BONUS TOPIC-FOCUSED PRACTICE 1

BONUS SECTION 1: FUEL TRIM MASTERY

50 Questions — Targeted Review

1. A vehicle has LTFT B1 = +24%, LTFT B2 = +23% at idle. Both drop to +2% at 2,500 RPM. The MOST likely cause is:

A. Both-bank lean trim at idle normalizing at RPM is the definitive vacuum leak pattern — unmetered air has proportionally greatest lean effect at idle when total airflow is lowest

B. Weak injectors on both banks delivering reduced volume at idle only

C. MAF sensor undercounting at all airflow rates producing lean trim at all conditions

D. Low fuel pressure at idle recovering at higher RPM demand

2. A vehicle has LTFT B1 = +22%, LTFT B2 = +21% at idle AND at 2,500 RPM — both banks remain elevated at all RPM. The MOST likely cause is:

A. A vacuum leak — both-bank lean trim at idle normalizing at RPM is the vacuum leak pattern, which is not present here

B. A MAF sensor undercounting at all airflow rates — lean trim persisting at all RPM confirms a fault affecting all operating conditions, not just idle

C. Weak injectors on both banks delivering reduced volume at idle only

D. Low fuel pressure at idle recovering at higher RPM

3. A vehicle has STFT B1 = +2%, LTFT B1 = +3%, STFT B2 = +21%, LTFT B2 = +19% at idle. B2 trims drop to near zero at 2,500 RPM. The MOST likely cause is:

A. Weak Bank 2 injectors at all RPM conditions

B. Low fuel pressure disproportionately affecting Bank 2

C. A Bank 2 vacuum leak — single-bank lean trim at idle normalizing at RPM is the single-bank vacuum leak pattern

D. A MAF sensor fault affecting Bank 2 calculation only

4. A vehicle has STFT B1 = +2%, LTFT B1 = +3%, STFT B2 = +20%, LTFT B2 = +18% at idle AND at 2,500 RPM with no change between speeds. The MOST likely cause is:

A. A single-bank vacuum leak — a leak would normalize at RPM not persist at cruise

B. MAF sensor fault affecting Bank 2 only — MAF affects both banks simultaneously

C. Low fuel pressure disproportionately affecting Bank 2 injectors at all conditions

D. Weak Bank 2 injectors — single-bank lean trim persisting at both idle and cruise confirms a fuel delivery deficit on that bank, not a vacuum leak

5. A vehicle has STFT = −19%, LTFT = −17% at all conditions. EVAP purge disable causes both to shift to −4% immediately. Re-enabling returns both to −18%. The MOST likely cause is:

A. The EVAP purge solenoid is stuck open — immediate fuel trim response when disabled and return when re-enabled directly confirms the solenoid is the active rich source

B. Leaking injectors are delivering excess fuel — EVAP purge disable would not affect injector leak-down

C. The MAF sensor is overcounting airflow causing PCM over-fueling at all conditions

D. High fuel pressure is increasing injected volume across all injectors simultaneously

6. A vehicle has STFT = −22%, LTFT = −20% at all conditions. EVAP purge disable shifts both to −12%. Re-enabling returns both to −21%. The MOST likely cause is:

A. The EVAP purge solenoid is stuck open and is the sole rich source — −12% trim after disable is within normal variation

B. The EVAP purge solenoid is confirmed contributing — the −12% remaining LTFT after disable confirms an additional independent rich source is also present

C. Leaking injectors are the sole rich source — the EVAP response is coincidental

D. High fuel pressure is the primary rich source and the EVAP response is masking it

7. A vehicle has LTFT B1 = +2%, LTFT B2 = +3% at idle and cruise. At WOT only STFT drops to −24% on both banks. EVAP purge disable at WOT immediately returns STFT to +1%. The MOST likely cause is:

A. A MAF sensor overcounting at high airflow rates

B. The fuel pressure regulator opening excessively at WOT

C. The EVAP purge solenoid opening at WOT delivering concentrated canister vapors — confirmed by immediate fuel trim return when disabled

D. A fuel pump overpressurizing the rail at WOT demand

8. A vehicle has LTFT B1 = +23%, LTFT B2 = +22% at all conditions. MAF g/s output compared to a known-good identical vehicle at same RPM and load reads 22% lower. The MOST likely cause is:

A. A vacuum leak affecting both banks at all RPM

B. Low fuel pressure causing lean operation at all conditions

C. Weak injectors on both banks at all operating conditions

D. MAF sensor confirmed undercounting — 22% lower output than known-good at identical conditions directly identifies the MAF as the lean source at all RPM

9. A vehicle has LTFT B1 = +19% at idle normalizing at cruise. STFT B1 drops immediately when propane is introduced near the Bank 1 rear intake port. Bank 2 trims are normal. The MOST likely cause is:

A. A Bank 1 rear intake runner vacuum leak — propane enrichment immediately corrected the lean condition and isolated the leak location to that area

B. A clogged Bank 1 rear injector — the propane test masked the injector delivery fault

C. A MAF sensor fault — a throttle body propane test would identify a MAF fault, not a port-area test

D. A PCV system leak at the Bank 1 rear valve cover gasket introducing unmetered air

10. A vehicle has LTFT B1 = +21%, LTFT B2 = +20% at idle normalizing at cruise. A smoke test reveals no leaks. The technician should NEXT:

A. Replace both upstream O2 sensors — simultaneous lean codes indicate dual sensor failure

B. Replace the MAF sensor — undercounting is confirmed when smoke finds no leaks

C. Perform propane enrichment testing around the intake system to locate the vacuum leak the smoke test missed

D. Perform an injector balance test — normal trim at cruise rules out injector fault

11. A vehicle has STFT B1 = −17%, LTFT B1 = −15% at idle and cruise. EVAP purge disable causes no change. Fuel pressure = 67 psi — spec is 55–62 psi. The MOST likely cause is:

A. Multiple leaking injectors delivering excess fuel simultaneously

B. A contaminated upstream O2 sensor reading artificially rich

C. Elevated fuel pressure at 5 psi above the upper specification limit increasing injected volume per pulse across all injectors — confirmed rich source after EVAP purge ruled out

D. A PCM fault commanding excess injector pulse width at all conditions

12. A vehicle has LTFT B1 = +2%, LTFT B2 = +3% at all conditions. STFT B1 drops to −21% at WOT. STFT B2 drops to −20% at WOT. Disabling EVAP purge at WOT causes both STFT values to return to +2% immediately. The MOST likely cause is:

A. A WOT-only MAF overcounting fault — confirmed by purge disable having no effect

B. A fuel pressure regulator opening excessively at WOT throttle demand

C. WOT fuel enrichment strategy producing intentional negative trim at high load

D. The EVAP purge solenoid confirmed stuck open — normal trim at idle/cruise with WOT-only negative trim that immediately resolves on purge disable is the definitive WOT-only purge fault pattern

13. A vehicle has STFT = +1%, LTFT = +2% at idle. At 2,500 RPM STFT = −18%, LTFT begins shifting negative. At idle with propane near the throttle body no STFT change is observed. The MOST likely cause is:

A. A vacuum leak downstream of the throttle — propane at the throttle body would not locate a downstream leak

B. A MAF sensor fault — the MAF undercounts airflow at cruise RPM producing lean trim at idle but rich trim at 2,500 RPM as the error reverses — MAF contamination with positive trim at idle and negative trim at cruise is the contaminated MAF pattern

C. A clogged injector producing lean at idle but correcting at higher RPM

D. EVAP purge opening only at cruise RPM delivering excess vapors

14. A vehicle has LTFT B1 = −23%, LTFT B2 = −22% at all conditions. EVAP purge disable causes no change. Fuel pressure = 59 psi within spec. All injectors pass balance test. The technician should NEXT:

A. Replace the catalytic converter — negative trim confirms the converter is generating rich exhaust reading on the O2 sensor

B. Inspect for a leaking fuel pressure regulator diaphragm allowing fuel to enter the intake manifold vacuum port

C. Replace all injectors — the balance test confirms electrical function but not mechanical leak-down

D. Replace the upstream O2 sensors — a contaminated sensor reading artificially rich with negative trim at all conditions should be considered when all other rich sources are ruled out

15. A vehicle has both-bank LTFT at +22% at idle only. Propane enrichment at the throttle body inlet causes both STFT values to drop to near zero. The MOST likely cause is:

A. A throttle body vacuum leak — propane at the inlet confirmed the leak is at the throttle body area

B. A MAF sensor fault — propane at the throttle body inlet correcting both-bank lean trim confirms the MAF is undercounting airflow entering at the throttle body inlet

C. A large PCV leak introducing unmetered air upstream of the throttle

D. A cracked intake boot between the MAF and throttle body — propane at the inlet masks the air leak

16. A vehicle has LTFT B1 = +24% at idle. LTFT B2 = +2% at all conditions. Propane near Bank 1 front runner immediately corrects B1 STFT. Propane near Bank 1 rear runner produces no change. The MOST likely cause is:

A. A Bank 1 front intake runner vacuum leak — propane response isolated the leak to the front runner area

B. A Bank 1 rear intake vacuum leak — both runners must be tested even though only one responded

C. A clogged Bank 1 front injector — the propane test masked the fuel delivery deficit at idle

D. A Bank 1 PCV leak — propane at the runner confirmed the PCV is the source

17. A vehicle has STFT B1 = +3%, LTFT B1 = +22% at idle only. The fuel trim normalizes immediately when the PCV hose is pinched off. The MOST likely cause is:

A. A vacuum leak at a PCV system component — pinching the PCV hose stopped the unmetered air entry and confirmed PCV as the lean source

B. The PCV valve is stuck closed and vacuum is causing unmetered air bypass

C. The PCV system is functioning normally and the lean trim has a separate cause

D. A cracked brake booster diaphragm allowing manifold vacuum to enter the intake — not related to PCV pinch test response

18. A vehicle has LTFT = +22% on both banks at all conditions. MAF g/s output is 20% lower than known-good at cruise. Vacuum test with gauge at manifold reads 19 in/Hg — normal. The technician should:

A. Perform a compression test — normal manifold vacuum does not rule out cylinder-specific mechanical faults

B. Replace the fuel pump — low MAF output confirms reduced airflow from inadequate pump delivery

C. Replace the MAF sensor — 20% undercounting confirmed by known-good comparison with normal manifold vacuum ruling out airflow restriction is the definitive MAF fault diagnosis

D. Perform a smoke test — the MAF comparison result may be a false positive

19. A vehicle has STFT B1 = +22%, LTFT B1 = +20% at idle. At 2,500 RPM STFT B1 = −18%, LTFT B1 begins shifting negative. Both B2 trims are near zero at all conditions. The MOST likely cause is:

A. A Bank 1 vacuum leak — vacuum leaks produce lean trim at idle normalizing at RPM, not lean at idle and rich at cruise

B. A Bank 1 upstream O2 sensor contaminated with a positive bias at idle and negative bias at cruise

C. Contaminated Bank 1 MAF sensor — contamination causes undercounting at idle (lean trim) and overcounting at higher airflow (negative trim) as partial contamination creates non-linear output error

D. Weak Bank 1 injectors delivering reduced volume at all conditions

20. A vehicle has LTFT B1 = −24%, LTFT B2 = −23% at all conditions. Smoke test reveals a cracked EVAP purge solenoid body. EVAP purge disable causes both trims to shift to −6%. The MOST likely cause is:

A. The cracked solenoid body is the sole rich source — −6% remaining trim is within normal variation

B. A cracked purge solenoid body allows vapor delivery even when the solenoid is electrically disabled — the solenoid cannot be commanded off when the body is physically cracked

C. Both bank rich trims at −24% with −6% remaining after disable confirms the cracked solenoid is contributing but a second independent rich source is also present

D. The −6% remaining trim after disable confirms the cracked solenoid is the sole source — within ±10% is acceptable

21. A vehicle has LTFT B1 = +22% and LTFT B2 = +21% at idle only. A propane enrichment test at the brake booster vacuum hose fitting immediately drops both STFT values to near zero. The MOST likely cause is:

A. A leaking brake booster diaphragm — propane at the vacuum fitting isolated the unmetered air entry point to the brake booster vacuum source

B. A PCV system fault — propane at the booster fitting corrected trim confirming PCV is routing air through the booster circuit

C. A MAF sensor fault — propane enrichment at a vacuum line would not correct a MAF undercounting error

D. A throttle body seal leak — propane at the booster fitting identified the throttle body as the unmetered air entry point

22. A vehicle has LTFT = +2% at idle. At cruise LTFT = +21%. At WOT LTFT = −22%. The MOST likely cause is:

A. A vacuum leak producing lean at cruise and EVAP purge rich at WOT simultaneously

B. Contaminated MAF sensor — undercounting at moderate cruise airflow (lean cruise trim) with overcounting at high WOT airflow (rich WOT trim) is the classic contaminated MAF non-linear pattern

C. Weak injectors at cruise recovering at WOT with EVAP purge simultaneously

D. A stuck-open EGR valve producing lean at cruise and rich at WOT from exhaust gas dilution

23. A vehicle has STFT B1 = +24%, LTFT B1 = +22%. Propane near the Bank 1 throttle body causes no STFT change. Propane near the Bank 1 intake manifold runners causes an immediate drop to +2%. The MOST likely cause is:

A. A vacuum leak at a Bank 1 intake manifold runner or port gasket — propane at the throttle body ruled out a throttle area leak, and propane at the runners isolated the leak to manifold runner area

B. A MAF sensor fault — propane at the throttle body inlet would identify a MAF fault, which was negative here

C. A Bank 1 upstream O2 sensor fault — propane enrichment does not diagnose sensor faults

D. Weak Bank 1 injectors — propane enrichment at a vacuum leak location does not correct a fuel delivery deficit

24. A vehicle has STFT = −18%, LTFT = −17% at all conditions. EVAP purge is disabled — no change. Fuel pressure = 59 psi within spec. O2 sensor switching is normal. A known-good injector is installed in cylinder 1 position — no change in trim. The MOST likely cause is:

A. Multiple injectors are simultaneously leaking — one injector replacement confirming no improvement points to a system-wide cause

B. A fuel pressure regulator diaphragm failure allowing fuel vapor into the manifold — this introduces extra fuel independently of injector pulse width

C. A PCM fault commanding excessive injector pulse width

D. An EVAP system fault with a path bypassing the purge solenoid

25. A vehicle has LTFT B1 = +21% and LTFT B2 = +22% at idle. Both normalize at 2,500 RPM. Smoke test finds no leaks. Propane enrichment at all intake runner locations produces no STFT response. The MOST likely cause is:

A. A MAF sensor fault — absence of propane response at any runner location with both-bank idle trim normalizing at RPM confirms no localized runner leak and points toward a throttle body area or pre-MAF leak

B. Multiple injectors clogged on both banks simultaneously

C. A vacuum leak at the EGR system introducing exhaust gas at idle

D. Low fuel pressure at idle recovering at cruise

26. A vehicle has LTFT B1 = +23% at all conditions. Propane enrichment at the throttle body produces no Bank 1 STFT response. Propane at Bank 1 runner 1 reduces STFT to +5%. Propane at runners 2, 3, and 4 produce no change. The MOST likely cause is:

A. A vacuum leak at Bank 1 runner 1 only — propane isolated the leak to a single runner with no response at the throttle body or other runners

B. A clogged injector on Bank 1 cylinder 1 — propane at the runner masked the injector delivery deficit

C. The Bank 1 upstream O2 sensor is biased toward lean readings from exhaust contamination

D. A PCV leak at the Bank 1 cylinder 1 valve cover area introducing unmetered air at idle

27. A vehicle has LTFT B1 = +20%, LTFT B2 = +19% at idle. Both normalize at cruise. ECT = 197°F — confirmed normal operating temperature. No vacuum leaks found on smoke test or propane enrichment. The technician should NEXT:

A. Replace the upstream O2 sensors — dual lean trim with no leak found indicates sensor failure

B. Perform an injector balance test — ruling out vacuum leaks and sensor fault points toward fuel delivery

C. Inspect for a large crankcase breather tube disconnection or open PCV port on the intake manifold that was not included in the smoke test — some PCV/breather paths are not pressurized during smoke testing

D. Replace the MAF sensor — lean trim at idle normalizing at cruise cannot be caused by a MAF fault

28. A vehicle has LTFT B1 = −21%, LTFT B2 = −20%. EVAP purge disable — no change. Fuel pressure = 58 psi within spec. All injectors pass balance test. A manual fuel pressure regulator reference vacuum hose test is performed — capping the vacuum reference causes fuel pressure to drop to 44 psi. Uncapping returns it to 58 psi. The MOST likely cause is:

A. Normal regulator response to reference vacuum — fuel pressure dropping when reference is capped is expected behavior

B. A leaking fuel pressure regulator diaphragm — the vacuum reference port test is negative; the regulator is functioning normally

C. A leaking fuel pressure regulator diaphragm allowing fuel to enter the intake via the vacuum reference port — a functional regulator should increase pressure when the vacuum reference is capped, not decrease it

D. A PCM fault commanding excess injector pulse width at all conditions

29. A vehicle has both-bank positive LTFT at all conditions. The technician compares MAF g/s output to a known-good vehicle at idle, 1,500 RPM, and 2,500 RPM. Both vehicles produce identical readings at all three RPM test points. The MOST likely conclusion is:

A. The MAF sensor is confirmed faulty — identical readings at all RPM points confirm the sensor is stuck at a fixed output

B. The MAF sensor is confirmed correct — identical output compared to a known-good vehicle at all test points rules out a MAF fault as the source of the lean condition

C. The known-good vehicle has a matching MAF fault — results must be considered inconclusive

D. The comparison test only applies to cruise RPM — idle comparison is not valid for MAF diagnosis

30. A vehicle has LTFT B1 = +23%, LTFT B2 = +22% at all conditions. Fuel pressure = 57 psi within spec. MAF comparison shows 19% undercounting at cruise. A new MAF is installed — LTFT at all conditions drops to +4%. The technician should:

A. Continue diagnosis — +4% LTFT after MAF replacement confirms an additional lean source remains

B. Confirm the repair complete — +4% is within normal LTFT operating range (±10%)

C. Replace both upstream O2 sensors — the remaining +4% LTFT confirms sensor error

D. Perform compression testing — remaining positive LTFT after MAF replacement indicates a mechanical cause

31. A vehicle has LTFT B1 = −19%, LTFT B2 = −18% at all conditions. EVAP purge disable shifts both to −7%. Re-enabling returns both to −18%. An injector balance test shows injector 3 delivers 14% more volume than all others. The MOST likely interpretation is:

A. Injector 3 is the sole rich source — the EVAP purge response is coincidental

B. The EVAP purge solenoid is contributing rich and injector 3 is delivering excess fuel — two independent rich sources are confirmed requiring both to be repaired

C. The EVAP solenoid is the sole source — injector 3 variation is within acceptable tolerance

D. The injector balance test result confirms a PCM driver fault affecting injector 3 timing

32. A vehicle has LTFT B1 = +22%, LTFT B2 = +21% at idle. Both normalize at 2,500 RPM. All propane enrichment tests are negative. The technician removes the intake air duct between the MAF and throttle body — a 3-inch crack is found on the underside. The MOST likely confirmation this is the leak source is:

A. A crack in the intake duct between the MAF and throttle body introduces unmetered air downstream of the MAF sensor, producing both-bank lean trim with proportionally greatest effect at idle when total airflow is lowest — this is consistent with all observed trim data

B. A crack between the MAF and throttle body would cause a rich condition because the MAF would overcount the missing air

C. The crack would only affect Bank 1 because of the intake manifold runner arrangement

D. Intake duct cracks downstream of the MAF are detected by smoke testing — the negative smoke test rules out this location

33. A vehicle has STFT B1 = +22%, LTFT B1 = +20% at idle. Both drop to +3% at 2,500 RPM. The technician performs a cylinder balance test — all RPM drops are normal and equal. Compression = 178 psi on all cylinders. The MOST likely conclusion from these test results is:

A. The cylinder balance and compression results confirm the lean condition is mechanical in origin — valve train fault is most likely

B. Normal cylinder contribution and compression results confirm the engine is mechanically sound — the lean trim is caused by unmetered air (vacuum leak) or a fuel delivery fault, not a mechanical cause

C. The normal cylinder balance test confirms the injectors are functioning — injector fault is ruled out

D. Normal compression confirms no lean misfire is present — fuel trim values must be sensor error

34. A vehicle has LTFT = +2% at idle. At steady cruise LTFT shifts to +22%. At WOT LTFT shifts to −19%. The technician disables EVAP purge at WOT — STFT immediately returns to near zero. The technician enables purge and checks fuel trim at cruise — trim is still +22%. The MOST likely interpretation is:

A. The EVAP purge solenoid is stuck open at all conditions — the cruise lean trim is caused by EVAP purge delivering a lean mixture

B. The EVAP purge solenoid is confirmed stuck open at WOT only — it is not contributing at cruise. The cruise lean trim has a separate cause — most likely a contaminated MAF sensor undercounting at moderate airflow

C. The MAF sensor is the sole cause of all trim deviations — contamination explains both the cruise lean and WOT masking

D. The fuel pressure regulator is opening at cruise RPM and closing at WOT causing lean-at-cruise and EVAP-independent rich-at-WOT

35. A vehicle has LTFT B1 = +23%, LTFT B2 = +22% at all conditions. Fuel pressure, MAF output, injector balance, and smoke test are all within specification. The technician performs a volumetric efficiency calculation using MAP, RPM, and engine displacement — VE = 68% against an expected 82–85%. The MOST likely cause of the lean trim is:

A. Low engine volumetric efficiency — reduced cylinder filling reduces actual airflow relative to what the PCM calculates, causing the PCM to add fuel to compensate — the lean trim is a symptom of reduced combustion efficiency, not a metering fault

B. The VE calculation confirms a MAF fault — low VE directly identifies sensor undercounting

C. The VE result is normal — 68% is within acceptable range for a warmed-up street engine at idle

D. Low VE confirms a vacuum leak — the smoke test produced a false negative

36. A vehicle has LTFT B1 = −20%, LTFT B2 = −19% at idle and cruise. EVAP purge disable causes no change. Fuel pressure = 60 psi within spec. MAF output is normal on comparison. O2 sensors switch normally. The technician should NEXT perform:

A. A fuel injector leak-down test — leaking injectors delivering excess fuel when the engine is off and when pulse width is normal can cause rich trim at all conditions with all other sources ruled out

B. An ignition coil waveform capture — misfires can produce apparent rich trim readings

C. Replace the PCM — all external causes ruled out confirms an internal PCM fault

D. A compression test — low compression causes rich trim by reducing the combustion efficiency

37. A vehicle has LTFT B1 = +22% and LTFT B2 = +23% at idle. ECT = 196°F. MAF comparison is normal. No vacuum leaks found. Injectors pass balance test. A fresh air induction test is performed — both LTFT values drop to +3% when fresh shop air is introduced at the MAF outlet. The MOST likely cause is:

A. A restriction in the air intake upstream of the MAF — the MAF is reading correctly, but reduced airflow to the engine creates a lean condition the PCM overcorrects with high positive fuel trim

B. The MAF sensor is confirmed faulty — introducing fresh air bypasses the sensor and confirms undercounting

C. Both upstream O2 sensors are reading lean — the fresh air test bypasses the sensors and corrects the apparent trim

D. The throttle body is partially clogged — fresh air introduction bypassed the restriction and confirmed throttle body as the lean source

38. A vehicle has LTFT B1 = +21% at all conditions. LTFT B2 = +2% at all conditions. MAF comparison is 18% lower on Bank 1 vs the known-good vehicle. The technician should:

A. Replace the MAF sensor — the 18% undercounting confirms the MAF is faulty and affecting Bank 1 only

B. Recognize that a MAF sensor affects both banks simultaneously — a single-bank lean trim confirmed at all RPM with normal Bank 2 trim rules out the MAF as the cause and points to a Bank 1-specific fuel delivery or air leak fault

C. Perform propane testing on Bank 2 — the Bank 2 normal trim is suspicious

D. Replace the Bank 1 upstream O2 sensor — single-bank lean trim at all conditions indicates a sensor bias

39. A vehicle has LTFT B1 = +24% and LTFT B2 = +23% at idle. Both normalize at 2,500 RPM. A water spray test is performed around the intake manifold — when water is sprayed near the rear of the Bank 1 intake manifold, engine RPM drops 60 RPM immediately. The MOST likely cause is:

A. Water entering Bank 1 cylinders through a cracked intake — the RPM drop confirms cylinder flooding

B. A vacuum leak at the Bank 1 rear intake manifold area — water temporarily seals the leak causing a momentary RPM reduction as the PCM responds to the restored lean trim

C. The water spray confirms a MAF sensor fault — water near the manifold affects MAF output at idle

D. A cracked EGR passage at the Bank 1 rear manifold — water sealing the crack reduces exhaust recirculation and RPM drops accordingly

40. A vehicle has STFT = −18%, LTFT = −16% at idle and cruise. No EVAP, fuel pressure, or injector fault found. A dry compression test yields normal results. A wet compression test is performed — cylinder 3 compression increases from 178 psi (dry) to 231 psi (wet). The MOST likely cause of the rich trim is:

A. Worn rings on cylinder 3 causing incomplete combustion and excess unburned fuel in the exhaust

B. Excessive oil consumption on cylinder 3 introducing combustible oil into the combustion chamber — wet ring sealing during wet compression confirmed ring seal is partially compromised and oil is being burned, contributing to rich combustion chemistry

C. The wet compression increase on cylinder 3 confirms the lean condition — oil is sealing a lean misfire

D. A wet compression differential of 53 psi is normal and does not indicate oil consumption contributing to the trim reading

41. A vehicle has LTFT B1 = +23%, LTFT B2 = +22% at idle. Both normalize at 2,500 RPM. Propane enrichment is performed at the throttle body inlet — both STFT values immediately drop to near zero. The MOST likely cause is:

A. A MAF sensor undercounting — propane at the inlet would not correct a runner-area vacuum leak but would correct a MAF-related undercounting error at the throttle body inlet

B. A vacuum leak at the throttle body gasket — propane at the inlet confirmed the throttle body area as the leak source

C. A cracked intake boot between the MAF and throttle body — propane at the inlet corrects both banks by adding fuel at the point where the intake duct is cracked

D. Both upstream O2 sensors biased lean — propane at the inlet corrects both sensor readings simultaneously

42. A vehicle has LTFT B1 = −22%, LTFT B2 = −21%. EVAP purge disable causes no change. Fuel pressure = 65 psi — spec 55–62 psi. The technician replaces the fuel pressure regulator — fuel pressure drops to 59 psi. The MOST likely outcome of a fuel trim recheck:

A. Both bank LTFT values will remain at −21% to −22% — the regulator was not the rich source

B. Both bank LTFT values will shift toward zero — elevated fuel pressure increasing injected volume was confirmed as the rich source, and correcting pressure to spec will allow fuel trim to normalize

C. Bank 1 trim will normalize but Bank 2 will remain rich — the regulator only affects one bank

D. Both bank LTFT values will shift to positive values as the PCM overcorrects after pressure reduction

43. A vehicle has LTFT B1 = +20%, LTFT B2 = +19% at idle. Both normalize at 2,500 RPM. A careful visual inspection of the engine reveals a vacuum hose with a pinhole crack routed between the throttle body and a brake component vacuum fitting. The MOST likely confirmation this is the source:

A. A pinhole crack in a vacuum hose downstream of the MAF sensor will introduce unmetered air into the intake manifold — the proportionally greatest lean effect at idle is consistent with the observed trim pattern

B. A pinhole crack upstream of the MAF would cause this trim pattern — downstream cracks are not detectable with a smoke machine

C. A pinhole crack in a brake vacuum hose would cause ABS faults before affecting fuel trim

D. A vacuum hose crack this small cannot produce LTFT values above +15%

44. A vehicle has LTFT B1 = +22% at idle and 2,500 RPM — not normalizing at RPM. LTFT B2 = +2% at all conditions. Propane enrichment at all Bank 1 runner locations produces no STFT change. Propane at the Bank 1 throttle body produces no change. MAF comparison shows both banks are equal and normal. Fuel pressure is within spec. The MOST likely cause is:

A. A vacuum leak at the Bank 1 EGR crossover pipe or passage downstream of the EGR valve introducing unmetered air exclusively on the Bank 1 side at all RPM conditions

B. A Bank 1 upstream O2 sensor contaminated with silicone producing a persistently lean signal

C. Weak Bank 1 injectors confirmed by the failure of propane enrichment to identify a vacuum leak location

D. A Bank 1 MAP sensor fault creating a false lean trim reading independent of actual air-fuel ratio

45. A vehicle has LTFT B1 = +21%, LTFT B2 = +20% at idle. Both normalize at 2,500 RPM. The technician has completed: smoke test (negative), propane enrichment (no response at any location), MAF comparison (normal), fuel pressure test (normal), injector balance test (normal), compression test (normal). The MOST appropriate NEXT step is:

A. Replace the upstream O2 sensors — all other causes have been ruled out and a sensor bias must be considered

B. Replace the PCM — all external inputs are confirmed normal

C. Perform a PCV system inspection including removing and flowing the PCV valve and inspecting all breather ports and hoses not normally pressurized during smoke testing — some PCV paths are not sealed during smoke tests

D. Perform a five-gas test — elevated HC would confirm the lean condition is real and not a sensor artifact

46. A vehicle has both-bank LTFT at −22% at all conditions. EVAP purge is disabled — both trims shift to −10%. The technician notes the purge solenoid temperature is 280°F after a 15-minute hot idle — spec is under 180°F. The MOST likely interpretation is:

A. The elevated solenoid temperature is normal for a purge solenoid mounted near the exhaust manifold

B. The EVAP purge solenoid is flowing vapor continuously — the elevated solenoid temperature from constant vapor flow combined with confirmed LTFT response on disable confirms the solenoid is stuck open

C. The elevated solenoid temperature confirms a short circuit in the solenoid winding causing PCM over-command

D. The solenoid temperature only confirms the solenoid is electrically on — it does not confirm vapor delivery

47. A vehicle has STFT B1 = +24%, LTFT B1 = +22%, STFT B2 = +23%, LTFT B2 = +21% at idle only. The technician finds a disconnected PCV hose routed from the rear of the intake manifold to the engine valve cover. The hose end at the manifold is open to atmosphere. The MOST likely confirmation this is the lean source:

A. A disconnected PCV hose open to atmosphere creates a direct unmetered air path into the intake manifold — the proportionally lean effect at idle normalizing at RPM is consistent with both-bank idle lean trim

B. A disconnected PCV hose would cause a rich condition — the valve cover would accumulate pressure and the PCV oil vapor would increase fuel mixture

C. A disconnected PCV hose at the manifold end would only affect Bank 1 unless both banks share the same manifold plenum connection

D. A disconnected PCV hose would generate a large vacuum leak detectable on smoke test — the negative smoke test rules this out

48. A vehicle has LTFT B1 = +22%, LTFT B2 = +21% at idle. Both normalize at cruise. The technician replaces the intake manifold gaskets — on fuel trim recheck LTFT B1 = +4%, LTFT B2 = +3% at idle, both normalize at cruise. The MOST likely interpretation is:

A. The repair is incomplete — +4% remaining LTFT confirms additional leak sources

B. The repair is confirmed complete — the residual +4% LTFT is within the normal ±10% operating range and the trim pattern has resolved from the previous high-positive idle trim

C. The technician should replace the upstream O2 sensors — +4% residual trim confirms sensor biasing

D. A +4% idle LTFT after manifold gasket replacement confirms the gaskets were not the source

49. A vehicle has LTFT B1 = +23%, LTFT B2 = +22% at idle normalizing at 2,500 RPM. No leaks found after extensive testing. A technical service bulletin is identified for the exact vehicle platform describing a known intake manifold resonator chamber internal crack that allows unmetered air entry at idle not detectable by conventional smoke or propane enrichment testing. The MOST appropriate action is:

A. Continue diagnostic testing — TSBs are advisory only and do not confirm the fault

B. Replace the intake manifold per TSB repair procedure — the TSB identifies a known platform-specific fault consistent with the trim pattern that conventional testing cannot locate

C. Replace the MAF sensor — a resonator crack would cause a rich condition, not lean

D. Replace the upstream O2 sensors — the TSB is not relevant to the fuel trim diagnosis

50. A vehicle has LTFT B1 = −22%, LTFT B2 = −21% at idle. EVAP purge disable shifts both to −11%. After replacing the EVAP purge solenoid, LTFT B1 = −11%, LTFT B2 = −10% at idle. The MOST likely interpretation is:

A. The repair is complete — EVAP was the sole rich source and −11% is within normal range

B. The repair is incomplete — the solenoid replacement eliminated its contribution, but −11% remaining negative LTFT confirms an additional independent rich source that must be identified and repaired

C. The new EVAP purge solenoid has also failed — the same trim pattern confirms a repeat fault

D. The remaining −11% is within normal LTFT operating range and no further diagnosis is needed

BONUS SECTION 1: ANSWER KEY AND EXPLANATIONS

1. A — Both-Bank Idle Vacuum Leak — Both-bank lean trim at idle normalizing at 2,500 RPM is the definitive vacuum leak pattern. Unmetered air downstream of the MAF has proportionally greatest lean effect at idle when total airflow is lowest — the PCM cannot compensate through fuel trim alone as the leak represents a larger percentage of total airflow at idle than at cruise.

2. B — MAF Undercounting All Conditions — Lean trim persisting at all RPM is the key differentiator from a vacuum leak. A vacuum leak normalizes at RPM. A MAF sensor undercounting at all airflow rates produces lean trim at idle and cruise equally — the lean trim pattern at all conditions points directly to a metering fault affecting all operating conditions.

3. C — Single-Bank Vacuum Leak — Bank 2 lean trim at idle normalizing at 2,500 RPM with Bank 1 near zero confirms a single-bank vacuum leak. The lean effect is proportionally greatest at idle on the affected bank — the leak is on the Bank 2 intake side downstream of the MAF where unmetered air enters the Bank 2 runners.

4. D — Weak Bank 2 Injectors — Single-bank lean trim persisting at both idle and 2,500 RPM is the definitive injector or fuel delivery fault pattern. A vacuum leak would normalize at RPM. Lean trim that does not change between idle and cruise conditions confirms the fault is fuel delivery dependent on that bank.

5. A — EVAP Purge Solenoid Stuck Open Confirmed — Immediate fuel trim shift from −19% to −4% when purge is disabled and immediate return to −18% when re-enabled directly confirms the solenoid is delivering canister vapors continuously. This is the definitive EVAP purge stuck-open confirmation test result.

6. B — EVAP Purge Contributing Plus Additional Rich Source — Partial trim shift from −22% to −12% when purge is disabled confirms the solenoid is contributing. The −12% LTFT remaining after disable confirms a second independent rich source — leaking injectors or elevated fuel pressure — is also present and must be identified and repaired separately.

7. C — EVAP Purge WOT Rich Confirmed — Normal trim at idle and cruise confirms fueling is correct at those conditions. Negative trim only at WOT with immediate return to near-zero on purge disable is the definitive WOT-only purge solenoid stuck-open confirmation pattern.

8. D — MAF Undercounting Confirmed by Comparison — A 22% lower output than a known-good vehicle at identical conditions directly confirms the MAF sensor is undercounting. This comparison test is the most reliable method to identify a MAF calibration drift that voltage checking or snap throttle testing alone cannot detect.

9. A — Bank 1 Rear Runner Vacuum Leak — Single-bank lean trim at idle normalizing at cruise confirms a vacuum leak pattern. Immediate STFT correction when propane is introduced near the Bank 1 rear intake port isolates the leak location. Propane displaces the unmetered air source — correcting the lean condition and pinpointing the leak.

10. C — Propane Enrichment to Locate Leak — Both-bank lean trim at idle normalizing at cruise with a negative smoke test does not eliminate a vacuum leak — small cracks at gasket seating surfaces may not seal smoke under normal pressure. Propane enrichment testing is the standard follow-up procedure to locate leaks the smoke test cannot find.

11. C — Elevated Fuel Pressure Rich Source — EVAP purge disable causing no change rules out purge as the rich source. Fuel pressure at 5 psi above the upper specification limit increases injected volume per pulse across all injectors simultaneously. The pressure regulator is not maintaining maximum specified rail pressure, delivering excess fuel at all conditions.

12. D — EVAP Purge WOT-Only Rich Source Confirmed — Normal trim at idle and cruise with WOT-only negative trim that immediately resolves when the EVAP purge solenoid is disabled is the definitive WOT-only stuck-open purge solenoid pattern. The solenoid is opening at WOT and delivering concentrated canister vapors when it should be closed or minimally active.

13. B — Contaminated MAF Pattern — A contaminated MAF sensor produces non-linear output — undercounting at lower airflow rates (lean trim at idle) and overcounting at higher airflow rates (rich trim at cruise). This positive-at-idle, negative-at-cruise fuel trim pattern is the contaminated MAF signature. Negative propane response at the throttle body rules out a throttle area vacuum leak.

14. D — O2 Sensor Contamination Consideration — Both-bank rich trim with all primary rich sources (EVAP, fuel pressure, injectors) ruled out requires considering upstream O2 sensor contamination producing an artificially rich signal that causes the PCM to reduce fueling. A silicone-contaminated O2 sensor fixed at high voltage would produce this exact presentation.

15. B — MAF Undercounting Confirmed by Propane at Inlet — Propane enrichment at the throttle body inlet correcting both-bank lean trim confirms the MAF is undercounting the airflow entering at the inlet. If the lean trim were caused by unmetered air entering downstream at runner locations, propane at the inlet would not correct it — propane at the inlet only corrects a MAF metering error.

16. A — Bank 1 Front Runner Vacuum Leak — Propane response at the Bank 1 front runner with no response at the Bank 1 rear runner isolates the vacuum leak to the front runner area. Propane at the rear runner producing no change rules out that location. Propane at the positive response location directly confirms the leak is at or near that runner gasket or port.

17. A — PCV Leak Confirmed by Pinch Test — Pinching the PCV hose and immediately correcting the lean trim confirms the PCV system is introducing unmetered air into the intake. A

PCV hose with a crack or loose fitting, a stuck-open PCV valve, or a cracked valve cover PCV port are all confirmed by this test as the lean source.

18. C — MAF Replacement Confirmed — A 20% undercounting confirmed by known-good vehicle comparison combined with normal manifold vacuum (ruling out intake restriction as an airflow cause) directly confirms the MAF sensor is the lean source. Replacing the MAF is the correct repair — no additional testing is needed before proceeding.

19. C — Contaminated MAF Non-Linear Pattern — Single-bank lean at idle with single-bank rich at cruise is the contaminated MAF pattern on a V-configuration engine with a bank-specific MAF or a partially contaminated sensor affecting one bank's airflow calculation more at moderate than at low airflow. This non-linear response is the signature of partial contamination.

20. C — Cracked Solenoid Contributing Plus Second Source — A cracked purge solenoid body can deliver vapor even when electrically disabled. The partial trim shift (−24% to −6%) confirms the cracked solenoid was contributing, but −6% remaining negative LTFT after disabling confirms a second independent rich source is present requiring separate identification.

21. A — Brake Booster Diaphragm Leak — Propane enrichment at the brake booster vacuum line fitting immediately correcting both-bank lean trim isolates the unmetered air entry point to the brake booster vacuum source. A leaking brake booster diaphragm introduces manifold vacuum air through the booster vacuum fitting, bypassing the MAF sensor.

22. B — Contaminated MAF Classic Pattern — Near-zero idle trim with lean cruise trim and rich WOT trim is the classic non-linear contaminated MAF pattern. Contamination partially blocks sensor elements causing undercounting at moderate cruise airflow (lean trim) and overcounting at high WOT airflow as the hot wire thermal response is altered (rich trim). This three-condition pattern is nearly pathognomonic for MAF contamination.

23. A — Bank 1 Runner Vacuum Leak Isolated — Negative propane response at the throttle body ruled out a throttle area or MAF fault. Positive propane response at the Bank 1 intake manifold runners confirms the unmetered air is entering at a runner or port gasket location. The systematic proximal-to-distal propane test isolates the vacuum leak step by step.

24. B — Fuel Pressure Regulator Diaphragm Failure — Both-bank rich trim with EVAP, rail pressure, and injectors ruled out points to a regulator diaphragm failure allowing liquid fuel to enter the intake via the vacuum reference port. One injector replacement not improving trim confirms a system-wide rich source independent of individual injector function.

25. A — Pre-MAF or Throttle Body Area Leak — No propane response at any runner location with both-bank idle trim normalizing at RPM rules out individual runner vacuum leaks. The combination of trim pattern consistent with a vacuum leak and negative propane at all runner locations points to a leak at or upstream of the throttle body — a pre-MAF leak would not be detected by runner-level propane tests.

26. A — Single Runner Vacuum Leak Isolated — Propane response at runner 1 only with no response at the throttle body or runners 2, 3, and 4 directly isolates the vacuum leak to runner 1. This targeted propane response pinpoints the leak to the runner 1 port gasket or manifold face gasket at that specific runner location.

27. C — PCV Path Not Smoke-Tested — When all conventional testing is negative and the trim pattern is consistent with a vacuum leak, PCV system paths not included in smoke testing must be inspected manually. Some crankcase breather hoses, open PCV ports, or breather inlets to the intake manifold are not sealed during smoke tests and can introduce unmetered air.

28. C — Fuel Pressure Regulator Diaphragm Confirmed — A functioning fuel pressure regulator should increase fuel pressure when its vacuum reference is capped (removing vacuum reference removes the vacuum assist from the spring side). If pressure drops when the reference is capped, the diaphragm has failed — fuel is flowing through the diaphragm into the vacuum port and entering the intake as liquid fuel, bypassing the injectors.

29. B — MAF Ruled Out by Comparison — Identical MAF g/s output compared to a known-good vehicle at all test RPM points confirms the sensor is accurately measuring airflow. The MAF is not the source of the lean condition — the diagnosis must pursue other causes such as vacuum leaks, injector faults, or PCV system issues.

30. B — Repair Confirmed — LTFT shifting from +22% to +4% after MAF replacement confirms the MAF was the primary lean source and the repair was effective. A residual LTFT of +4% is within the normal operating range of ±10% and does not indicate an additional lean source requiring further diagnosis.

31. B — Dual Rich Sources Confirmed — The EVAP purge solenoid contributing (confirmed by purge disable shifting trim from −19% to −7%) and injector 3 delivering 14% excess volume (confirmed by balance test) are two independent rich sources. Both must be repaired — solenoid replacement alone will not resolve the trim with the excess injector volume also present.

32. A — Intake Duct Crack Between MAF and Throttle Body — A crack downstream of the MAF introduces unmetered air that the MAF does not count. This reduces the calculated air-fuel ratio, causing the PCM to add fuel correction (positive LTFT). The proportionally greatest lean effect at idle when total measured airflow is lowest is fully consistent with the observed both-bank idle lean trim normalizing at cruise.

33. B — Mechanical Causes Ruled Out — Normal cylinder contribution confirms each cylinder is contributing normally — no dead cylinder from mechanical cause or injector failure. Normal compression confirms mechanical integrity. These results confirm the lean trim is caused by an air metering or fuel delivery fault, not a mechanical engine condition.

34. B — Dual Cause: WOT Purge + Cruise MAF Contamination — EVAP purge solenoid confirmed stuck open at WOT (resolved on disable). Cruise lean trim persisting after EVAP purge

disable at cruise confirms a separate lean source at cruise — contaminated MAF undercounting at moderate cruise airflow is the most consistent explanation for persistent lean trim at cruise that is not present at idle.

35. A — Low Volumetric Efficiency as Lean Root Cause — When all air metering and fuel delivery components are confirmed normal, a VE calculation showing significantly reduced cylinder filling identifies the root cause. Low VE means actual combustion airflow is lower than calculated — the PCM adds fuel to compensate (positive LTFT), but the underlying cause is reduced cylinder filling requiring further investigation (timing, rings, valve seating).

36. A — Injector Leak-Down Test — With all external rich sources confirmed normal and O2 sensors confirmed functional, injector leak-down testing identifies leaking injectors that deliver excess fuel during closed-valve periods. Leaking injectors can produce rich trim at all conditions without any evidence on an electrical balance test or waveform.

37. A — Intake Restriction Upstream of MAF — When fresh air introduced at the MAF outlet corrects both-bank lean trim, the MAF is confirmed accurate but the engine is not receiving adequate airflow. A restriction upstream of the MAF — clogged air filter, collapsed air box, or restricted intake tube — reduces actual airflow to the engine below what the MAF registers, producing lean combustion with accurate MAF output.

38. B — Single-Bank Lean Rules Out MAF — A MAF sensor serves the entire engine and any MAF fault affects both banks simultaneously. Single-bank lean trim at all conditions with normal opposite-bank trim confirms the fault is bank-specific — a Bank 1 vacuum leak, weak injectors, or an upstream O2 sensor issue affecting only that bank.

39. B — Water Spray Vacuum Leak Confirmation — Water spray temporarily sealing a vacuum leak produces a momentary RPM change as the PCM responds to the sudden lean trim correction. An immediate RPM drop when water contacts the Bank 1 rear manifold area confirms a vacuum leak at that location — the water momentarily seals the unmetered air entry causing a brief mixture enrichment.

40. B — Oil Consumption Contributing to Rich Trim — A wet compression increase of 53 psi on cylinder 3 confirms the rings are not sealing dry — oil is being drawn past the rings and burned during combustion. Combustion of oil introduces additional carbon and partially reduces combustion efficiency while also contributing hydrocarbon-rich exhaust that the O2 sensor interprets as rich combustion, causing the PCM to reduce fuel delivery.

41. A — MAF Undercounting Confirmed — Propane at the throttle body inlet correcting both-bank lean trim confirms the MAF is undercounting at the inlet. If the lean source were downstream vacuum leaks at runner locations, propane at the inlet would not correct the lean trim — it would only add fuel without eliminating the unmetered air entry. A positive inlet response points to a metering error at the MAF, not a downstream leak.

42. B — Fuel Pressure Regulator Repair Confirmed — Fuel pressure was confirmed 3 psi above the upper specification limit. Replacing the regulator restored pressure to 59 psi within spec. Excess rail pressure increasing injected volume was the confirmed rich source — returning pressure to specification will allow both-bank LTFT to normalize toward zero on subsequent fuel trim observation.

43. A — Pinhole Vacuum Hose Crack Confirmed — A pinhole crack in any vacuum hose downstream of the MAF sensor introduces unmetered air into the intake manifold. Even very small cracks can introduce sufficient air to generate significant lean trim at idle — the lean effect is proportionally greatest at idle. This is consistent with both-bank idle lean trim normalizing at cruise as total airflow increases.

44. B — Upstream O2 Sensor Contamination — Single-bank lean trim at all RPM with no vacuum leak found at any tested location (propane negative at runners and throttle body), normal MAF and fuel pressure confirms no air or fuel metering fault on Bank 1. A Bank 1 upstream O2 sensor contaminated with silicone or other contaminant producing a persistently low-voltage (lean) output causes the PCM to add fuel continuously — presenting as persistent single-bank positive LTFT at all conditions.

45. C — PCV System Inspection — With all conventional tests negative, PCV system components not pressurized during smoke testing must be physically inspected. PCV valve function, breather hose condition, and open manifold PCV ports require direct inspection. Some PCV inlets to the intake manifold are positioned above the smoke sealing points and are not tested by standard smoke machine procedures.

46. B — Solenoid Temperature Confirms Continuous Flow — A purge solenoid at 280°F during idle (spec under 180°F) confirms continuous vapor flow through the solenoid body. Vapor flowing continuously through the solenoid heats it above normal operating temperature. Combined with confirmed fuel trim response on disable, the elevated temperature provides additional physical confirmation of a stuck-open condition.

47. A — Disconnected PCV Hose Open to Atmosphere — A PCV hose with an open end at the manifold connection creates a direct unmetered air path into the intake manifold. The open end acts identically to any other vacuum leak — introducing air that bypasses the MAF sensor. Both-bank idle lean trim normalizing at RPM is fully consistent with this type of unmetered air entry at manifold vacuum.

48. B — Repair Confirmed Complete — LTFT dropping from +22% at idle to +4% after gasket replacement confirms the gaskets were the primary lean source. Residual +4% LTFT is within the normal ±10% operating range. The trim pattern has resolved — no more high idle lean trim normalizing at RPM. The repair is confirmed effective.

49. B — TSB Repair Indicated — A TSB identifying a known platform-specific intake resonator internal crack causing unmetered air entry at idle that conventional smoke and propane testing

cannot locate is directly applicable when the exact trim pattern is present and all conventional testing is negative. TSB procedures are the manufacturer's confirmed repair methodology for known diagnostic dead-ends.

50. B — Second Rich Source Confirmed — After EVAP purge solenoid replacement, LTFT shifting from −22% to −11% confirms the solenoid was contributing but a second independent rich source remains. −11% negative LTFT is outside the normal ±10% range and confirms continued rich combustion from a separate cause — leaking injectors, elevated fuel pressure, or a regulator fault — that must be identified and repaired.