock most prominent at idle that becomes louder when the affected cylinder is loaded (by grounding its injector wire) confirms a worn connecting rod bearing. Grounding the injector increases the combustion load on the rod, pushing it harder against the journal through the enlarged clearance and amplifying the knock. At idle, the oil film is thinnest (lowest pump output) and the rod has the most time to shift during each revolution, making the noise most prominent.

19. B — The fuel rail pressure undershoots the commanded value during rapid acceleration because the high-pressure pump momentarily cannot receive enough fuel from the transfer pump. The transfer pump must respond instantly to the sudden increase in demand, and a sluggish pump, a restricted filter, or a limited-flow pickup tube delays the fuel supply to the high-pressure pump. The high-pressure pump starves momentarily until the supply catches up, causing the 200-bar undershoot.

20. C — A leaking EGR cooler introduces coolant into the intake system through the exhaust gas recirculation circuit. The coolant contaminates the intake air with moisture, minerals, and coolant additive residue. These contaminants deposit on the EGR valve, the intake manifold surfaces, and the intake ports as the coolant evaporates, progressively building restrictions. The ongoing coolant loss also depletes the cooling system's capacity and reduces its heat rejection reserve.

21. A — The "hot restart" problem is caused by fuel drainback from the high-pressure system during the hot-soak period after shutdown. A leaking check valve, worn injector seats, or worn high-pressure pump seals allow the fuel rail pressure to bleed to zero while the engine sits. Cold starts are unaffected because the system retains adequate fuel in the rail from the longer, cooler soak period. The engine must re-prime the empty system during the extended cranking before achieving sufficient rail pressure.

22. D — A functioning DOC produces a measurable exotherm — the exothermic oxidation of hydrocarbons and CO in the exhaust raises the DOC outlet temperature above the inlet temperature. Zero temperature rise across the DOC confirms the catalyst is no longer catalytically active. The DOC cannot support passive DPF regeneration (which requires NO<sub>2</sub> produced by the DOC) or generate the heat for active regeneration (which requires the DOC's exothermic reaction). The DOC must be replaced.

23. B — Engines equipped with engine brakes (Jake Brakes) have slave pistons integrated into the valve train that open the exhaust valves during the engine braking event. The slave piston lash must be adjusted to the manufacturer's specification during every overhead procedure. Incorrect slave piston lash that is too tight can hold the exhaust valve open during combustion (causing damage), and lash that is too loose reduces the exhaust valve opening during braking, diminishing braking effectiveness.

24. C — The progressive idle speed increase from 650 to 800 RPM over 10 minutes after startup is the ECM's programmed warm-up idle strategy. As the coolant temperature sensor reports the engine warming from cold-start temperature toward operating temperature, the ECM adjusts the idle speed according to its designed warm-up schedule. This strategy promotes faster catalyst light-off, reduces warm-up emissions, and provides adequate oil circulation during the critical warm-up period.

25. A — An exhaust leak between the manifold and the turbocharger allows exhaust gas to bypass the turbine wheel. The energy lost through the leak is unavailable to spin the turbine, and the compressor produces less boost because it receives less drive energy. The engine may produce reduced power under load, increased smoke from the reduced air supply, and an audible hiss or whistle from the escaping gas that varies with engine speed and load.

26. D — Extended idle and low-load operation produces low exhaust temperatures that prevent the crankcase ventilation system from reaching temperatures that keep oil vapors in their vapor state. The oil vapors in the blow-by gas condense and solidify inside the oil separator from the cold operating conditions. Over time, the solidified oil builds a blockage that restricts ventilation. Vehicles that operate predominantly at idle (PTO operations, delivery trucks) are particularly susceptible to this condition.

27. B — A static pressure test confirms the system's integrity — no external leaks exist. But a water pump with an eroded or loose impeller maintains the system's sealed integrity (the shaft seals hold) while failing to circulate adequate coolant volume. Under loaded driving, the engine generates maximum heat that requires maximum coolant flow. The failed impeller cannot deliver this flow, and the engine overheats despite passing the static pressure test.

28. A — Each common rail injector has manufacturing variations that affect its flow characteristics. The calibration code (IMA or trim code) tells the ECM the specific correction factors needed to compensate for each individual injector's variations. Without these codes, the ECM applies default values that cannot account for the individual differences, resulting in cylinder-to-cylinder fuel delivery imbalances that produce rough idle, increased emissions, and reduced fuel economy.

29. D — A slight roughness in the turbocharger shaft rotation without measurable play indicates early-stage bearing surface degradation. The bearing surfaces have developed microscopic pitting or scoring that creates the tactile roughness, but the clearances have not yet enlarged to produce measurable play. The turbocharger is serviceable for continued operation but should be monitored through oil analysis and boost pressure trending. Scheduling replacement at the next planned maintenance prevents an unplanned failure.

30. A — The governor senses system pressure and sends a signal to the compressor's unloader mechanism at the cut-out pressure. If the governor's sensing port is plugged, the signal line is kinked, or the governor's internal mechanism has failed, the compressor never receives the unload signal. The compressor pumps continuously against the system that is already at pressure, the safety valve prevents overpressure, and the compressor's duty cycle is 100%.

31. C — The trailer's relay valve converts a small-volume signal pressure from the foot valve into a high-volume delivery from the local reservoir to the brake chambers. When brakes are released, the relay valve must quickly exhaust the application air from the chambers through its exhaust port. If the exhaust port is restricted from contamination, corrosion, or a stuck internal component, the air cannot escape quickly and the brakes release slowly.

32. B — The automatic slack adjuster has over-adjusted — it has advanced the worm gear beyond the correct setting, positioning the shoes too close to the drum. The pushrod stroke measurement appears correct because the pushrod starts from a position that is already closer to the drum than it should be. The shoes never fully release from the drum surface between brake applications, generating continuous friction heat that produces the smoke and hot smell.

33. D — Brake fluid that has turned dark brown with a burnt smell has been thermally degraded from repeated exposure to excessive heat. The caliper pistons transfer heat from the brake friction surfaces through the hydraulic circuit to the fluid. Sustained or repeated overheating breaks down the fluid's chemical structure, reduces its boiling point (increasing the risk of vapor lock), and compromises its moisture resistance. The degraded fluid must be flushed and replaced with fresh fluid.

34. A — The regulation requires the low-pressure warning to activate BEFORE the pressure drops below 60 psi — the buzzer must sound while the system pressure is still above 60 psi. A warning that activates at 55 psi means the pressure dropped to 55 before the warning sounded, which means the system was below 60 psi without a warning. The truck fails the inspection because the warning did not activate before the pressure reached the 60 psi threshold.

35. C — The caliper slide mechanism (guide pins or slider rails) allows the caliper body to float so that both pads apply evenly against the rotor. When the guides are seized, corroded, or binding, the caliper cannot slide freely. The piston pushes the inboard pad against the rotor with full force, but the caliper body cannot move to pull the outboard pad against the opposite rotor face. The outboard pad scrubs against the rotor with reduced force, wearing it faster than the evenly-loaded inboard pad.

36. B — The front axle relay valve or quick-release valve has a higher crack pressure than the rear's. The crack pressure determines the minimum signal pressure needed to open the valve and deliver air to the chambers. If the front valve requires more signal pressure to open, the rear brakes begin applying at a lower pedal effort while the front brakes wait for the higher signal pressure to be reached. This creates the noticeable delay in front brake engagement.

37. D — The spring brakes apply full force (confirmed by testing) and the adjustment is correct (stroke within specification). But the foundation brake components have reached their wear limit. Severely worn linings with minimal friction area, or drums at maximum diameter that have reduced the shoe-to-drum contact geometry, reduce the mechanical advantage even though the individual measurements appear acceptable. The combined effect of worn components at their individual limits fails to produce adequate holding friction.

38. A — An empty school bus has significantly less weight on the rear axle than a loaded bus. The reduced axle weight means less normal force pressing the tires against the road, which reduces the maximum friction force available before the tires lock. The ABS activates when the braking force approaches the lockup threshold — with less weight, this threshold is lower, and the ABS intervenes at lower brake forces. Adding passengers increases the weight, raises the lockup threshold, and the ABS is no longer needed at normal brake forces.

39. B — The compressor was rebuilt and is now passing excessive oil. The most common cause of excessive oil pass-by after a rebuild is incorrect piston ring installation — rings installed upside down (with the taper facing the wrong direction), gaps aligned (allowing oil to pass through the aligned gaps), or the wrong ring installed in the wrong groove. Properly installed rings create a labyrinth seal that prevents oil from passing. Incorrectly installed rings fail to seal effectively.

40. B — The trailer hand valve has failed internally — the piston, seal, or mechanical linkage has failed and the valve cannot generate output pressure when the handle is applied. The foot valve sends its trailer signal through a different path (through the tractor protection valve and the service gladhand to the trailer's relay valve), which is why the trailer brakes respond to the foot valve. The hand valve uses its own direct path that bypasses the foot valve circuit.

41. D — The regulation's static leak test measures the pressure drop rate over a short time window (typically 1-2 minutes). A leak rate of 1.5 psi/minute passes the 2 psi/minute threshold but drains approximately 90 psi over a 1-hour parking period. The truck is technically compliant with the regulation, but the leak is significant enough to require repair. The air dryer purge valve is a common source of slow leaks that pass the static test but drain the system during extended parking.

42. A — The SAE Type designation (30/30) standardizes the effective diaphragm area, ensuring that both chambers produce the same force at the same air pressure. However, different manufacturers may have slight variations in internal return spring force, pushrod length, and diaphragm compliance that create subtle differences in application characteristics. Best practice is to match brands on the same axle to ensure identical application and release behavior on both sides.

43. C — The 3-4 second delay between pulling the parking brake valve and the spring brakes engaging indicates the hold-off air is exhausting slowly. The relay valve's exhaust port or the air line between the relay valve and the spring brake chambers has a restriction — contamination, corrosion, a kinked line, or an undersized fitting. The hold-off air cannot escape quickly enough, and the springs take 3-4 seconds to progressively extend as the air slowly vents.

44. B — Recently replaced automatic slack adjusters that all show over-stroke indicate the problem is not the adjusters themselves but the component they are trying to compensate for. Drums that have been machined too large or have worn beyond the ASA's maximum compensation range require more pushrod travel than the ASA can accommodate. The drum diameter must be checked against the maximum specification, and oversized drums must be replaced.

45. A — The anti-squeal shim (dampening layer) is installed between the pad backing plate and the caliper piston to absorb the high-frequency vibration that causes brake squeal. During light brake application, the clamping force is insufficient to dampen the pad's natural vibration against the rotor — the pad vibrates and produces the squeal. During hard braking, the increased clamping force presses the pad firmly enough to suppress the vibration. Missing or incorrect shims allow the vibration to occur unchecked.

46. D — The compressor's duty cycle (percentage of loaded time) of 40% exceeds the 25% maximum specification. The system passes the static leak test (confirming no single large leak), but the cumulative air consumption from one or more small leaks forces the compressor to run 60% longer than designed to maintain system pressure. The increased duty cycle accelerates compressor wear, generates more heat, and shortens the compressor's service life.

47. C — The ECM requires both adequate power supply voltage and a solid ground connection to initialize its internal electronics and begin communicating on the CAN bus. Without power (blown fuse, open wire, corroded connector) or ground (open ground wire, corroded ground bolt), the ECM is electrically dead and invisible to the scan tool. All other modules communicate normally because they have independent power and ground circuits that are unaffected by the ECM's power/ground fault.

48. A — Many electronic modules store their user-configurable settings (radio presets, clock, seat memory) in volatile memory that requires continuous low-current power to retain. A memory keep-alive circuit wired directly from the battery to the modules' memory power input, bypassing the main disconnect switch, maintains this power during disconnection. Without this circuit, the modules lose all stored data when the disconnect opens.

49. D — The instrument cluster has 12.4V at its power input (confirmed by measurement), but the cluster is completely dead. If the ground circuit is open, no current can flow through the cluster's electronics regardless of the voltage available at the power pin. The cluster cannot illuminate any display, move any gauge, or communicate on the CAN bus without a complete circuit. Measuring the ground pin voltage relative to battery negative confirms whether the ground is intact (near 0V) or open (voltage present).

50. B — The headlight and brake light circuits share a common ground point. When the brake lights activate, the combined current of both circuits flows through the high-resistance ground connection. The increased voltage drop across the shared resistance reduces the voltage available to the headlights. The dimming occurs only during brake application because the brake light current is only present during that event. Repairing the shared ground connection eliminates the voltage drop.

51. D — A rationality error means the sensor's output is physically within its normal operating voltage range but the value does not make logical sense when compared to other correlated data. The ECM cross-references the manifold pressure reading against barometric pressure, turbocharger boost, engine RPM, throttle position, and other related parameters. If the manifold pressure reading contradicts what these other sources indicate it should be, the ECM flags the inconsistency as a rationality error.

52. A — The alternator produces adequate voltage at its output terminal (14.2V) and adequate current. But the charging voltage must travel through the output cable, fusible link, and battery cables to reach the batteries. If this path has excessive resistance (corroded connections, deteriorated cables), the voltage drops below the effective charging level by the time it reaches the battery terminals. The batteries receive insufficient charging voltage despite the alternator's adequate output.

53. D — The turn signal operates correctly with the engine off (stable voltage from the battery) but becomes erratic with the engine running (alternator adding AC ripple to the DC system). A faulty rectifier diode in the alternator allows more AC component than normal to pass through to the DC system. This AC ripple modulates the voltage at the flasher module's timing circuit, causing the flash rate to vary with the alternator's ripple pattern.

54. B — The battery voltage is currently 12.6V (fully charged) and the charging system is 14.1V (normal). The fault code was set at some point in the past when the voltage momentarily dropped below the ECM's minimum threshold. This could have occurred during a high-current event (starter cranking, PTO engagement), a momentary loose battery connection, or a brief alternator dropout. The voltage recovered, but the stored code documents the historical event.

55. A — The right-side marker lights and the right turn signal share a common power wire. The wire's cross-section is sized for the turn signal current alone. When the turn signal activates, the additional current flowing through the shared wire creates a voltage drop that is large enough to extinguish the lower-wattage marker lights (which require less voltage to illuminate and are more sensitive to voltage reduction). The turn signal bulbs, designed for higher current, remain lit at the reduced voltage.

56. A — The telematics unit receives its fuel consumption data from the engine ECM via the CAN bus. The ECM calculates fuel consumption from the injection pulse width, fuel pressure, and injector characteristics — this is a calculated estimate, not a physical measurement. The calculated values can deviate from actual consumption due to injector calibration tolerances, fuel temperature variations, and return fuel volume that the calculation may not fully account for. Tank dipping measures actual physical consumption.

57. B — The horn relay clicks (confirming the control circuit is functional), but the horn's acoustic output is weak. The horn's internal sound-producing mechanism has degraded — a cracked diaphragm vibrates at reduced amplitude, or a partially shorted electromagnetic coil produces a weaker magnetic field that drives the diaphragm with less force. Either condition reduces the horn's acoustic energy output while still producing an audible, but inadequate, sound.

58. C — The scan tool shows stable, correct vehicle speed data from the ECM, confirming the speed data source is accurate. The erratic needle movement is internal to the instrument cluster — the stepper motor that positions the speedometer needle is either electrically malfunctioning (degraded driver transistor that intermittently loses signal) or mechanically failing (worn gear in the stepper mechanism that allows the needle to drop to zero momentarily).

59. D — The BCM detects trailer presence by monitoring the current draw on the trailer lighting circuits. When LED trailer lamps are connected, their significantly lower current draw may fall below the BCM's detection threshold (which was calibrated for higher-current incandescent lamps). The BCM correctly determines that lamps are drawing current but interprets the low current as "no trailer connected" because the draw does not meet the minimum threshold for trailer detection.

60. D — Battery cables that are warm during normal operation indicate resistance at the cable terminals or cable-to-terminal crimps. Current flowing through a resistance generates heat ( $P = I^2R$ ). Corroded terminals, loose clamp bolts, or poor crimping connections all create resistance points that convert electrical energy to heat. The progressive heat generation can damage the terminal, degrade the cable insulation, and in severe cases, ignite adjacent combustible materials.

61. B — The APP1 sensor signal reads 4.8V with the pedal fully released — far above the normal 0.5-0.8V released voltage. The signal wire is shorted to the 5V reference voltage supply wire. The short circuit bypasses the sensor's variable resistance element and delivers the reference voltage directly to the ECM's input pin. The ECM reads near-5V at all pedal positions because the signal is connected to the reference rather than through the sensor.

62. C — The rapid clicking (10-15 times per second) is the starter solenoid repeatedly engaging and releasing. The solenoid pulls in (click), the contacts close, the heavy starter motor current draw pulls the battery voltage below the solenoid's hold-in threshold, the solenoid drops out (contacts open), the voltage recovers without the load, and the cycle repeats. This confirms the batteries cannot sustain the voltage under the starter's current demand — from dead or weak batteries, corroded connections, or undersized cables.

63. A — The TCM receives two different vehicle speed values that disagree by 8 km/h. The TCM uses speed data for shift scheduling, lockup clutch control, and ratio verification. If the TCM selects one speed source for shift timing and the other for lockup control, the 8 km/h discrepancy produces shifts at incorrect speeds and lockup engagement at incorrect times. The conflicting data may also trigger a diagnostic fault code for speed sensor correlation.

64. D — The dual-filament bulb socket has a bad ground. When the turn signal activates, the turn signal filament (higher wattage) seeks ground through the tail light filament (lower wattage) instead of through the compromised ground connection. The current flows backward through the tail light filament, extinguishing it while the turn signal uses that filament as its ground return path. Repairing the ground connection provides both filaments with their proper return path.

65. B — The scan tool's ground wire provides a parallel ground path that bypasses the ECM's high-resistance ground connection. The ECM's degraded ground creates a voltage offset on its sensor inputs that the ECM interprets as a fault condition, triggering the derate. When the scan tool connects, its ground wire reduces the overall ground resistance, the voltage offset disappears, the sensor readings normalize, and the ECM removes the derate.

66. A — The ABS module broadcasts vehicle speed data on the J1939 CAN bus. The engine ECM uses this vehicle speed data as one of the inputs for its fan control algorithm. When the ABS module goes offline (ABS lamp on), the ECM loses the vehicle speed input. Without vehicle speed data, the ECM cannot determine whether the vehicle is moving and needs cooling, so it defaults the fan to full speed as a protective measure.

67. C — A wiring fault has created an unintended connection between the headlight power circuit and the backup alarm trigger circuit. When the headlights are turned on, the headlight power energizes the backup alarm through this unintended connection. The reverse switch circuit may have an open that prevents normal activation, or the alarm has multiple trigger paths and the headlight connection provides an alternate activation that overrides the reverse switch.

68. D — The crankshaft position sensor is the ECM's fundamental timing reference for fuel injection. Every injection event is timed relative to the crankshaft's angular position. An intermittent signal causes momentary loss of this timing reference — the ECM cannot determine when to inject, producing the stumble. During hot restart, the intermittent signal may not provide consistent enough data for the ECM to establish the continuous timing reference needed to start and run the engine.

69. B — The 3rd gear synchronizer's friction cone or blocker ring has worn to the point where it cannot match speeds effectively during the higher-speed-differential downshift from 4th to 3rd. Downshifts present a greater speed-matching challenge than upshifts because the input shaft must be accelerated to match the higher mainshaft speed. The worn synchronizer cannot generate adequate friction to complete this speed match before the driver advances the shift lever, causing the grind.

70. D — A whining noise that varies with output shaft speed regardless of which gear is engaged indicates the noise source is in the output path — components that rotate at output speed in every gear. The output shaft bearing or the transfer gear set (which connects the mainshaft to the output shaft) are the most likely sources. If the noise varied with engine RPM, the source would be in the input path; if it appeared only in one specific gear, the source would be that gear set.

71. A — Flywheel runout (warping or high spots) causes the pressure plate to contact the clutch disc unevenly during partial engagement. At the high spot, the clamping force increases and the disc grips; at the low spot, the force decreases and the disc slips. This alternating grip-slip cycle creates a pulsation felt through the clutch pedal. Once fully engaged, the full clamping force holds the disc regardless of the runout. When fully released, no contact exists to transmit the pulsation.

72. D — The clutch actuator position error means the actuator cannot reach the position the TCU commands. This could be a failed actuator motor (no movement), a hydraulic leak in the actuator circuit (lost force), a seized clutch mechanism (physical obstruction), or a worn clutch disc that has pushed the actuator's required travel beyond its mechanical limit. The TCU will not shift gears until it confirms the clutch is fully disengaged through the position feedback.

73. D — During a right turn, the right wheel slows relative to the left wheel. The differential's spider gears must rotate on their cross pin to accommodate this speed difference. Worn spider gear teeth, worn cross pin bores, or a dry cross pin produce the grinding noise as the gears rotate under load. The noise occurs only during right turns because that is when the right-side differential action is engaged. Left turns load the left side, and straight-line driving requires no differential action.

74. B — When the clutch pedal is depressed, the release bearing contacts the pressure plate's release mechanism and must rotate under load at engine speed. A dry or damaged release bearing produces a squeal from the metal-to-metal contact between the bearing race and the pressure plate fingers. The squeal is present only when the bearing is loaded (pedal depressed) and stops immediately when the bearing lifts off the fingers (pedal released).

75. A — All other variables (engine, tires, driving patterns, gear ratio) are identical across the fleet. Excessively tight wheel bearing preload on one or more axle positions creates continuous friction drag that the engine must overcome, consuming additional fuel. The cumulative effect of tight bearings across multiple positions can account for a measurable fuel economy penalty. The affected truck's bearing preload on all axle positions should be checked and compared to the fleet standard.

76. C — The gear position sensor's range error means it has detected a position that does not correspond to any valid gear in the transmission's configuration. The TCU cannot verify which gear is engaged, so it cannot safely execute any shift command. The TCU defaults to the known-good gear (3rd gear, which provides a reasonable balance between low-speed operation and highway capability) and reverse only, providing limp-home capability until the sensor fault is diagnosed.

77. B — A rhythmic clicking at low speed during parking lot maneuvers that corresponds to wheel rotation indicates a gear tooth defect. A chipped or broken tooth on the ring gear or pinion produces a click once per revolution as the damaged tooth contacts its mating gear at the mesh point. The clicking is most audible during low-speed maneuvering in parking lots because road noise, wind noise, and drivetrain noise at higher speeds mask the relatively quiet click.

78. D — The shift collar inside the transfer case engaged the 4WD gears while the vehicle was transmitting torque. The torque load presses the collar's teeth against the engagement teeth with force that prevents the shift motor from sliding the collar back to the 2WD position. Stopping the vehicle, shifting the transmission to neutral, or rocking the vehicle slightly relieves the torque binding and allows the shift motor to disengage the collar.

79. A — A vibration present during acceleration and deceleration (both transmitting torque) that disappears during cruise (minimal torque transfer) is torque-dependent. Unequal U-joint operating angles produce a speed fluctuation that is amplified proportionally to the transmitted torque. During cruise with minimal torque, the fluctuation is not excited. The U-joint angles must be measured and equalized to eliminate the torque-dependent vibration.

80. C — The transmission shifts normally in automatic mode but rejects the manual downshift command. The TCM has a safety interlock that prevents manual downshifts that would cause the engine speed to exceed its maximum RPM limit. If the current vehicle speed would produce an engine overspeed in the requested lower gear, the TCM blocks the downshift to protect the engine. The driver must reduce speed before the TCM will allow the manual downshift.

81. D — The clutch pedal goes to the floor with no resistance — this is a total loss of hydraulic pressure. The hydraulic clutch system uses a master cylinder, a hydraulic line, and a slave cylinder to transmit pedal force to the release bearing. A blown master cylinder piston seal, a ruptured hydraulic line, or a catastrophically leaking slave cylinder allows all hydraulic fluid to escape, eliminating the system's ability to transmit force. The clutch remains fully engaged because the release bearing is never actuated.

82. C — The noise is present only during acceleration (drive side of the gear teeth loaded) between 50 and 70 km/h and absent during deceleration (coast side loaded) at any speed. The drive-side gear mesh has a wear pattern that produces noise at specific mesh frequencies — the speed range corresponds to the RPM where the gear mesh frequency excites a resonance in the axle housing. Above and below this speed, the mesh frequency does not excite the housing's resonance and the noise is not amplified.

83. A — A rhythmic clunking at PTO shaft rotation frequency indicates a defect at one specific point on the PTO gear's circumference. A chipped or broken tooth produces a clunk once per PTO shaft revolution as the damaged section meshes with the transmission's PTO drive gear. The clunking frequency corresponds exactly to the shaft speed because the damage is at one point that contacts the mating gear once per revolution.

84. A — The TCM commands lockup and fluid pressure reaches the lockup clutch, but the clutch cannot hold. The 50 RPM speed difference confirms continuous slippage — the clutch plate is spinning against the converter housing without locking. The solenoid and apply circuit are functioning (pressure reaches the clutch), but the friction surface is worn, contaminated, or glazed and cannot generate adequate friction force to lock the plate to the housing under the engine's torque.

85. B — A two-speed rear axle does not have a synchronizer — the shift collar engages directly with the gear teeth. The shift should only be made at reduced speed or when stopped to minimize the speed difference between the collar and the gears. Shifting to low range at highway speed forces the collar to engage the low-range gears at a significant speed mismatch, producing the bang from the violent impact of the mismatched teeth. Repeated high-speed downshifts will destroy the shift mechanism.

86. C — A steering wheel oscillation at a specific speed range that disappears above and below indicates a resonance condition in the wheel/tire assembly. The assembly has a harmonic imbalance (a vibration mode) that is excited only at the rotational frequency corresponding to 90-100 km/h. Standard balancing machines may not detect this harmonic because they operate at a single test speed. Road-force balancing, match-mounting the tire to the wheel, or replacing the wheel may be needed to address the harmonic.

87. A — A knocking noise from the steering gear area that occurs once per steering wheel revolution indicates a component that has a defect at one specific rotational position. A worn input shaft bearing or a damaged internal coupling (flexible element or pot joint) produces a mechanical impact at one point in each revolution. The knock corresponds to the steering wheel's rotational frequency because the input shaft turns at the same rate as the steering wheel.

88. D — Both caster readings are individually within the specification range ( $+3.0^\circ$  to  $+4.5^\circ$ ). However, the  $1.5^\circ$  side-to-side difference causes the vehicle to pull toward the side with less positive caster ( $+3.0^\circ$  on the left). The vehicle pulls to the left because the left side has less self-centering force and less directional stability than the right. Equalizing the caster side-to-side (not just meeting the individual specification) eliminates the pull.

89. A — The total toe is within specification, but inside-edge wear on one side only suggests the individual wheel angles are not equal. The right wheel may have significantly more toe-in than the left — the total of both angles is correct but the individual contributions are unequal. The right wheel's excessive toe-in scrubs the inside edge while the left wheel tracks normally. Individual wheel toe angles must be measured and equalized.

90. C — A metallic pop during lock-to-lock steering transition indicates a component that binds and releases. The upper strut mount bearing (on strut-type suspensions) must rotate freely to allow the strut to follow the steering. A corroded or dry bearing binds under the steering force, storing energy until the force overcomes the binding. The sudden release produces the metallic pop as the bearing breaks free. The pop occurs once per direction change because the binding loads and releases during each transition.

91. A — Outside-edge wear on one side only with equal inflation pressures indicates a camber problem on the affected side. Excessive positive camber tilts the top of the wheel outward, concentrating the vehicle's weight on the tire's outside edge. The opposite side's camber is within specification, producing normal wear. Measuring and correcting the camber on the affected side equalizes the tire contact and eliminates the one-sided wear pattern.

92. D — An unauthorized weld on a heavy-duty truck frame rail creates significant structural concern. Frame rails are manufactured from specific high-strength steel alloys (often high-strength low-alloy or heat-treated steel) that require controlled welding procedures — specific filler metal, pre-heat temperatures, interpass temperatures, and post-heat treatments. A general-purpose MIG weld on these materials creates a brittle heat-affected zone that is weaker than the original material and prone to cracking under the dynamic loads of vehicle operation.

93. B — Both axles are individually aligned correctly, and the tires are the right specification and pressure. The remaining variable is the geometric relationship between the two axles — specifically their spacing. If the axle spacing has changed from its designed dimension, the geometric interaction between the two axles produces tire scrub even though each axle individually measures as correctly aligned. The spacing must be verified and corrected.

94. A — Irregular tire wear (cupping, feathering, flat spots) creates noise because each irregularity contacts the road surface and generates a sound pulse. As the speed increases, the pulse frequency increases and the noise intensifies. The noise is constant regardless of braking or steering because the irregularity is on the tire surface and contacts the road during every revolution. Rotating the tires to a non-steer position confirms whether the noise follows the tires.

95. C — Hub pilot pads center the wheel on the hub. Corroded pilot pads have an uneven surface — high and low spots from the corrosion. The wheel seats unevenly on these irregular surfaces, and the clamping force concentrates on the high spots. As the vehicle operates, the high spots compress and the corrosion breaks down under the dynamic loads, reducing the total clamping force. The nuts loosen as the compressed material yields over time.

96. D — Cold power steering fluid has high viscosity — it resists flow through the pump, hoses, steering gear, and metering orifices. The pump must work harder to circulate the thick fluid, and the metering orifices inside the steering gear cannot pass adequate flow volume for responsive assist. After 30 seconds of circulation, the fluid warms enough from the pumping friction and engine heat to reduce its viscosity to the operating range, and the steering effort normalizes.

97. B — Valve stems crack from fatigue caused by repetitive stress. A rough edge or burr in the rim's valve stem hole cuts into the rubber base of the stem during each wheel revolution. Over 3 months of continuous operation, the progressive cut weakens the stem until it cracks and leaks. The damage is specific to this wheel position because only this rim has the rough edge. Smoothing the hole edge and installing a new stem resolves the recurrence.

98. A — Maintenance-free sealed king pin assemblies are complete units with integral bearing surfaces that cannot be repacked, re-greased, or have individual components replaced. When the internal bearing surfaces wear beyond the specification, the entire assembly must be replaced as a unit. This is different from traditional greaseable king pins where the bushings can be pressed out and replaced independently of the king pin itself.

99. D — One tire running cooler than its partner on the same axle with identical specifications and inflation indicates a heat source difference. The most common heat source for drive tires is brake friction. If the cooler tire's brake is not applying (disconnected air line, failed chamber, non-functioning slack adjuster), that tire does not receive braking friction heat. The warmer tire's brake functions normally, generating friction heat that transfers through the drum and hub to the tire.

100. B — The equalizer beam bushings and center pivots have been recently replaced (ruling them out). The torque arms (torque rods) are the components that locate the axles longitudinally and laterally relative to the frame. If the torque arm bushings are worn or the arms are bent, the axles can shift laterally during cornering forces, creating the "walking" sensation. The equalizer beam handles load distribution between the axles, but the torque arms handle axle positioning.

101. C — Incorrect toe produces scrubbing on one side of each tire's tread. On a toe-in condition, the outside half of each tread scrubs and feathers while the inside half tracks cleanly. The clear dividing line at the tread center separates the scrubbing zone (where the toe angle directs the tread) from the tracking zone (where the tread rolls straight). The feathered half is always on the side corresponding to the direction of the toe error.

102. A — A replacement tie rod with a different arm length changes the steering geometry's ratio between steering wheel rotation and road wheel deflection. A shorter tie rod translates each degree of steering wheel rotation into more degrees of road wheel movement — making the steering "quicker" or more responsive. The alignment can be set to the correct toe specification with either tie rod length, but the driver feels the different steering ratio.

103. D — Frame crack repairability depends on multiple factors: the crack location (flange, web, or radius each has different structural significance), the crack length and direction (longitudinal versus transverse), the frame rail material (mild steel can be welded with standard procedures, but high-strength low-alloy and heat-treated steels require specific procedures to avoid creating brittle heat-affected zones), and whether the manufacturer has published an approved repair procedure for the specific location and material.

104. C — A leak that occurs during heavy rain but not during light rain or car-wash pressure indicates a seal that requires significant water volume and pressure to penetrate. Roof seam sealant, clearance light gaskets, and cab-mounted accessory gaskets at the highest point of the cab are the most common heavy-rain leak sources. Water enters at the roof level and travels along the headliner or internal cab structure to drip at a location that may be far from the actual entry point.

105. B — The seat hisses continuously but maintains correct height. The height control valve is rapidly cycling between adding and venting small amounts of air to compensate for a marginal condition — a slow leak, a worn valve, or an unstable sensor. The seat holds height because the valve successfully compensates, but the continuous cycling produces the audible hiss. The valve, air spring, fittings, and supply lines must be inspected for the condition causing the continuous compensation.

106. D — The cab tilts forward normally (hydraulic pressure extends the cylinder), but the cab's weight cannot push the cylinder's piston back to lower the cab. The lowering function depends on oil flowing back through the return circuit to the reservoir. A failed check valve, a restricted return line, or a blocked port in the lowering circuit prevents the oil from exiting the cylinder fast enough for the cab to lower under its own weight.

107. A — The wiper motor receives full system voltage on the high-speed circuit (which bypasses the speed control components), but the low and intermediate speeds depend on resistors or an electronic module to reduce the voltage. When the speed control component fails, the motor defaults to the high-speed direct-power path. The motor itself is functional at all speeds — the fault is in the speed-reducing components that cannot limit the voltage for lower speeds.

108. C — A blurred mirror image that cannot be corrected by angle adjustment and has no visible cracks indicates surface-level damage to the mirror glass. Chemical etching from de-icing spray, solvent overspray, or abrasive cleaning pads creates microscopic surface damage that scatters the reflected light. The damage is permanent and the mirror glass must be replaced to restore a clear reflection.

109. A — Trailer roof panels are thin-gauge aluminum or fiberglass stretched between structural roof bows. The skin cannot support concentrated loads between the bows. Walking on the unsupported areas creates depressions that collect water, snow, and ice — accelerating corrosion, adding weight, and potentially leaking into the cargo area. Roof-top work requires walking platforms or planks to distribute the worker's weight across multiple roof bows.

110. D — All brake positions have accelerated pad wear simultaneously — from 100,000 km life to 40,000 km. This universal condition points to a systemic cause rather than an individual caliper fault.

Contamination in the brake fluid (moisture or petroleum-based product) that has swollen all caliper piston seals prevents the pistons from fully retracting after each application. The continuously extended pistons hold all pads in light contact with the rotors, generating continuous wear.

111. B — The bottom flange of an I-beam carries the tensile load when the beam is loaded from above (which is the normal loading condition for a trailer). A 15% reduction in bottom flange thickness from corrosion proportionally reduces the flange's cross-sectional area and its tensile load capacity. The trailer's rated payload must be reassessed based on the reduced flange dimensions, and the corrosion must be treated to prevent further material loss.

112. A — The TRU compressor short-cycles every 90 seconds (30 seconds on, 60 seconds off). The most common cause is the high-pressure switch tripping from elevated discharge pressure. A dirty condenser, a failed condenser fan, or excessive refrigerant charge all cause the discharge pressure to rise rapidly to the switch's trip point. The 60-second off period allows the pressure to equalize below the switch's reset point, and the cycle repeats.

113. C — Rub rails that extend 50 mm beyond the trailer's legal maximum width violate dimensional regulations. Overwidth vehicles require special permits and operating restrictions. The protruding rails also create a side-swipe hazard to adjacent vehicles and infrastructure during normal driving. The rails must be straightened to their original position or replaced to bring the trailer within its legal width.

114. D — The landing gear was not extended before the trailer was disconnected from the tractor. With the legs retracted and no tractor support, the trailer's nose dropped to the ground. The impact likely damaged the front crossmember, deformed the king pin area, bent or ruptured the brake and electrical connections at the nose, and may have cracked the trailer frame at the gooseneck. The landing gear may also be damaged from the weight bearing on the retracted legs.

115. B — Sliding tandem suspensions ride on slider rails that must be clean and lubricated for the tandem to move freely. Corrosion buildup, road debris accumulation, and lack of lubrication dramatically increase the friction between the slide pads and the rails. The tractor cannot generate enough force to overcome this friction through the fifth wheel coupling. Cleaning and lubricating the rails and verifying the locking pins are fully retracted restores slide function.

116. B — Conspicuity tape contains microscopic glass beads or prismatic elements that retroreflect light back to its source. UV exposure and weathering degrade these reflective elements over the tape's service life, reducing its reflective performance below the minimum standard required by CMVSS 108. The

faded tape must be replaced with new tape that meets current reflectivity requirements to maintain the trailer's nighttime visibility and regulatory compliance.

117. C — The condenser fins are partially blocked with debris (bugs, leaves, dirt, road grime). At highway speed, the significant ram airflow forces enough air through the partially blocked condenser for adequate heat rejection. At city speeds, the reduced ram airflow combined with the debris blockage limits the condenser's ability to reject heat. The high-side pressure rises, the expansion valve receives warmer liquid refrigerant, and the cooling performance degrades.

118. B — The sweet odor of ethylene glycol coolant is the characteristic early warning sign of a heater core micro-leak. The leak is too small to produce visible dripping but large enough to vaporize coolant into the HVAC airstream. The blower distributes the coolant vapor throughout the cab. This is an early stage of heater core failure — the leak will progressively worsen until visible coolant appears on the cabin floor and the windshield develops a film from the glycol vapor.

119. D — A proper vacuum hold should maintain the achieved vacuum level throughout the test period. The rising reading from 500 to 1,500 microns over 30 minutes indicates atmospheric air is entering the system through a leak. The leak allows air and moisture into the system that will cause operational problems after charging. The leak must be located (using an electronic leak detector or nitrogen pressure test) and repaired before the system is recharged.

120. A — The defroster effectively clears the windshield (confirming the HVAC system produces adequate heated, dry air), but the side windows remain fogged. The defroster ductwork may not include dedicated outlets for the side windows, or existing outlets may be blocked, disconnected, or misaimed. Adding, repairing, or redirecting side-window defrost outlets ensures the heated air reaches the side window surfaces.

121. C — The new expansion valve has a lower flow rating than the original specification. The reduced refrigerant flow through the evaporator causes the small amount of refrigerant that does enter to absorb heat more completely (higher superheat), producing a colder evaporator temperature than the design intent. However, the reduced total refrigerant volume passing through the evaporator limits the system's total cooling capacity, and the system may not perform adequately under high ambient temperature conditions.

122. B — The heating element is a resistance wire grid that should distribute heat evenly across the entire mirror surface. A partial open circuit (break) in the element forces all current through a shorter path — the remaining functional section heats intensely while the disconnected section receives no

current and stays cold. The total element resistance has changed (lower, since the path is shorter), which also increases the current through the functional section.

123. D — The evaporator unit produces adequate cooling (confirmed near the unit), but the far end of the bus is warm. The distribution ductwork between the evaporator and the rear of the bus has a failure — a collapsed section, a disconnected joint, or a blockage that prevents the cooled air from reaching the distant passengers. The upstream passengers receive cooling because they are between the evaporator and the ductwork failure. Inspecting the duct system's entire length identifies the failure point.

124. A — The extend circuit operates smoothly (its valve spool is clean), but the retract circuit has a jerky, stick-slip motion. The retract valve spool has contamination (particles or varnish) on its surface that creates areas of increased friction. The spool sticks at these points, then breaks free and moves abruptly when enough pilot force overcomes the friction. This stick-slip cycle produces the jerky retraction while the extend spool operates independently and smoothly.

125. C — The system overheats within 30 minutes even in standby with no functions commanded. The heat is generated by the pump continuously converting hydraulic energy to heat — either through internal bypass from pump wear (fluid circulating through the pump's clearances) or through continuous flow across the relief valve (if the relief is set near the standby pressure). Both conditions waste the pump's output as heat rather than performing useful work.

126. D — The boom telescope cylinder drifts outward (extends) under load during standby. The load pushes against the retract side of the cylinder, and the pressurized fluid on the retract side is escaping through an internal leak path to the extend side. The leak source could be the counterbalance valve, the pilot-operated check valve, or the directional valve spool. Each must be tested individually by isolating it from the circuit and checking for continued drift.

127. D — The heat exchanger bypass valve or thermostat routes fluid around the cooler when cold (to allow faster warm-up) and through the cooler when hot (for heat rejection). If the bypass is stuck in the open position, the fluid continuously routes around the cooler regardless of temperature. No cooling occurs because the fluid never passes through the heat exchange surfaces. The system overheats because its heat rejection mechanism is bypassed.

128. A — Volumetric efficiency is the ratio of flow at load to flow at no load:  $(14 \text{ GPM} / 20 \text{ GPM}) \times 100 = 70\%$ . This means 30% of the pump's output at rated pressure is lost to internal leakage through worn clearances. Most manufacturers specify a minimum acceptable volumetric efficiency of 80-85%.

At 70%, the pump has significant internal wear that reduces system performance and generates excess heat. The pump should be rebuilt or replaced.

129. A — The function operates normally for the first 10 cycles, then progressively slows. After a 5-minute rest, it operates normally again for 10 cycles. This pattern matches a thermal expansion issue — the directional valve spool for the packer extend circuit heats from repeated cycling. The heated spool expands and begins to bind in the valve body, progressively restricting flow. The 5-minute rest allows the spool to cool, contract, and restore normal clearance.

130. B — Adding fluid to the pump inlet port provides some initial priming, but the correct method is to fill the reservoir to the proper level and then briefly jog the motor or engine to allow the pump to self-prime through its normal suction path. Running a hydraulic pump dry — even for a fraction of a second — can cause immediate surface damage to the pump's precision-machined internal components. Pre-filling the pump and ensuring the reservoir is at the correct level before starting prevents dry-running damage.

131. D — The outrigger extends fully but cannot hold the vehicle's weight — it slowly retracts under load. The cylinder is leaking internally (piston seal bypass) or the holding valve (pilot-operated check valve or counterbalance valve) is leaking. Fluid escapes from the pressurized side of the cylinder through an internal leak path. This is a critical safety issue — losing outrigger support during aerial work can cause the vehicle to tip. The specific leak source must be isolated by testing the cylinder and valve separately.

132. A — The three-phase inverter converts DC battery voltage to three-phase AC for the traction motor. Each phase must deliver equal current for balanced motor operation. A fault in one phase's power module, gate driver, or current sensor produces an unbalanced power supply to the motor. The unbalanced power reduces total torque output, can cause motor vibration, and the ECU detects the imbalance through its current monitoring system.

133. C — As the battery ages, its internal resistance increases and its usable capacity decreases. The BMS must limit the maximum regenerative charging current to protect the degraded cells from overcurrent damage — exceeding the maximum charge rate causes lithium plating, heat generation, and accelerated cell degradation. The reduced maximum charging current directly translates to reduced regenerative braking torque from the traction motor, which the driver perceives as weaker regenerative braking.

134. B — Standard automotive coolant contains dissolved ions from corrosion inhibitor additives (sodium, potassium, silicate, phosphate) that make it electrically conductive. Adding conductive coolant to a dielectric cooling circuit creates an electrical path between high-voltage components and the vehicle chassis through the conductive fluid. A coolant leak would then present a shock hazard. Only the specified dielectric coolant, which does not conduct electricity, may be used.

135. D — At 20% SOC, the battery's voltage sags significantly under high current draw, and the cells are approaching the minimum safe voltage threshold. The VCU limits maximum motor power output to prevent the cell voltage from dropping below the minimum safe level under load. This power limitation directly limits the vehicle's maximum speed because the motor cannot produce the torque needed for higher speeds. The limitation protects the cells from deep discharge damage that would permanently reduce their capacity.