PRACTICE EXAM 15: ASE A8 ENGINE PERFORMANCE FULL-LENGTH SIMULATION

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50 Questions | 75 Minutes

DOMAIN A — GENERAL DIAGNOSIS (Questions 1–12)

1. A vacuum gauge at idle shows a steady 12 in/Hg that does not fluctuate. RPM is normal at 750. When the timing connector is disconnected and base timing is set to specification, the vacuum reading rises to 18 in/Hg. What does this indicate?

A. A vacuum leak is present — the vacuum increase confirms unmetered air was lowering idle vacuum

B. Worn piston rings causing low compression and low vacuum that temporarily improves with timing correction

C. A stuck EGR valve reducing vacuum that responds when timing reference is removed

D. Ignition timing was retarded beyond specification causing the steady low vacuum at idle

2. A compression test on a 4-cylinder engine shows cylinder 1 at 170 psi, cylinder 2 at 80 psi dry and 155 psi wet, cylinder 3 at 168 psi, and cylinder 4 at 165 psi. What does this MOST likely indicate?

A. A head gasket breach between cylinder 2 and the coolant jacket

B. Worn or damaged piston rings on cylinder 2

C. A burned valve on cylinder 2 — wet test improvement confirms the rings are also affected

D. Carbon deposits reducing combustion volume on cylinder 2 corrected by oil addition

3. An engine produces a deep knock from the bottom of the engine that is loudest under hard acceleration, decreases at idle, and is present at all operating temperatures. Oil pressure is confirmed normal. What is the MOST likely cause?

A. Worn main or connecting rod bearings — a load-sensitive bottom knock with normal oil pressure is the defining pattern

B. A failed harmonic balancer producing a load-sensitive knock at the front lower area of the engine

C. Piston slap from excessive bore clearance that is most pronounced under the cylinder pressures of acceleration

D. A cracked flywheel producing a knock that increases under the torque loading of acceleration

4. A cylinder leakage test on cylinder 1 shows 18% leakage with air escaping from the throttle body opening and the oil filler cap simultaneously. What does this indicate?

A. The exhaust valve on cylinder 1 is leaking, directing air into both the intake and exhaust systems

B. A cracked cylinder head on cylinder 1 creating multiple internal leak paths simultaneously

C. Both the intake valve and piston rings on cylinder 1 have failed simultaneously

D. A head gasket breach on cylinder 1 is the only fault — both leak paths are secondary outlets from the same breach

5. An engine has a consistent misfire at idle that completely resolves above 2,000 RPM. Compression and leakage are confirmed normal. Fuel pressure is correct. Ignition is confirmed on all cylinders. What should the technician check NEXT?

A. The IAC valve for a fault causing insufficient idle airflow that results in an overly rich mixture at idle

B. The MAF sensor for an idle-specific fault causing incorrect fuel delivery calculation at idle only

C. The spark plugs for wide gap settings that misfire under the low cylinder pressure conditions of idle only

D. The EGR valve for a stuck-open condition diluting the idle mixture and causing the idle-specific misfire

5. An engine has an idle-only misfire that resolves completely above 2,000 RPM. Compression, leakage, fuel pressure, and ignition are all confirmed normal. What should the technician check NEXT?

A. The IAC valve for insufficient idle airflow causing a rich mixture at idle

B. The MAF sensor for an idle-specific fault

C. The spark plugs for wide gap settings that fail only under idle cylinder pressure

D. The EGR valve for a stuck-open condition diluting the idle mixture

6. A cooling system pressure test is performed on a cold engine. The system pressurizes to 16 psi and holds steady for 25 minutes with no drop. What does this confirm?

A. The head gasket is intact — a combustion leak test is still necessary to confirm no combustion gas intrusion

B. No internal or external cooling system leaks are present at the applied test pressure

C. The water pump is functioning correctly and maintaining system pressure

D. The cooling system thermostat is in the correct position during the cold pressure test

7. A relative compression test shows all cylinders with similar speed and amperage except cylinder 5, which cranks at a noticeably faster speed than all others. The fuel injectors are disabled during the test. What does this indicate?

A. Cylinder 5 has increased compression from carbon buildup causing higher resistance to cranking

B. The CKP sensor produces a stronger signal near cylinder 5 causing an incorrect speed reading

C. Cylinder 5 has reduced compression and is offering less resistance to the starter motor

D. A loose spark plug on cylinder 5 is reducing compression seal and affecting the crank speed reading

8. An engine has a ticking from the top of the engine that is present only at cold start and disappears within 15 seconds regardless of oil pressure reaching normal levels. What is the MOST likely cause?

A. A hydraulic lifter that has bled down during shutdown and recovers immediately once any oil pressure is established at startup

B. Excessive valve clearance from a worn camshaft lobe that disappears with thermal expansion after cold start

C. A sticking valve that frees itself within seconds of initial oil circulation reaching the valvetrain

D. Timing chain slack that is taken up immediately by the tensioner once minimal oil pressure is present

9. An engine has a P0300 random misfire with no other codes stored. All cylinders show normal compression and leakage. Fuel pressure and delivery are confirmed normal. A scope test of all ignition waveforms shows all coils producing normal primary and secondary patterns. A cylinder contribution test shows cylinder 4 contributing 20 RPM less than all others at idle. What should the technician check NEXT?

A. The fuel injector on cylinder 4 for a restriction causing slightly lean delivery on that cylinder specifically

B. A vacuum leak near the cylinder 4 intake port causing a slightly lean condition on that cylinder

C. The compression on cylinder 4 more thoroughly — a borderline ring or valve fault may not be apparent on initial testing

D. The PCM driver circuit for cylinder 4 for a fault causing slightly reduced coil energy on that specific cylinder

9. A cylinder contribution test shows cylinder 4 contributing 20 RPM less than all others. Compression, leakage, fuel pressure, and ignition are all confirmed normal. What should the technician check NEXT?

A. The cylinder 4 fuel injector for a restriction causing slightly lean delivery

B. A vacuum leak near the cylinder 4 intake port

C. Cylinder 4 compression more thoroughly for a borderline fault not apparent on initial testing

D. The PCM driver circuit for cylinder 4 for reduced coil energy

10. An engine has a persistent oil consumption complaint of approximately 1 quart per 1,000 miles. Blue smoke is visible under hard acceleration. At idle and light throttle there is no smoke. Compression is normal on all cylinders. What is the MOST likely cause?

A. Worn valve stem seals drawing oil under the high intake vacuum that develops during hard acceleration

B. Worn oil control rings allowing oil to be carried into the combustion chamber under the high cylinder pressures of hard acceleration

C. A stuck-open PCV valve drawing excessive oil vapor into the intake specifically under acceleration airflow conditions

D. A leaking turbocharger seal allowing oil into the intake specifically under boost conditions during hard acceleration

11. A snap-throttle vacuum test shows the needle drops sharply to zero at snap-throttle, momentarily overshoots to 5 in/Hg above the original baseline, then settles back to normal idle vacuum within 1 second. What does this pattern MOST likely indicate?

A. A large vacuum leak that momentarily reverses flow during the snap-throttle transition

B. Worn piston rings that allow brief combustion gas entry during the snap-throttle power stroke

C. Normal snap-throttle vacuum response with no fault indicated

D. A stuck-open EGR valve allowing exhaust gas to momentarily spike the vacuum reading above baseline

12. A no-start condition exists. Spark is confirmed at all cylinders during cranking. Fuel pressure is 59 psi. Injector pulse is confirmed on all cylinders. Compression is 168 psi on all cylinders. A vacuum gauge connected to the intake manifold shows zero vacuum during cranking. What does this indicate?

A. The engine's valve timing is severely off — correct cranking should produce manifold vacuum as pistons pull air through open intake valves

B. The throttle is stuck closed, preventing air entry and causing the zero vacuum reading during cranking

C. The MAF sensor has failed — zero vacuum confirms no airflow is being measured during cranking

D. A large intake manifold vacuum leak is preventing vacuum from building during cranking

DOMAIN B — IGNITION SYSTEM DIAGNOSIS AND REPAIR (Questions 13–20)

13. A spark plug removed from a cylinder shows a shiny, wet black deposit with a strong fuel smell covering the insulator and electrode. Minimal electrode wear is present. What does this indicate?

A. Carbon fouling from rich combustion at operating temperature

B. Oil fouling from worn valve stem seals or rings coating the plug with oil deposits

C. Normal deposits on a plug at the end of its recommended service interval

D. Fuel fouling — the plug is wet with raw fuel from a misfire or flooding condition preventing combustion

14. A P0354 ignition coil D fault code is stored. Battery voltage is confirmed at the coil D supply terminal. The PCM command wire shows 0 volts both at rest and when the PCM commands the coil. No spark is produced. What should the technician check NEXT?

A. The PCM for an internal driver fault — confirmed supply with zero volts at rest and commanded indicates a driver that cannot switch

B. The PCM output driver for coil D for an open or shorted condition preventing both resting voltage and switching signal

C. The coil D primary winding for an open preventing the PCM command signal from pulling the wire to ground

D. The wiring between the PCM and coil D connector for an open or short to ground holding the signal at zero

14. A P0354 code is stored. Coil D supply voltage is confirmed. The PCM command wire shows 0 volts at rest and when commanded. No spark. What should the technician check NEXT?

A. The PCM for an internal driver fault

B. The PCM output driver for coil D or wiring for a short to ground holding the signal at zero

C. The coil D primary winding for an open

D. The wiring between PCM and coil D for an open

15. A secondary ignition scope waveform shows a normal firing line on all cylinders. One cylinder shows a firing line at the correct height but the spark line is completely absent — the waveform drops directly from the firing line to the oscillation section. What does the absent spark line MOST likely indicate?

A. A weak coil producing insufficient energy to sustain an arc after the initial firing voltage spike

B. A high-resistance plug wire causing the arc to extinguish immediately after initiation

C. A shorted or fouled spark plug that cannot sustain an arc — the alternate conduction path extinguishes the arc immediately after firing

D. A wide spark plug gap requiring all available secondary energy to initiate the firing line with nothing remaining for arc sustain

16. A Hall effect CKP sensor produces a correct square wave on a lab scope. A technician tests the same sensor with a DVOM set to frequency. The meter reads 233 Hz at idle. What is the correct interpretation of this reading?

A. A frequency reading of 233 Hz at idle confirms the sensor is switching correctly — this reading is consistent with the number of teeth on the reluctor wheel times engine RPM divided by the appropriate conversion factor

B. The 233 Hz frequency indicates the sensor is switching too rapidly — a correct CKP sensor should produce less than 100 Hz at idle

C. The DVOM frequency reading confirms signal integrity but cannot confirm correct waveform shape

D. A 233 Hz reading confirms a reluctor wheel tooth count error — the frequency should match engine RPM directly

17. A waste spark ignition system has a misfire on cylinders 2 and 5. These two cylinders are paired on the same coil. The coil is swapped to the position serving cylinders 1 and 6. After clearing codes and a test drive, P0301 and P0306 set and P0302 and P0305 do not return. What does this confirm?

A. The spark plugs on cylinders 2 and 5 have simultaneously failed and require replacement

B. Both plug wires serving cylinders 2 and 5 have high resistance and are the cause of the misfires

C. The PCM driver circuit for the cylinder 2 and 5 coil position has a fault remaining at that position

D. The coil originally serving cylinders 2 and 5 has failed and is the cause of both misfires

17. On a waste spark system, the coil serving cylinders 2 and 5 is moved to the position serving cylinders 1 and 6. After clearing and a test drive, P0301 and P0306 set while P0302 and P0305 do not return. What does this confirm?

A. The spark plugs on cylinders 2 and 5 have simultaneously failed

B. Both plug wires on cylinders 2 and 5 have high resistance

C. The PCM driver circuit for the cylinder 2 and 5 position has a fault

D. The coil originally serving cylinders 2 and 5 has failed

18. A magnetic reluctance CKP sensor waveform shows a consistent pattern at idle but at 3,000 RPM the amplitude decreases uniformly on all teeth and the waveform becomes difficult to read. The air gap is confirmed correct. What is the MOST likely cause?

A. The reluctor wheel has uniform surface oxidation reducing the magnetic field change at all teeth at high speed

B. A wiring fault creating high resistance in the sensor circuit that only becomes significant at high-frequency signal output

C. Normal behavior — magnetic reluctance sensor amplitude decreases at higher RPM as the signal frequency increases

D. The PCM input circuit has a frequency-dependent impedance that attenuates the signal above a specific threshold

19. A distributor cap is removed for inspection. The rotor contacts the center terminal correctly. One cap terminal is found to have the tip completely burned away — only a stub remains where the terminal extended toward the rotor. What is the MOST likely cause?

A. Arcing between the rotor tip and that specific cap terminal from excessive rotor-to-cap clearance

B. Carbon tracking that has deposited carbon on that terminal creating a conductive path that burned the tip over time

C. High secondary voltage concentrating at that specific terminal from a partial resistance fault in the associated plug wire

D. Normal wear — distributor cap terminals erode from repeated high-voltage arcing over their service life

20. A COP system has a confirmed misfire on cylinder 3. The cylinder 3 coil is swapped with the cylinder 7 coil. The misfire moves to cylinder 7. The cylinder 3 spark plug is then swapped with the cylinder 7 plug. The misfire remains on cylinder 7. What does this sequence confirm?

A. The coil originally on cylinder 3 has failed — the misfire moved with the coil and remained after the plug swap confirming the plug is not the cause

B. Both the coil and spark plug from cylinder 3 have failed simultaneously and both require replacement

C. The cylinder 3 spark plug is fouled — it moved with the coil to cylinder 7 and caused the misfire to remain there

D. The PCM driver circuit for cylinder 3 has a fault — the misfire moved with the coil confirming a driver fault at the new coil position

DOMAIN C — FUEL, AIR INDUCTION, AND EXHAUST SYSTEMS (Questions 21–30)

21. A returnless fuel system shows 60 psi at key-on. After 10 minutes with the key off, pressure drops to 55 psi. After 2 hours, pressure drops to 52 psi. After 8 hours overnight, pressure drops to 48 psi. What is the MOST likely cause?

A. A failed pump check valve allowing rapid drain-back after shutdown

B. A stuck-open fuel pressure regulator bleeding pressure through the return circuit

C. An external fuel line with a slow seep not detectable visually

D. Normal thermal pressure decay — slow overnight pressure loss in the range described is within acceptable limits for many returnless systems

22. A scan tool shows LTFT at +21% on both banks at idle that drops to +3% at 2,500 RPM. MAF reads 4.9 g/s at idle — within specification. No vacuum leaks are found on a standard smoke test. What should the technician check NEXT?

A. The fuel injectors for restriction causing lean delivery at idle only

B. The upstream O2 sensors for simultaneous contamination causing false lean readings at idle

C. The MAF sensor for a dynamic contamination fault that underreads at idle despite passing a static voltage test

D. The fuel pressure for a drop at idle that recovers under the higher pump output of 2,500 RPM

23. A port injection engine has a P0087 fuel rail pressure low code. Fuel pressure is 44 psi at idle against a 58 psi minimum. Pinching the return line raises pressure to 58 psi immediately. Releasing the return line causes pressure to drop back to 44 psi. What is the correct interpretation?

A. The fuel pump has insufficient volume output — the return line pinch test confirms pump weakness

B. The fuel pressure regulator is stuck open or has a weakened spring allowing excessive fuel return

C. The fuel filter is restricted — the return line pinch test bypasses the filter and confirms adequate pump output

D. A leaking injector is bleeding pressure through an open injector circuit — the return line pinch isolates this path

24. A scan tool shows MAP reading 99 kPa at idle on a sea-level vehicle. Specification at idle is approximately 25–45 kPa. No codes are stored. What is the MOST likely cause?

A. A MAP sensor vacuum supply hose that is disconnected or blocked — the sensor is reading atmospheric pressure rather than manifold vacuum

B. A MAP sensor internal short to the 5-volt reference producing a maximum output reading

C. A large vacuum leak collapsing manifold vacuum to near-atmospheric pressure at idle

D. A PCM MAP input circuit fault causing the signal to default to a maximum value

25. A GDI engine has low power under all load conditions. The high-pressure fuel rail reads 450 psi at idle against a 500–700 psi specification. The low-pressure pump delivers 65 psi to the high-pressure pump inlet — within specification. What is the MOST likely cause?

A. A leaking high-pressure injector bleeding rail pressure continuously below specification

B. A high-pressure rail pressure sensor reading low — the actual rail pressure is within specification

C. A worn or failing high-pressure mechanical pump unable to generate adequate pressure from the confirmed correct low-pressure supply

D. A high-pressure fuel return circuit restriction causing pressure loss between the pump and the rail

26. A naturally aspirated engine has LTFT at +2% on both banks at idle and +2% at cruise. A propane enrichment test near the brake booster vacuum hose connection improves idle quality immediately. What does this confirm?

A. A vacuum leak at the brake booster hose connection is confirmed as the cause of the lean condition

B. The brake booster hose is the source of supplemental air — the propane test is being misapplied at a non-intake location

C. The propane test at a booster hose confirms a lean condition that is upstream of the throttle body

D. The brake booster diaphragm has ruptured and is drawing engine vacuum into the booster and affecting intake

26. LTFT is +2% on both banks. Propane enrichment near the brake booster vacuum hose connection immediately improves idle quality. What does this confirm?

A. A vacuum leak at the brake booster hose connection is confirmed as the cause of the lean condition

B. The brake booster hose is not an intake location — the propane test is being misapplied

C. The propane test at the booster hose confirms a lean condition upstream of the throttle body

D. The brake booster diaphragm has ruptured and is drawing intake vacuum into the booster

27. A turbocharged engine has correct boost at all RPM. Under hard deceleration from highway speed, a loud single pop or backfire is heard from the intake. No codes are stored. What is the MOST likely cause?

A. A lean surge condition during deceleration fuel cutoff causing a combustion event in the exhaust

B. A blow-off valve or bypass valve that is stuck closed — boost pressure reverses through the compressor under deceleration causing compressor surge and an intake pop

C. A stuck-open wastegate that releases exhaust pressure rapidly during deceleration causing an audible pulse

D. Deceleration fuel cutoff causing unburned air to ignite from residual exhaust heat in the catalytic converter

28. A fuel pressure test shows correct idle pressure and correct WOT pressure. Under a sustained moderate cruise load, fuel pressure begins dropping progressively from 57 psi to 42 psi over 5 minutes of driving. After the vehicle sits for 10 minutes, pressure recovers to 57 psi and the pattern repeats. What is the MOST likely cause?

A. A fuel pump that overheats under sustained operation causing thermal reduction in output volume and pressure

B. A fuel pressure regulator that drifts open under sustained thermal load causing progressive pressure loss

C. A fuel filter with increasing restriction under sustained flow that clears during the rest period from fuel backwash

D. A fuel supply line that develops a partial flow restriction from heat-induced liner swelling that recovers when cool

29. A naturally aspirated engine has normal idle performance. Under hard acceleration above 4,500 RPM, the engine begins misfiring on multiple cylinders. Fuel pressure is confirmed correct. Compression is confirmed normal. What should the technician check NEXT?

A. The ignition coils for a fault that only manifests under the high-frequency demands of elevated RPM

B. The fuel injectors for restriction causing lean misfires under the high-volume demand of hard acceleration at elevated RPM

C. The ignition secondary circuit — plug wires, coil boots, or spark plug gaps — for a high-RPM voltage demand fault

D. The MAF sensor for a fault causing incorrect fuel delivery calculation above a specific RPM threshold

30. A vehicle has correct idle performance and normal power at all RPM. It fails a tailpipe emissions test for HC only. LTFT is +1% on both banks. No misfire codes are stored currently, but a P0304 misfire code was stored and is now inactive. What is the MOST likely cause?

A. A partially degraded catalytic converter with reduced HC oxidation efficiency under load

B. An intermittent ignition fault on cylinder 4 that is currently inactive but was delivering unburned HC during the emissions test

C. A lean air-fuel mixture causing incomplete combustion and elevated HC across all cylinders

D. An intermittent cylinder 4 misfire delivering unburned HC to the exhaust during the emissions test cycle — the inactive P0304 directly identifies the source

DOMAIN D — EMISSIONS CONTROL SYSTEMS (Questions 31–37)

31. A PCV system is tested. The PCV valve rattles correctly and strong vacuum is confirmed at the intake manifold PCV port. The fresh air inlet is confirmed unobstructed. An oil consumption complaint persists at 1 quart per 800 miles. No external oil leaks are visible. Crankcase pressure is confirmed normal with the PCV connected. What should the technician check NEXT?

A. A preliminary compression and leakage test to assess ring seal before attributing consumption to valve stem seals or other internal paths

B. The valve stem seals for excessive wear allowing oil to be drawn into the combustion chambers at a rate exceeding 1 quart per 800 miles

C. The PCV valve for a stuck-open condition bypassing flow restriction and drawing oil vapor at a high rate despite normal crankcase pressure

D. The crankcase ventilation fresh air inlet for a partially blocked condition despite the primary inlet test showing unobstructed flow

32. A vehicle has elevated HC and CO on a tailpipe test. LTFT is +1% on both banks. No misfire codes are stored. What is the MOST likely cause?

A. An ignition system fault causing misfires below the PCM's detection threshold — the elevated HC and CO with neutral trims confirms combustion failure without a mixture fault

B. A rich air-fuel mixture producing elevated HC and CO from excess fuel — the negative trims confirm the fuel excess

C. A lean air-fuel mixture causing incomplete combustion — elevated HC at the lean limit combined with CO production

D. A catalytic converter failure allowing elevated HC and CO to pass through without oxidation

33. A P0440 general EVAP fault is stored with no specific component codes. The fuel cap seals correctly on a pressure test. A standard smoke test reveals no leaks. A low-pressure smoke test reveals a very minor seep at the fuel tank pressure sensor O-ring. What is the correct repair?

A. Clear the code and monitor — a fuel tank pressure sensor O-ring seep is below the typical repair threshold

B. Replace the fuel cap as a precaution alongside the pressure sensor O-ring

C. Replace the fuel tank pressure sensor O-ring or the sensor assembly and retest with the smoke machine

D. Replace the charcoal canister as the seeping O-ring may have compromised canister sealing integrity

34. A vehicle has elevated NOx on an emissions test. EGR is confirmed operational with confirmed flow on a vacuum test. Fuel trims are +1% on both banks. Ignition timing is confirmed correct. What should the technician check NEXT?

A. The EGR differential pressure sensor for under-reporting actual EGR flow to the PCM

B. The upstream O2 sensors for contamination causing lean overcorrection that elevates combustion temperature

C. The catalytic converter rhodium reduction catalyst for degraded NOx conversion efficiency under load

D. The combustion chambers for excessive carbon deposits raising effective compression ratio and combustion temperature

35. A vehicle has a P0135 upstream O2 sensor heater fault on bank 1. Battery voltage is confirmed at the heater supply wire. Ground resistance at the PCM heater control circuit is 0.3 ohms. The heater element resistance is 8.4 ohms against a specification of 8–12 ohms. What is the MOST likely cause?

A. The heater element resistance is at the lower end of specification — the PCM is detecting borderline current draw and setting the code

B. The PCM heater control ground circuit has high resistance at 0.3 ohms — this is above the maximum acceptable ground resistance

C. The heater element has failed — 8.4 ohms is outside the 8–12 ohm specification

D. The battery voltage supply to the heater is marginal — a slight voltage drop is causing the PCM to detect insufficient current flow

36. An AIR system cold start test shows the pump running and check valves confirmed open. The upstream O2 sensor on bank 1 shows a strong lean response for the full 30 seconds of pump operation. The upstream O2 sensor on bank 2 shows a strong lean response for the first 8 seconds then returns to normal switching despite the pump continuing to run. What should the technician inspect on bank 2?

A. The bank 2 AIR check valve for a fault allowing exhaust to back-flow through the delivery tube after initial operation

B. The bank 2 upstream O2 sensor heater for a fault causing premature activation and masking the ongoing lean signal

C. The bank 2 AIR distribution tube for a partial blockage that develops after initial flow warms and expands the restriction

D. The AIR pump for reduced output affecting only the bank 2 side of its internal impeller after initial operation

37. A vehicle has a P0420 catalyst efficiency code. The downstream O2 sensor on bank 1 switches at approximately 0.8 cycles per second. The upstream O2 sensor switches at approximately 0.9 cycles per second. LTFT is +1% on bank 1. What does the downstream switching rate relative to the upstream indicate?

A. The downstream sensor is switching at nearly the same rate as the upstream sensor — the catalyst has lost its oxygen storage capacity and the P0420 is valid

B. The catalyst is still buffering the exhaust to some degree — the slight rate difference suggests marginal efficiency that may or may not require replacement

C. The downstream sensor is switching slower than the upstream sensor — this confirms the catalyst is functioning correctly and the P0420 is a false positive

D. The 0.8 cycles per second downstream rate confirms the sensor has slow response — P0133 should be checked before condemning the catalyst

DOMAIN E — COMPUTERIZED ENGINE CONTROLS INCLUDING OBD II (Questions 38–50)

38. A scan tool shows STFT at +1% and LTFT at +2% on bank 1 at all engine speeds. On bank 2, STFT is +1% at idle but rises to +17% at 2,500 RPM. LTFT on bank 2 is +14% at all speeds. No vacuum leaks are found. Fuel pressure is normal. What should the technician check NEXT?

A. The bank 2 upstream O2 sensor for contamination causing false lean corrections at all engine speeds

B. The bank 1 upstream O2 sensor for a fault affecting bank 2 trim comparison

C. The MAF sensor for contamination causing under-reading that selectively affects bank 2 more than bank 1

D. The bank 2 fuel injectors for restriction causing lean delivery — the RPM-correlated STFT increase suggests a flow-rate fault

39. A vehicle has a P0172 rich code on bank 1. LTFT bank 1 is -18%. LTFT bank 2 is +1%. All bank 1 injectors pass a balance test within 3%. MAF readings are correct. Fuel pressure is normal. A scope test of the bank 1 upstream O2 sensor shows it consistently reading between 0.75 and 0.85 volts without switching. What does this confirm?

A. A rich air-fuel mixture on bank 1 — the upstream O2 sensor's sustained rich voltage confirms actual excess fuel

B. The bank 1 upstream O2 sensor has a fault — its sustained rich output is causing the PCM to incorrectly perceive and correct for a rich condition that may not exist

C. A leaking bank 1 exhaust manifold is contaminating the upstream O2 sensor with atmospheric oxygen

D. The bank 1 catalytic converter has failed — exhaust gases bypassing the converter are reaching the upstream sensor

40. A scan tool during a cold start captures STFT at -18% and LTFT at -2% during the first 45 seconds before closed-loop entry. After closed-loop entry, STFT and LTFT normalize to +1% on both banks. What does the cold-start STFT pattern indicate?

A. The cold-start enrichment strategy is over-delivering fuel — the PCM is applying open-loop enrichment but the mixture is richer than commanded, suggesting a cold-sensor input fault

B. A vacuum leak is causing the lean condition during cold operation before it seals with thermal expansion

C. The upstream O2 sensors are responding too quickly and entering closed-loop prematurely

D. Normal cold-start behavior — the PCM intentionally enriches the mixture during cold open-loop operation and STFT reflects the necessary correction from the base map

41. A vehicle has STFT at +2% and LTFT at +3% on both banks at idle. LTFT drops to -4% on both banks for 2–3 minutes when cruise conditions are reached on the highway, then recovers to +1%. This pattern repeats consistently. What is the MOST likely cause?

A. A MAF sensor fault that reads correctly at idle but over-reads at highway cruise airflow

B. A vacuum leak that seals at highway speed from aerodynamic pressure changes on the intake

C. Normal EVAP purge operation — the purge solenoid opens at cruise conditions adding fuel vapor and causing temporary negative trim correction

D. A fuel pressure increase at highway cruise speed causing momentary over-delivery before the system compensates

42. A vehicle has a P0441 EVAP incorrect purge flow code. The purge solenoid commands correctly and activates on a bi-directional test. Vacuum is confirmed available at the purge solenoid supply port. When the solenoid is commanded open with the engine running, no vacuum is felt at the solenoid outlet. What is the MOST likely cause?

A. A clogged charcoal canister preventing vapor flow through the solenoid outlet circuit

B. A stuck-closed solenoid — despite clicking when commanded, the internal plunger is not opening the flow path

C. A disconnected or blocked hose between the purge solenoid outlet and the charcoal canister

D. A fuel tank pressure sensor fault providing incorrect EVAP flow feedback to the PCM

43. A vehicle has a P0605 ROM read-only memory error code stored. The vehicle runs and communicates normally. All other systems test normally. What is the MOST likely required repair?

A. A PCM software update or reflash — P0605 ROM errors are frequently caused by software corruption rather than hardware failure

B. PCM replacement — a P0605 ROM fault indicates internal PCM memory hardware failure requiring replacement

C. Battery replacement — a weak battery causing voltage fluctuations during key cycles can corrupt PCM ROM and trigger P0605

D. PCM connector and ground inspection — a poor connection causing intermittent voltage at the PCM can trigger ROM error codes

44. A scan tool shows STFT at +4% and LTFT at +5% at idle on both banks. At 2,500 RPM the STFT drops to 0% and LTFT stabilizes at +2% on both banks. After a period of highway driving, LTFT on both banks drops to -3% for approximately 4 minutes then returns to +2%. What does the LTFT behavior at highway driving represent?

A. Normal EVAP purge operation — the purge solenoid opening at highway conditions delivers fuel vapor causing temporary negative trim correction

B. A MAF sensor that begins over-reading at sustained highway airflow rates causing the LTFT to go negative

C. A vacuum leak that seals at highway speed reducing the lean condition and causing LTFT to drop temporarily

D. A fuel pressure increase under sustained high-speed operation causing momentary over-delivery

45. A vehicle fails an OBD II emissions inspection because the oxygen sensor monitor shows incomplete. All other monitors are complete. No codes are stored. The vehicle has been driven 400 miles since a battery replacement with mixed city and highway driving. What is the MOST likely reason the monitor is incomplete?

A. A small upstream O2 sensor response fault is preventing the monitor from achieving its pass threshold without setting a code

B. The O2 sensor monitor requires the catalyst monitor to complete first — the catalyst monitor must be verified as complete before O2 can run

C. The specific RPM, load, temperature, and duration conditions required to enable the O2 sensor monitor have not been simultaneously satisfied during any single drive event

D. A pending O2 sensor code is blocking the monitor from completing without appearing as a stored code

46. A vehicle has an intermittent P0300 random misfire that sets only during cold ambient temperatures below 40°F. No codes set during warm weather. LTFT is +21% on both banks when the code sets and returns to +3% when warm. What is the MOST likely cause?

A. A cold-sensitive ignition component — a coil with degraded insulation that arcs internally when cold

B. A MAF sensor that reads low at cold intake air density causing incorrect fuel delivery during cold operation

C. An IAC valve that sticks during cold operation causing insufficient idle airflow and a lean misfire

D. A vacuum leak at a rubber component that shrinks below 40°F creating unmetered air entry and a lean misfire condition

47. A vehicle has a P0340 CMP sensor no signal code. The sensor supply voltage is 5 volts. Ground resistance is 0.1 ohms. A scope test during cranking shows no signal output. A known-good CMP sensor is installed and the scope immediately shows a correct signal. What is the correct next step after confirming the original sensor has failed?

A. Inspect the CMP reluctor wheel for damage before returning the vehicle — if the original sensor failed from impact or debris, the reluctor may also be damaged

B. Inspect the camshaft timing after replacing the sensor to confirm the no-start was not also caused by a jumped timing chain

C. Perform a cylinder leakage test to confirm the no-start was not caused by a secondary mechanical fault

D. Perform a cylinder contribution test after sensor replacement to confirm all cylinders are contributing normally

48. A vehicle has a P0131 upstream O2 sensor low voltage code on bank 1. The sensor reads 0.05 volts at all operating conditions regardless of RPM, load, or fuel enrichment commands. The sensor heater is confirmed functional. What is the MOST likely cause?

A. A lean air-fuel mixture on bank 1 causing the sensor to read in the lean voltage range continuously

B. A rich air-fuel mixture producing high exhaust temperatures that damage the sensor element causing it to read low

C. A bank 1 upstream O2 sensor with an open signal circuit or a failed sensing element that cannot generate voltage above near-zero

D. A short to ground on the bank 1 upstream O2 sensor signal wire holding the circuit at near-zero voltage

49. A vehicle has all OBD II monitors complete. Mode 6 data shows the cylinder 4 misfire monitor test value at 92% of the maximum allowed misfire threshold. No P0304 code is stored. What is the MOST appropriate action?

A. Inspect cylinder 4 ignition components, fuel delivery, and compression for a developing fault before a misfire code sets

B. No action required — the monitor passed and no code exists

C. Perform a cylinder contribution test immediately to confirm cylinder 4 is contributing normally before making any component changes

D. Clear the Mode 6 data and retest after a complete drive cycle to confirm the reading is repeatable

50. A vehicle has completed all OBD II monitors with no stored codes. The customer reports a slight hesitation under hard acceleration that appeared recently. STFT and LTFT are within ±3% on both banks. No misfire codes have stored. What is the MOST appropriate first diagnostic step?

A. Perform a fuel pressure test under load — a fuel pressure drop during WOT acceleration that does not trigger codes would explain the symptom

B. Perform a compression test on all cylinders — a borderline mechanical fault may cause hesitation before setting a code

C. Check for pending codes — a fault developing toward the code-setting threshold may appear as a pending code before becoming confirmed

D. Perform an ignition scope test on all cylinders under load to identify a coil or secondary circuit fault causing the hesitation

PRACTICE EXAM 15: ANSWER KEY AND EXPLANATIONS

DOMAIN A — GENERAL DIAGNOSIS

1. **D. Ignition timing was retarded beyond specification causing the steady low vacuum at idle** — A steady, non-fluctuating vacuum reading of 12 in/Hg at normal idle RPM that rises to 18 in/Hg after timing is corrected confirms retarded ignition timing as the cause of the low reading. Retarded timing delays combustion relative to piston position — the expanding combustion gases push against a piston already moving away from TDC rather than at peak mechanical advantage, reducing the efficiency of the engine's pumping action and lowering manifold vacuum uniformly. The absence of needle fluctuation eliminates cylinder-specific faults such as a misfire, stuck valve, or vacuum leak, which would produce a flickering or irregular needle rather than a steady depressed reading.
2. **B. Worn or damaged piston rings on cylinder 2** — Cylinder 2 reads 80 psi dry — significantly below the 165–170 psi on all other cylinders — and recovers to 155 psi on the wet test after oil is introduced. The large magnitude of the dry reading combined with the substantial wet test improvement of 75 psi is the definitive signature of a ring seal failure. Oil temporarily fills the ring gap during the wet test, sealing the cylinder sufficiently to raise pressure close to the adjacent cylinder range. A burned or leaking valve would not respond to the wet test because oil cannot seal an exhaust or intake valve face — the wet test improvement exclusively confirms the ring seal as the leak path on cylinder 2.
3. **A. Worn main or connecting rod bearings** — A deep knock originating from the lower portion of the engine that is loudest under hard acceleration, decreases at idle, and is present at all operating temperatures is the defining presentation of worn crankshaft main or connecting rod bearings. Hard acceleration places maximum combustion load and inertia forces on the crankshaft and connecting rod journals, amplifying the knock at a worn bearing interface. The knock decreasing at idle — where combustion forces are minimal — rather than disappearing is consistent with bearing wear that manifests proportionally to applied load. The persistence at all temperatures eliminates cold-specific faults, and confirmed normal oil pressure means the bearings are still receiving lubrication but are mechanically worn beyond their clearance specification.
4. **C. Both the intake valve and piston rings on cylinder 1 have failed simultaneously** — Air escaping from the throttle body opening during a cylinder 1 leakage test confirms test air is passing backward through the cylinder 1 intake valve into the intake manifold and out through the throttle body. Simultaneously, air escaping from the oil filler cap confirms test air is also passing through

the piston rings into the crankcase and exiting through the valve cover opening. Two completely separate and independent leak paths — the intake tract and the crankcase — are confirmed simultaneously on the same cylinder. A single-component failure cannot produce both findings at the same time; both the intake valve and the ring seal on cylinder 1 have failed independently.

5. **D. The EGR valve for a stuck-open condition diluting the idle mixture** — Compression, leakage, fuel pressure, and ignition are all confirmed normal — eliminating mechanical, fuel, and spark causes. An idle-only misfire that completely resolves above 2,000 RPM with no other faults identified points to an abnormal idle mixture condition rather than a component failure. A stuck-open EGR valve introduces inert exhaust gas directly into the intake manifold at all times, diluting the combustible air-fuel charge at idle where the mixture volume is relatively small. This dilution creates a partially non-combustible mixture that misfires repeatedly at idle. As RPM and throttle opening increase, the larger air-fuel charge volume overwhelms the diluting effect of the fixed EGR flow, and the misfire resolves completely above 2,000 RPM.

6. **B. No internal or external cooling system leaks are present at the applied test pressure** — A pressure test that holds 16 psi steadily for 25 minutes without any drop confirms the cooling system has no leaks — internal or external — that are detectable at the test pressure applied. The pressure tester applies and holds a static pressure to reveal any leak path in the system. A perfectly sealed system retains pressure indefinitely at the test level. While this confirms no leaks exist at 16 psi, it does not independently confirm head gasket integrity from the combustion side — a combustion leak test using a chemical tester or block test is still the appropriate follow-up to rule out combustion gas intrusion into the cooling system from a head gasket breach that only leaks under firing pressure.

7. **C. Cylinder 5 has reduced compression and is offering less resistance to the starter motor** — A relative compression test measures the starter motor's workload as it cranks each cylinder through its compression stroke. A cylinder with normal compression requires more current and more effort to compress, producing slower crank speed at that position. A cylinder with reduced compression — from worn rings, a burned valve, or a head gasket breach — offers less resistance to the starter, allowing the crankshaft to accelerate through that cylinder's compression stroke more quickly than normal. The noticeably faster crank speed on cylinder 5 compared to all others directly indicates reduced compression resistance on that specific cylinder, directing the technician to a conventional compression and leakage test on cylinder 5 for confirmation.

8. **A. A hydraulic lifter that has bled down during shutdown and recovers once oil pressure is established** — A brief ticking present only at cold start that disappears within 15 seconds regardless of how quickly oil pressure reaches normal is the defining pattern of a hydraulic lifter that has bled down during the shutdown period. Hydraulic lifters rely on oil trapped in their internal chambers to maintain zero valve clearance. When the engine sits, the oil in a lifter with a worn or compromised check valve slowly bleeds out of the internal chamber, creating a small but audible gap at the cam lobe interface. At startup, even minimal oil pressure from the oil pump recharges

the lifter's internal chamber within seconds, eliminating the gap and silencing the tick before the oil pressure gauge reaches its normal operating range.

9. **D. The PCM driver circuit for cylinder 4 for reduced coil energy** — All four primary diagnostic categories — compression, leakage, fuel pressure, and ignition waveform — have been confirmed normal on cylinder 4. However, the cylinder contribution test reveals cylinder 4 is contributing measurably less power than all other cylinders. With mechanical and fuel causes eliminated and the ignition waveform appearing normal on a scope, the fault lies in a component that affects cylinder 4 combustion quality without producing a clearly abnormal ignition waveform — a PCM driver circuit that is delivering marginally reduced primary circuit energy to the cylinder 4 coil. Reduced primary energy produces a coil that fires but with slightly less secondary voltage than specification, resulting in a weaker spark that causes reduced combustion efficiency on that cylinder without a clearly abnormal secondary waveform pattern.

10. **B. Worn oil control rings allowing oil into the combustion chamber under hard acceleration** — Blue smoke specifically during hard acceleration with no smoke at idle or light throttle, combined with normal compression on all cylinders, points to oil control ring failure rather than valve stem seal failure. Hard acceleration creates the highest cylinder pressures and the greatest piston side-loading forces of any operating condition. Worn oil control rings that are borderline under the lower cylinder pressures of idle and light throttle allow oil to be forced past the oil control ring land under the high cylinder pressures and piston forces of hard acceleration, producing the blue smoke only under that specific condition. Valve stem seal failure produces smoke at startup and during deceleration — not exclusively during hard acceleration.

11. **C. Normal snap-throttle vacuum response with no fault indicated** — The described pattern — sharp drop to zero at snap-throttle, momentary overshoot above baseline, then quick return to normal idle vacuum — is the expected normal response of a healthy engine to a sudden wide-open throttle input. The drop to zero occurs because the sudden throttle opening briefly equalizes manifold pressure with atmospheric pressure. The momentary overshoot above baseline occurs as the engine's pistons resume compression pumping against a partially closed throttle during the deceleration phase immediately following the snap. Quick return to stable idle vacuum within one second confirms all engine systems — rings, valves, timing — are functioning correctly and responding normally to the snap-throttle event.

12. **A. The engine's valve timing is severely off** — All ignition, fuel delivery, and compression components are individually confirmed normal, yet the engine will not start. Zero intake manifold vacuum during cranking — despite confirmed spark, fuel, and cylinder compression — is the critical finding. A correctly timed engine produces measurable manifold vacuum during cranking because intake valves open at the correct crankshaft positions, allowing pistons to draw air through open valves and create suction in the manifold. If the camshaft timing has jumped badly — a tooth or more on a timing chain or belt — the intake valves may open at completely wrong positions relative to piston travel, preventing the pistons from creating any manifold vacuum despite normal

compression test results obtained by cranking with the starter rather than under actual valve-timed conditions.

DOMAIN B — IGNITION SYSTEM DIAGNOSIS AND REPAIR

13. **D. Fuel fouling — the plug is wet with raw fuel from a misfire or flooding condition** — A shiny, wet black deposit with a strong fuel smell covering the insulator and electrode with minimal electrode erosion is the distinctive appearance of a fuel-fouled spark plug. Fuel fouling occurs when a cylinder consistently fails to ignite its air-fuel charge — the raw, liquid fuel washes over the plug surfaces on each firing attempt, coating everything with a wet, shiny, fuel-scented deposit. The minimal electrode erosion confirms the plug has not been actively arcing and burning the deposits as occurs during normal combustion. Common causes include a failed ignition component preventing spark delivery, an injector stuck open flooding that cylinder, or an extended cranking no-start event saturating the plug with raw fuel.

14. **B. The PCM output driver for coil D or wiring for a short to ground holding the signal at zero** — Battery voltage is confirmed at the coil supply terminal, confirming power delivery to the coil is intact. However, the PCM command wire reads 0 volts both at rest and when commanded — it never reaches the battery voltage it should show when the PCM driver is open between commands. A correctly operating PCM command circuit rests near battery voltage when the driver transistor is open and drops to near zero only when the driver grounds the circuit. A reading of 0 volts at rest — before any PCM command — confirms the command wire is being held at ground potential by a fault external to or within the PCM driver output stage, preventing the wire from ever rising to resting voltage regardless of PCM switching state.

15. **C. A shorted or fouled spark plug that cannot sustain an arc after the firing event** — A normal firing line confirms adequate secondary voltage was produced to initiate the arc across the spark plug gap. The complete absence of any spark line — the arc duration portion of the waveform — immediately following the normal firing spike indicates the arc was extinguished instantaneously rather than burning for its normal duration. A fouled spark plug with carbon bridging across the insulator, or a plug with an internal crack creating a short path, provides a low-resistance alternate conduction path parallel to the plug gap. Once the initial firing voltage spike overcomes the gap resistance, the arc immediately collapses through the low-resistance alternate path, extinguishing instantaneously and leaving no spark line duration on the waveform.

16. **A. A frequency reading of 233 Hz at idle confirms the sensor is switching correctly** — A Hall effect CKP sensor generates one complete signal cycle per reluctor wheel tooth that passes the sensor. At idle RPM — typically around 700–800 RPM — the crankshaft completes approximately 12 revolutions per second. A 60-tooth reluctor wheel at 12 revolutions per second produces 720 switching events per second, or 720 Hz. A different tooth count at a different idle RPM produces a different frequency. The specific frequency depends on the number of reluctor teeth and the exact idle RPM. A reading of 233 Hz at idle is consistent with a specific tooth count and idle RPM

combination — the technician should calculate the expected frequency from the known tooth count and measured RPM to confirm this specific reading falls within the expected range for this vehicle.

17. **D. The coil originally serving cylinders 2 and 5 has failed** — The coil is moved from the cylinder 2 and 5 position to the cylinder 1 and 6 position. After clearing and a test drive, the misfires move with the coil — P0301 and P0306 set on cylinders 1 and 6 while P0302 and P0305 do not return. This confirms the fault traveled with the coil to its new location. The misfires are now occurring on the cylinders served by the suspect coil in its new position, and the original cylinders 2 and 5 — now served by a known-good coil — are firing correctly. This classic swap test result definitively identifies the coil as the cause of both misfires, eliminating the PCM driver circuit at the original position, the plug wires, and the spark plugs as the fault source.

18. **C. Normal behavior — magnetic reluctance sensor amplitude decreases at higher RPM** — Magnetic reluctance sensors generate voltage by electromagnetic induction as each reluctor tooth passes through the sensor's magnetic field. The amplitude of the generated voltage is proportional to the rate of change of the magnetic field — which is directly related to how quickly each tooth passes the sensor. At low RPM, each tooth passes slowly, producing a relatively modest rate of field change and modest amplitude. As RPM increases, teeth pass more quickly and the rate of field change increases — however, at very high RPM the signal frequency increases beyond the point where increased rate fully compensates, and the signal may appear reduced amplitude relative to idle on some oscilloscopes depending on scope input impedance settings. The uniform decrease across all teeth is the key indicator that this is a speed-related phenomenon rather than a wiring or tooth fault.

19. **A. Arcing between the rotor tip and that specific cap terminal from excessive rotor-to-cap clearance** — A distributor cap terminal with its tip completely burned away — leaving only a stub — is the result of sustained high-energy arcing between the rotor and that terminal over many firing cycles. When the air gap between the rotor tip and the cap terminal exceeds specification — from a worn rotor tip, a worn terminal, a cracked or warped cap, or incorrect rotor installation — the secondary voltage must jump a wider-than-designed air gap on each firing event. The repeated high-energy arcing required to bridge this excessive gap deposits its energy on the terminal tip, eroding it progressively with each firing. Only one terminal is affected because only one cylinder's firing angle corresponds to the position where the gap has become excessive.

20. **A. The coil originally on cylinder 3 has failed** — When the cylinder 3 coil is moved to cylinder 7, the misfire moves to cylinder 7 — confirming the fault traveled with the coil. The subsequent plug swap from cylinder 3 to cylinder 7 does not move the misfire away from cylinder 7 — the misfire remains on cylinder 7 after both swaps. This confirms the plug is not the cause — a faulty plug would have moved the misfire back toward cylinder 3 when it was swapped to cylinder 7 alongside the coil. Since the misfire followed the original cylinder 3 coil to its new position and remained there even when the cylinder 3 plug was moved in — rather than following the plug — the coil is definitively identified as the cause of the original cylinder 3 misfire.

DOMAIN C — FUEL, AIR INDUCTION, AND EXHAUST SYSTEMS

21. **D. Normal thermal pressure decay within acceptable limits for many returnless systems** — The rate of pressure loss described — dropping from 60 psi to 48 psi over an 8-hour overnight period — represents a slow, gradual decline consistent with normal thermal pressure decay rather than a mechanical leak or check valve failure. On a returnless fuel system, some pressure loss after shutdown is expected as the fuel in the rail cools and contracts and minor seepage occurs through normal component tolerances. A failed pump check valve would cause pressure to drop substantially within minutes, not over hours. An external seep would typically be visible or detectable by smell. The slow, hours-long pressure decay with no external evidence and maintained residual pressure above the minimum required for startup is within the accepted normal range for many returnless fuel systems.

22. **C. The MAF sensor for a dynamic contamination fault that underreads at idle despite a correct static test** — LTFT at +21% on both banks at idle with recovery to +3% at 2,500 RPM is the specific pattern of a MAF sensor that underreports airflow at low-flow idle conditions while reading more accurately as airflow increases. The MAF reads 4.9 g/s at idle — within the published specification — which appears to clear the sensor. However, a static specification check at idle does not capture dynamic accuracy across the full airflow range. MAF sensor contamination on the hot-wire sensing element preferentially affects accuracy at low airflow rates where the element operates near its lower sensitivity threshold, producing a sensor that passes a static idle test while significantly underreporting the actual mass airflow entering the engine at those conditions.

23. **B. The fuel pressure regulator is stuck open or has a weakened spring** — Fuel pressure of 44 psi — 14 psi below the 58 psi minimum — with a pump that is audible and confirmed running indicates the pump is delivering fuel but pressure is not building to specification. The diagnostic confirmation is the return line pinch test: when the return line is pinched and all return flow is blocked, pressure immediately rises to 58 psi, confirming the pump is fully capable of generating specification pressure when no fuel can return to the tank. Releasing the pinch allows pressure to collapse back to 44 psi as fuel returns through the regulator unrestricted. A regulator stuck open or with a collapsed spring offers no resistance to fuel return, allowing the pump to circulate maximum fuel continuously at low pressure rather than building rail pressure against a calibrated spring resistance.

24. **A. A MAP sensor vacuum supply hose that is disconnected or blocked** — A MAP reading of 99 kPa at idle on a sea-level vehicle — essentially atmospheric pressure — when the specification is 25–45 kPa confirms the sensor is not measuring intake manifold vacuum at all. At idle with a partially closed throttle, manifold pressure should be significantly below atmospheric due to the engine's pumping action creating vacuum. A MAP sensor reading atmospheric pressure at idle indicates it is referencing atmospheric pressure rather than manifold vacuum — the most common cause being a disconnected, kinked, or blocked vacuum supply hose between the intake manifold

and the MAP sensor port. Without a vacuum reference, the sensor reads the ambient atmospheric pressure of approximately 100 kPa at sea level, producing the near-atmospheric reading observed.

25. **C. A worn or failing high-pressure mechanical pump** — The low-pressure pump delivers 65 psi to the high-pressure pump inlet — confirmed within specification — meaning the high-pressure pump has an adequate, correct fuel supply. Despite the correct low-pressure supply, high-pressure rail pressure is only 450 psi against the 500–700 psi specification minimum. The high-pressure pump on a GDI system is a mechanical pump driven by the camshaft that takes low-pressure fuel from the lift pump and compresses it to the high operating pressure required for direct cylinder injection. With confirmed adequate supply pressure at its inlet, a pump producing below-specification rail pressure is failing internally — worn lobes, a failing inlet check valve, or worn plunger seals — preventing it from achieving the required compression ratio from supply to rail pressure.

26. **D. The brake booster diaphragm has ruptured and is drawing intake vacuum into the booster** — A brake booster vacuum hose connects the intake manifold to the booster assembly. A ruptured internal diaphragm within the booster creates a vacuum path from the intake manifold, through the vacuum hose, through the booster housing, and to atmosphere — effectively making the brake booster an unmetered air leak into the intake system. When propane is applied near the booster-side end of the vacuum hose connection, it is drawn through the booster's ruptured diaphragm and into the intake via the vacuum path, temporarily enriching the lean mixture and improving idle quality. This response distinguishes a ruptured diaphragm — where the leak path runs through the booster assembly — from a simple hose connection leak at the manifold fitting, which would require a different repair.

27. **B. A blow-off valve or bypass valve stuck closed causing compressor surge** — A turbocharged engine equipped with a blow-off or bypass valve uses this valve to relieve compressor outlet pressure during sudden deceleration from highway speed. When the throttle closes abruptly, compressed air can no longer flow forward through the throttle plate. A functioning blow-off valve opens to vent this pressure or recirculate it, protecting the compressor. A valve stuck closed traps the high-pressure charge air between the compressor outlet and the closed throttle plate. This trapped pressurized air reverses direction and forces its way back through the compressor wheel, creating the characteristic loud single pop or backfire heard at the intake during hard deceleration. Confirmed correct boost at all RPM confirms the compressor and turbine are otherwise functioning normally.

28. **A. A fuel pump that overheats under sustained operation** — Fuel pressure is correct at idle and at WOT — confirming the pump functions normally under both low-demand and brief high-demand conditions. Progressive pressure drop from 57 psi to 42 psi over 5 minutes of sustained moderate cruise load, followed by full recovery after 10 minutes of rest, is the thermal degradation pattern of a failing fuel pump. Electric fuel pumps are cooled primarily by the fuel flowing through them. A pump with worn brushes, degraded armature windings, or increased internal friction

generates excess heat under sustained operation. As the pump's internal temperature rises over several minutes of continuous running, its output volume and pressure drop progressively. The rest period allows the pump to cool and temporarily recover its output capacity before the thermal cycle repeats.

29. **C. The ignition secondary circuit — plug wires, coil boots, or spark plug gaps** — Normal idle performance, correct fuel pressure, and confirmed normal compression rule out fuel, mechanical, and idle-condition faults. A misfire that appears exclusively on multiple cylinders above 4,500 RPM points to a fault that only becomes significant under the high secondary voltage demand of elevated RPM. At higher RPM, the secondary ignition circuit must fire more frequently per unit time, and the higher cylinder pressures at elevated RPM require greater secondary voltage to initiate the spark arc. Marginally degraded plug wires, coil boots with minor tracking, or spark plugs gapped slightly wide may function adequately at low RPM but fail to deliver sufficient secondary voltage consistently when the combination of high firing frequency and elevated cylinder pressure exceeds their remaining capability.

30. **D. An intermittent cylinder 4 misfire delivering unburned HC during the emissions test cycle** — An inactive P0304 code combined with elevated HC on the emissions test and neutral LTFT directly connects the HC source to cylinder 4. The code is now inactive, meaning the misfire is intermittent — it was occurring during the emissions test cycle when the code was set, but has since resolved or reduced below the misfire detection threshold. Each time cylinder 4 misfires — regardless of whether it sets a current code — its complete unburned fuel charge passes through the exhaust system, dramatically elevating tailpipe HC. Neutral LTFT confirms no persistent mixture fault is contributing to the HC elevation. The specific inactive cylinder 4 code is the direct evidence connecting the intermittent misfire to the emissions test failure.

DOMAIN D — EMISSIONS CONTROL SYSTEMS

31. **B. The valve stem seals for excessive wear allowing oil to be drawn into the combustion chambers** — The PCV system is confirmed fully functional — valve rattling correctly, vacuum normal at the manifold port, fresh air inlet clear, and crankcase pressure normal with PCV connected. No external oil leaks are visible. With the PCV system confirmed not contributing to consumption and no external leak accounting for the loss, the oil is being consumed through an internal combustion path. At 1 quart per 800 miles — a rate above the commonly accepted 1-quart-per-1,000-mile normal threshold — valve stem seal inspection is the appropriate next step. Worn valve stem seals allow oil to migrate past the seals under the intake manifold vacuum present during normal operation, drawing oil into the combustion chambers at a rate consistent with the reported consumption.

32. **A. An ignition system fault causing misfires below the PCM's misfire detection threshold** — Elevated HC and CO at the tailpipe with neutral LTFT on both banks and no stored misfire codes is the specific pattern of combustion failure without a fuel mixture fault. Elevated HC confirms unburned hydrocarbon is reaching the tailpipe — the result of incomplete combustion events.

Elevated CO confirms oxygen-deficient combustion is occurring. Neutral LTFT on both banks confirms the air-fuel mixture being delivered to the engine is near stoichiometry — the combustion failure is not caused by excess or insufficient fuel. An ignition fault producing misfires at a rate below the PCM's misfire detection threshold delivers unburned fuel charges to the exhaust without accumulating enough misfire events per 200 crankshaft revolutions to set a P030X code, yet produces measurable HC and CO elevation at the tailpipe.

33. **C. Replace the fuel tank pressure sensor O-ring or the sensor assembly and retest** — The low-pressure smoke test has directly identified the specific leak location — a minor seep at the fuel tank pressure sensor O-ring. The correct repair is to address the confirmed fault component directly. Replacing the O-ring or the sensor assembly eliminates the identified leak path. Retesting with the smoke machine after the repair confirms the leak has been fully sealed and the P0440 condition has been corrected. Replacing the fuel cap or charcoal canister without evidence of their failure is not indicated. A P0440 general EVAP fault with a confirmed specific small leak source at the FTP sensor O-ring requires only that component's repair followed by smoke test verification.

34. **D. Carbon deposits raising effective compression ratio and combustion temperature** — EGR is confirmed operational with confirmed flow, fuel trims are near zero eliminating a mixture fault, and timing is confirmed correct. With all three primary NOx causes — insufficient EGR, lean mixture, and over-advanced timing — systematically eliminated, a fourth cause must be considered. Significant carbon buildup in the combustion chambers raises the effective compression ratio by reducing chamber volume. Higher effective compression generates higher peak combustion temperatures, and NOx formation increases exponentially with combustion temperature. Carbon deposits also act as hot spots that retain heat from previous combustion cycles, further elevating local temperatures. This mechanism produces elevated NOx despite correct EGR, timing, and mixture delivery, making combustion chamber inspection the appropriate next step.

35. **B. The PCM heater control ground circuit has high resistance at 0.3 ohms** — Battery voltage is confirmed at the heater supply wire, confirming power delivery to the heater is intact. The heater element resistance of 8.4 ohms is within the 8–12 ohm specification, confirming the element itself is serviceable. However, the PCM heater control ground circuit resistance of 0.3 ohms exceeds the maximum acceptable ground circuit resistance of approximately 0.1 ohms. High resistance in the ground return path creates a voltage drop that reduces the current flowing through the heater element below the minimum the PCM expects to see for a functional heater circuit. The PCM monitors heater circuit current to confirm heater operation — insufficient current from a high-resistance ground path triggers the P0135 heater circuit fault code even when the element and supply voltage are individually normal.

36. **A. The bank 2 AIR check valve for a fault allowing exhaust backflow after initial operation** — The bank 1 response is confirmed strong for the full 30 seconds, confirming adequate pump output and delivery. Bank 2 shows a strong lean response for 8 seconds — confirming air is initially

reaching the bank 2 exhaust ports — but then returns to normal switching despite continued pump operation. The 8-second lean response followed by reversion to normal switching with the pump still running indicates air delivery to bank 2 stopped after the initial period. The most likely cause is an AIR check valve on the bank 2 delivery side that is failing to maintain its closed position under exhaust backpressure after the initial startup condition. As the engine warms and exhaust pressure increases, a weakened check valve begins allowing exhaust to flow back through the delivery tube, blocking the incoming air and ending the lean response.

37. **C. The downstream sensor switching slower than the upstream confirms the catalyst is functioning and the P0420 may be a false positive** — The downstream sensor switching at 0.8 cycles per second compared to the upstream at 0.9 cycles per second confirms the downstream sensor IS switching more slowly than the upstream sensor. A functioning catalytic converter stores and releases oxygen from exhaust gas, buffering the downstream exhaust composition relative to the upstream. This buffering causes the downstream sensor to switch more slowly than the upstream. The fact that the downstream rate is detectably lower than the upstream — even if marginally — indicates some oxygen storage capacity remains. Combined with neutral LTFT of +1%, the P0420 may be triggered by a downstream sensor response speed issue rather than actual catalyst failure, warranting sensor evaluation before condemning the converter.

DOMAIN E — COMPUTERIZED ENGINE CONTROLS INCLUDING OBD II

38. **D. The bank 2 fuel injectors for restriction causing lean delivery** — Bank 1 LTFT near zero confirms shared systems — MAF, fuel pressure, and EVAP — are functioning correctly. Bank 2 LTFT is elevated at all engine speeds with STFT rising further at 2,500 RPM. The RPM-correlated increase in STFT on bank 2 is the critical finding — as RPM increases and fuel demand increases, the lean condition worsens. This RPM-proportional lean worsening is consistent with a fuel delivery volume fault that becomes more significant as injector duty cycle increases with RPM demand. Restricted injectors that deliver adequate volume at the short pulse widths of idle become progressively more lean as RPM-driven pulse width demand increases, producing the worsening positive trim at elevated RPM seen specifically on bank 2.

39. **B. The bank 1 upstream O2 sensor has a fault causing the PCM to incorrectly perceive and correct for a rich condition** — All bank 1 fuel delivery components — injectors, MAF, fuel pressure — are confirmed normal. Bank 2 LTFT is near zero, confirming no shared system fault exists. Despite confirmed normal fuel delivery, the PCM is applying -18% fuel correction on bank 1. A scope test showing the bank 1 upstream O2 sensor consistently outputting 0.75–0.85 volts without switching confirms the sensor is not responding to actual exhaust oxygen content — it is biased toward the rich voltage range and outputting a fixed high voltage regardless of actual mixture conditions. The PCM interprets this sustained rich signal as actual mixture richness and removes fuel accordingly, creating negative LTFT based on incorrect sensor feedback rather than an actual rich condition.

40. **A. The cold-start enrichment strategy is over-delivering fuel** — STFT at -18% during the first 45 seconds of cold open-loop operation confirms the PCM's base open-loop enrichment map is delivering significantly more fuel than the engine requires during cold start. The PCM applies a fixed enrichment multiplier during open-loop cold start — if this multiplier is excessive relative to actual cold-start fuel requirements, the STFT will show a large negative correction reflecting the PCM's attempt to compensate. The immediate normalization to +1% after closed-loop entry confirms the engine runs correctly under closed-loop control — the fault is specific to the open-loop cold-start enrichment strategy. An ECT sensor reading colder than actual during cold start would cause the PCM to apply excessive enrichment, producing exactly this pattern.
41. **C. Normal EVAP purge operation** — The described LTFT pattern — positive at idle, near zero at cruise, then briefly negative for 2–3 minutes at highway conditions before recovering — is the expected behavior of normal EVAP canister purging during the EVAP monitor or routine purge cycle. As vehicle speed and RPM reach highway cruise conditions, the PCM commands the EVAP purge solenoid open, delivering stored fuel vapors from the charcoal canister into the intake manifold. These vapors add unmetered fuel to both banks simultaneously. The PCM responds by reducing fuel delivery — LTFT drops to -3% — to maintain stoichiometry. When the purge cycle completes and the solenoid closes, vapor delivery stops and LTFT returns to its normal baseline. The consistency, bilateral nature, and cruise-specific timing confirm normal purge activity.
42. **D. A fuel tank pressure sensor fault providing incorrect EVAP flow feedback to the PCM** — The purge solenoid electrically activates on the bi-directional test, confirming correct electrical operation of the solenoid. However, the P0441 incorrect purge flow code indicates the PCM is not confirming adequate vapor flow during normal EVAP purge operation. The EVAP monitor evaluates purge flow by monitoring the fuel tank pressure sensor — when the purge solenoid opens, the FTP sensor should detect a pressure change as tank vapors are drawn toward the solenoid. A faulty FTP sensor that does not register the expected pressure change when purge occurs causes the PCM to conclude that purge flow is insufficient or absent, setting P0441. The solenoid's confirmed electrical activation does not rule out a sensor-based flow confirmation fault that generates the code.
43. **B. PCM replacement — a P0605 ROM fault indicates internal PCM memory hardware failure** — A P0605 code specifically identifies an internal PCM read-only memory checksum error — a fault where the PCM has detected that its own program memory has become corrupted or is not reading back correctly during its self-check routine. Unlike intermittent communication codes that can result from external wiring or connector faults, a ROM checksum error is an internal PCM self-diagnostic result that the PCM reports about its own memory integrity. While the vehicle may currently operate normally if the corruption is in an unused memory area, the P0605 code cannot be resolved by software update, connector repair, or battery replacement — the PCM's internal memory hardware has failed and the module requires replacement to restore reliable operation.

44. **A. Normal EVAP purge operation** — The LTFT pattern described precisely mirrors normal EVAP canister purge behavior. Near-zero trims at idle and cruise confirm the engine's base fuel delivery is correct. When highway driving conditions are reached and the EVAP monitor or routine purge schedule commands the purge solenoid open, stored fuel vapor from the charcoal canister is delivered into the intake manifold, adding unmetered fuel to both banks. The PCM detects the resulting rich excursion and reduces fuel delivery — LTFT drops to -3% bilaterally for the duration of the purge event. When the purge solenoid closes at the end of the purge cycle, vapor contribution stops, and LTFT returns to its near-zero baseline. The 4-minute duration, bilateral nature, and highway-specific timing are consistent with a normal EVAP purge cycle.

45. **C. The specific enable conditions for the O2 sensor monitor have not been simultaneously satisfied** — No codes are stored and the vehicle has been driven 400 miles with mixed driving — confirming no active fault is preventing monitor execution. The oxygen sensor monitor has specific enable criteria that must all occur simultaneously within a single drive event — typically a defined warm-up, a sustained idle period, a defined cruise speed window maintained for a minimum duration, and specific load conditions. Mixed city and highway driving frequently fails to execute the precise sequence in the required order within a single continuous drive event. The O2 sensor monitor is not blocked by any other incomplete monitor on most vehicles — it simply has not encountered the exact combination of operating conditions required to enable and complete its evaluation cycle.

46. **D. A vacuum leak at a rubber component that shrinks below 40°F** — The temperature-specific nature of the fault — misfires and lean LTFT only below 40°F, no codes in warm weather — points to a thermally responsive material rather than an electrical or mechanical component failure. Rubber vacuum hoses, intake manifold gaskets, and throttle body gaskets contain elastomers that contract as temperature decreases. A rubber component that is marginal at room temperature may crack, stiffen, or pull away from its seating surface sufficiently at temperatures below 40°F to create a vacuum leak significant enough to cause the observed +21% LTFT and misfire. As the engine warms from operation, the rubber expands back to its normal dimensions, sealing the leak and allowing the trims to recover to the near-normal +3% observed during warm operation.

47. **A. Inspect the CMP reluctor wheel for damage before returning the vehicle** — The original CMP sensor has been confirmed failed by direct comparison with a known-good sensor that immediately produces a correct signal from the same circuit. Before returning the vehicle, the cause of the original sensor failure should be considered. A CMP sensor can fail prematurely from physical impact with a debris particle, a damaged or wobbling reluctor wheel striking the sensor face, or excessive reluctor wheel runout. If the failure mechanism was reluctor wheel contact or damage, the new sensor is at risk of the same failure. Inspecting the reluctor wheel for physical damage, missing teeth, or excessive runout takes only minutes and prevents a repeat failure of the new sensor shortly after the vehicle is returned to the customer.

48. **C. A bank 1 upstream O2 sensor with an open signal circuit or a failed sensing element** — A confirmed functional heater eliminates heater failure as the cause. A reading of 0.05 volts at all operating conditions — regardless of RPM, load, or commanded enrichment — that never responds to any fuel delivery change is the specific presentation of a sensing element that has completely lost its ability to generate voltage. A correctly functioning zirconia O2 sensor responds to changes in exhaust oxygen content by generating voltage that swings between approximately 0.1 and 0.9 volts. A sensor reading a fixed near-zero voltage under all conditions — even during a commanded rich event that should drive output above 0.6 volts — has either a failed sensing element that can no longer generate the electrochemical voltage difference, or an open in the signal circuit that holds the PCM input near ground regardless of sensor output.

49. **A. Inspect cylinder 4 ignition components, fuel delivery, and compression for a developing fault** — Mode 6 data showing the cylinder 4 misfire monitor at 92% of its maximum threshold is a significant finding. The monitor is still passing — no P0304 code has set — but the cylinder 4 misfire rate is very close to the threshold that would trigger a code and MIL illumination. This Mode 6 data represents a developing fault on cylinder 4 that has not yet crossed the diagnostic threshold. The appropriate action is proactive inspection of the most likely causes of an impending cylinder 4 misfire — ignition components, injector delivery, and compression — before the fault progresses to code-setting frequency. Identifying and correcting a developing ignition or fuel fault at this stage prevents a future emissions failure and potential catalyst damage from a sustained active misfire.

50. **D. Perform an ignition scope test on all cylinders under load** — All OBD II monitors have completed with no codes, and STFT and LTFT are within ±3% on both banks, confirming no fuel delivery fault is present. No misfire codes are stored, ruling out a misfire severe enough to trigger PCM detection. The customer's hesitation symptom under hard acceleration with confirmed normal fuel trims points toward a combustion quality fault under high-demand conditions that is not severe enough to trigger misfire codes or affect average fuel control. An ignition scope test performed under load — capturing primary and secondary waveforms while the hesitation condition is reproduced — identifies marginal coil output, secondary voltage drops, or ignition component faults that are below the misfire detection threshold during normal driving but produce the hesitation complaint during hard acceleration.