

High School General or Applied Science - This document contains STEM initiatives and Next Generation Science Standards connections to be used as a guideline in conjunction with *Being Relevant Matters*, a NATEF publication on English, Math and Science integration with automotive technology at the MLR, AST, MAST program accreditation levels.

I. ENGINE REPAIR

A. General: Engine Diagnosis; Removal and Reinstallation (R & R)

		Science Principle/Concept	AST TASK	MLR TASK
1. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.	P-1		X	
2. Research applicable vehicle and service information, such as internal engine operation, vehicle service history, service precautions, and technical service bulletins.	P-1	engine operation 4 stroke engine, expansion of gas, compression, flame spread, head type	X	X
3. Verify operation of the instrument panel engine warning indicators.	P-1	types of switches, sending units and switches		
4. Inspect engine assembly for fuel, oil, coolant, and other leaks; determine necessary action.	P-1	environmental issues, handling waste products	X	X
5. Install engine covers using gaskets, seals, and sealers as required.	P-1	chemistry of sealants	X	X
6. Remove and replace timing belt; verify correct camshaft timing.	P-1		X	X
7. Perform common fastener and thread repair, to include: remove broken bolt, restore internal and external threads, and repair internal threads with thread insert.	P-1	metallurgy, torque to yield	X	X
8. Inspect, remove and replace engine mounts.	P-2		X	
9. Identify hybrid vehicle internal combustion engine service precautions.	P-3		X	X
10. Remove and reinstall engine in an OBDII or newer vehicle; reconnect all attaching components and restore the vehicle to running condition.	P-3	proper lifting techniques	X	

I. ENGINE REPAIR

B. Cylinder Head and Valve Train Diagnosis and Repair

AST MLR
TASK TASK

1. Remove cylinder head; inspect gasket condition; install cylinder head and gasket; tighten according to manufacturer's specifications and procedures.	P-1	torque, clamping force, one time use of fasteners, metal fatigue	X	
2. Clean and visually inspect a cylinder head for cracks; check gasket surface areas for warpage and surface finish; check passage condition.	P-1	metallurgy, chemical identification of cracks, warpage issues	X	
3. Inspect pushrods, rocker arms, rocker arm pivots and shafts for wear, bending, cracks, looseness, and blocked oil passages (orifices); determine necessary action.	P-2	friction and wear	X	
4. Adjust valves (mechanical or hydraulic lifters).	P-1		X	X
5. Inspect and replace camshaft and drive belt/chain; includes checking drive gear wear and backlash, end play, sprocket and chain wear, overhead cam drive sprocket(s), drive belt(s), belt tension, tensioners, camshaft reluctor ring/tone-wheel, and valve timing components; verify correct camshaft timing.	P-1	friction and wear		
6. Establish camshaft position sensor indexing.	P-1			
7. Inspect valve springs for squareness and free height comparison; determine necessary action.	P-3	metal fatigue		
8. Replace valve stem seals on an assembled engine; inspect valve spring retainers, locks/keepers, and valve lock/keeper grooves; determine necessary action.	P-3			
9. Inspect valve guides for wear; check valve stem-to-guide clearance; determine necessary action.	P-3	friction and wear		
10. Inspect valves and valve seats; determine necessary action.	P-3			
11. Check valve spring assembled height and valve stem height; determine necessary action.	P-3			

12. Inspect valve lifters; determine necessary action.	P-2
13. Inspect and/or measure camshaft for runout, journal wear and lobe wear.	P-2
14. Inspect camshaft bearing surface for wear, damage, out-of-round, and alignment; determine necessary action.	P-3

I. ENGINE REPAIR

C. Engine Block Assembly Diagnosis and Repair

1. Remove, inspect, or replace crankshaft vibration damper (harmonic balancer).	P-2	X
2. Disassemble engine block; clean and prepare components for inspection and reassembly.	P-1	chemical solvents and environmental issues
3. Inspect engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage; determine necessary action.	P-2	
4. Inspect and measure cylinder walls/sleeves for damage, wear, and ridges; determine necessary action.	P-2	
5. Deglaze and clean cylinder walls.	P-2	
6. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment; determine necessary action.	P-3	
7. Inspect crankshaft for straightness, journal damage, keyway damage, thrust flange and sealing surface condition, and visual surface cracks; check oil passage condition; measure end play and journal wear; check crankshaft position sensor reluctor ring (where applicable); determine necessary action.	P-1	friction and wear

8. Inspect main and connecting rod bearings for damage and wear; determine necessary action.	P-2	friction and wear
9. Identify piston and bearing wear patterns that indicate connecting rod alignment and main bearing bore problems; determine necessary action.	P-3	friction and wear
10. Inspect and measure piston skirts and ring lands; determine necessary action.	P-2	friction and wear
11. Determine piston-to-bore clearance.	P-2	friction and wear
12. Inspect, measure, and install piston rings.	P-2	friction and wear
13. Inspect auxiliary shaft(s) (balance, intermediate, idler, counterbalance or silencer); inspect shaft(s) and support bearings for damage and wear; determine necessary action; reinstall and time.	P-2	friction and wear
14. Assemble engine block.	P-1	friction and wear

I. ENGINE REPAIR

D. Lubrication and Cooling Systems Diagnosis and Repair

1. Perform cooling system pressure and dye tests to identify leaks; check coolant condition and level; inspect and test radiator, pressure cap, coolant recovery tank, heater core and galley plugs; determine necessary action.	P-1	Antifreeze chemistry, heat transfer, pressure vs. boiling point	X	X
2. Identify causes of engine overheating.	P-1			
3. Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment.	P-1		X	X

			AST TASK	MLR TASK
4. Inspect and test coolant; drain and recover coolant; flush and refill cooling system with recommended coolant; bleed air as required.	P-1	environmental issues, recycling coolant	X	X
5. Inspect, remove, and replace water pump.	P-2		X	
6. Remove and replace radiator.	P-2		X	
7. Remove, inspect, and replace thermostat and gasket/seal.	P-1	thermostat operation properties	X	X
8. Inspect and test fan(s) (electrical or mechanical), fan clutch, fan shroud, and air dams.	P-1	fluid coupling	X	
9. Perform oil pressure tests; determine necessary action.	P-1		X	
10. Perform engine oil and filter change.	P-1	oil weight, viscosity, additives, synthetics	X	X
11. Inspect auxiliary coolers; determine necessary action.	P-3	heat transfer	X	
12. Inspect, test, and replace oil temperature and pressure switches and sensors.	P-2	pressure transducer	X	
13. Inspect oil pump gears or rotors, housing, pressure relief devices, and pump drive; perform necessary action.	P-2	wear and friction		

II. AUTOMATIC TRANSMISSION AND TRANSAXLE

A. General: Transmission and Transaxle Diagnosis

1. Identify and interpret transmission/transaxle concern, differentiate between engine performance and transmission/transaxle concerns; determine necessary action.	P-1		X	
2. Research applicable vehicle and service information fluid type, vehicle service history, service precautions, and technical service bulletins.	P-1	fluid chemistry, environmental issues	X	X

			AST TASK	MLR TASK
3. Diagnose fluid loss and condition concerns; determine necessary action.	P-1	EPA, pressure vs volume	X	
4. Check fluid level in a transmission or a transaxle equipped with a dip-stick.	P-1	thermal effect on fluids	X	X
5. Check fluid level in a transmission or a transaxle not equipped with a dip-stick.	P-1	thermal effect on fluids	X	X
6. Perform pressure tests (including transmissions/transaxles equipped with electronic pressure control); determine necessary action.	P-1	Pascal's law		
7. Diagnose noise and vibration concerns; determine necessary action.	P-2	balancing and phasing of the drive line		
8. Perform stall test; determine necessary action.	P-3		X	
9. Perform lock-up converter system tests; determine necessary action.	P-3		X	
10. Diagnose transmission/transaxle gear reduction/multiplication concerns using driving, driven, and held member (power flow) principles.	P-1	fluid dynamics	X	
11. Diagnose electronic transmission/transaxle control systems using appropriate test equipment and service information.	P-1	fluid dynamics		
12. Diagnose pressure concerns in a transmission using hydraulic principles (Pascal's Law).	P-2	Pascal's Law	X	

II. AUTOMATIC TRANSMISSION AND TRANSAXLE

B. In-Vehicle Transmission/Transaxle Maintenance and Repair

1. Inspect, adjust, and replace external manual valve shift linkage, transmission range sensor/switch, and park/neutral position switch.	P-2	chemistry of sealants	X	X
2. Inspect for leakage; replace external seals, gaskets, and bushings.	P-2		X	X

3. Inspect, test, adjust, repair, or replace electrical/electronic components and circuits including computers, solenoids, sensors, relays, terminals, connectors, switches, and harnesses.	P-1	basic principles of electrical circuitry	X	
4. Drain and replace fluid and filter(s).	P-1	environmental issues when handling fluids	X	X
5. Inspect, replace and align powertrain mounts.	P-2		X	X

II. AUTOMATIC TRANSMISSION AND TRANSAXLE

C. Off-Vehicle Transmission and Transaxle Repair

1. Remove and reinstall transmission/transaxle and torque converter; inspect engine core plugs, rear crankshaft seal, dowel pins, dowel pin holes, and mating surfaces.	P-1	ergonomics (science of lifting properly)	X	
2. Inspect, leak test, and flush or replace transmission/transaxle oil cooler, lines, and fittings.	P-1	fluid dynamics	X	
3. Inspect converter flex (drive) plate, converter attaching bolts, converter pilot, converter pump drive surfaces, converter end play, and crankshaft pilot bore.	P-2		X	
4. Describe the operational characteristics of a continuously variable transmission (CVT).	P-3	rotational inertia	X	X
5. Describe the operational characteristics of a hybrid vehicle drive train.	P-3	power conversions	X	X
6. Disassemble, clean, and inspect transmission/transaxle.	P-2	chemical reaction on with metals		
7. Inspect, measure, clean, and replace valve body (includes surfaces, bores, springs, valves, sleeves, retainers, brackets, checkvalves/balls, screens, spacers, and gaskets).	P-2	metal fatigue, types of gasket materials		

8. Inspect servo and accumulator bores, pistons, seals, pins, springs, and retainers; determine necessary action.	P-2	
9. Assemble transmission/transaxle.	P-2	sequential torquing
10. Inspect, measure, and reseal oil pump assembly and components.	P-2	torque effect on fasteners
11. Measure transmission/transaxle end play or preload; determine necessary action.	P-1	
12. Inspect, measure, and replace thrust washers and bearings.	P-2	
13. Inspect oil delivery circuits, including seal rings, ring grooves, and sealing surface areas, feed pipes, orifices, and check valves/balls.	P-2	
14. Inspect bushings; determine necessary action.	P-2	
15. Inspect and measure planetary gear assembly components; determine necessary action.	P-2	friction and wear
16. Inspect case bores, passages, bushings, vents, and mating surfaces; determine necessary action.	P-2	friction and wear
17. Diagnose and inspect transaxle drive, link chains, sprockets, gears, bearings, and bushings; perform necessary action.	P-2	
18. Inspect, measure, repair, adjust or replace transaxle final drive components.	P-2	
19. Inspect clutch drum, piston, check-balls, springs, retainers, seals, and friction and pressure plates, bands and drums; determine necessary action.	P-2	
20. Measure clutch pack clearance; determine necessary action.	P-1	

21. Air test operation of clutch and servo assemblies. P-1 hydraulics and pneumatics

22. Inspect roller and sprag clutch, races, rollers, sprags, springs, cages, retainers; determine necessary action. P-2 friction and wear

III. MANUAL DRIVE TRAIN AND AXLES

A. General: Drive Train Diagnosis

1. Identify and interpret drive train concerns; determine necessary action.	P-1		X	
2. Research applicable vehicle and service information, fluid type, vehicle service history, service precautions, and technical service bulletins.	P-1	EPA, environmental issues, chemistry of fluids	X	X
3. Check fluid condition; check for leaks; determine necessary action.	P-1		X	X
4. Drain and refill manual transmission/transaxle and final drive unit.	P-1	chemistry of fluids	X	X

III. MANUAL DRIVE TRAIN AND AXLES

B. Clutch Diagnosis and Repair

1. Diagnose clutch noise, binding, slippage, pulsation, and chatter; determine necessary action.	P-1	coefficient of friction, clutch materials, fluid dynamics	X	
2. Inspect clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary action.	P-1		X	
3. Inspect and replace clutch pressure plate assembly, clutch disc, release (throw-out) bearing and linkage, and pilot bearing/bushing (as applicable).	P-1		X	
4. Bleed clutch hydraulic system.	P-1	Pascal's Law	X	

			AST TASK	MLR TASK
5.	Check and adjust clutch master cylinder fluid level; check for leaks.	P-1	disposal of fluids, fluid types	X
6.	Inspect flywheel and ring gear for wear and cracks; determine necessary action.	P-1	thermal metal fatigue, rotational inertia	X
7.	Measure flywheel runout and crankshaft end play; determine necessary action.	P-2	friction and wear	X

III. MANUAL DRIVE TRAIN AND AXLES

C. Transmission/Transaxle Diagnosis and Repair

1.	Inspect, adjust, and reinstall shift linkages, brackets, bushings, cables, pivots, and levers.	P-2		X
2.	Describe the operational characteristics of an electronically-controlled manual transmission/transaxle.	P-3	review of fundamentals of electricity level I	X
3.	Diagnose noise concerns through the application of transmission/transaxle powerflow principles.	P-2	kinetic motion	
4.	Diagnose hard shifting and jumping out of gear concerns; determine necessary action.	P-2	metal wear and friction	
5.	Diagnose transaxle final drive assembly noise and vibration concerns; determine necessary action.	P-3	friction and wear	
6.	Disassemble, inspect clean, and reassemble internal transmission/transaxle	P-3		

III. MANUAL DRIVE TRAIN AND AXLES

D. Drive Shaft and Half Shaft, Universal and Constant-Velocity (CV) Joint Diagnosis and Repair

AST MLR
TASK TASK

1. Diagnose constant-velocity (CV) joint noise and vibration concerns; determine necessary action.	P-1	friction and wear	X	
2. Diagnose universal joint noise and vibration concerns; perform necessary action.	P-2		X	
3. Inspect, remove, and replace front wheel drive (FWD) bearings, hubs, and seals.	P-1		X	X
4. Inspect, service, and replace shafts, yokes, boots, and universal/CV joints.	P-1		X	X
5. Check shaft balance and phasing; measure shaft runout; measure and adjust driveline angles.	P-2	balance, center of gravity	X	

III. MANUAL DRIVE TRAIN AND AXLES

E. Drive Axle Diagnosis and Repair

E.1 Ring and Pinion Gears and Differential Case Assembly

1. Clean and inspect differential housing; check for leaks; inspect housing vent.	P-2	metallurgy	X	X
2. Check and adjust differential housing fluid level.	P-1	fluid dynamics	X	X
3. Drain and refill differential housing.	P-1	EPA and environmental issues	X	X
4. Diagnose noise and vibration concerns; determine necessary action.	P-2	harmonic effects		
5. Inspect and replace companion flange and pinion seal; measure companion flange runout.	P-2	fluid dynamics	X	
6. Inspect ring gear and measure runout; determine necessary action.	P-3			

7. Remove, inspect, and reinstall drive pinion and ring gear, spacers, sleeves, and	P-3	
8. Measure and adjust drive pinion depth.	P-3	
9. Measure and adjust drive pinion bearing preload.	P-3	
10. Measure and adjust side bearing preload and ring and pinion gear total backlash and backlash variation on a differential carrier assembly (threaded cup or shim types).	P-3	
11. Check ring and pinion tooth contact patterns; perform necessary action.	P-3	simple machines, gears and levers
12. Disassemble, inspect, measure, and adjust or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.	P-3	friction and wear
13. Reassemble and reinstall differential case assembly; measure runout; determine necessary action.	P-3	

E.2 Limited Slip Differential

1. Diagnose noise, slippage, and chatter concerns; determine necessary action.	P-3	fluid dynamics
2. Measure rotating torque; determine necessary action.	P-3	definition of torque

E.3 Drive Axles

1. Inspect and replace drive axle wheel studs.	P-1	states of a fastener	X	X
2. Remove and replace drive axle shafts.	P-1		X	
3. Inspect and replace drive axle shaft seals, bearings, and retainers.	P-2		X	
4. Measure drive axle flange runout and shaft end play; determine necessary action.	P-2		X	

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|--|-----|---|--|--|
| 5. Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine necessary action. | P-2 | chemistry of seals and sealants, environmental issues, harmonic effects | | |
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III. MANUAL DRIVE TRAIN AND AXLES

F. Four-wheel Drive/All-wheel Drive Component Diagnosis and Repair

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|--|-----|--|---|---|
| 1. Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets. | P-3 | electrical fundamentals and principles of vacuum | X | |
| 2. Inspect front-wheel bearings and locking hubs; perform necessary action(s). | P-3 | friction and wear | X | X |
| 3. Check for leaks at drive assembly seals; check vents; check lube level. | P-3 | environmental issues | X | X |
| 4. Identify concerns related to variations in tire circumference and/or final drive ratios. | P-3 | simple machines | X | |
| 5. Diagnose noise, vibration, and unusual steering concerns; determine necessary action. | P-3 | harmonic effects, enter of gravity | | |
| 6. Diagnose, test, adjust, and replace electrical/electronic components of four-wheel drive systems. | P-3 | electrical fundamentals | | |
| 7. Disassemble, service, and reassemble transfer case and components. | P-3 | | | |

IV. SUSPENSION AND STEERING

A. General: Suspension and Steering Systems

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|--|-----|----------------------|---|---|
| 1. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins. | P-1 | environmental issues | X | X |
| 2. Identify and interpret suspension and steering system concerns; determine necessary action. | P-1 | | | |

IV. SUSPENSION AND STEERING

B. Steering Systems Diagnosis and Repair

			AST TASK	MLR TASK
1. Disable and enable supplemental restraint system (SRS).	P-1	chemical reactions	X	X
2. Remove and replace steering wheel; center/time supplemental restraint system (SRS) coil (clock spring).	P-1	basic electrical	X	
3. Diagnose steering column noises, looseness, and binding concerns (including tilt mechanisms); determine necessary action.	P-2	wear and fatigue	X	
4. Diagnose power steering gear (non-rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action.	P-2	friction, levers	X	
5. Diagnose power steering gear (rack and pinion) binding, uneven turning effort, looseness, hard steering, and noise concerns; determine necessary action.	P-2	fluid dynamics	X	
6. Inspect steering shaft universal-joint(s), flexible coupling(s), collapsible column, lock cylinder mechanism, and steering wheel; perform necessary action.	P-2	friction and wear	X	
7. Remove and replace rack and pinion steering gear; inspect mounting bushings and	P-2		X	
8. Inspect rack and pinion steering gear inner tie rod ends (sockets) and bellows boots; replace as needed.	P-2	properties of materials	X	
9. Determine proper power steering fluid type; inspect fluid level and condition.	P-1	chemistry of fluids	X	X
10. Flush, fill, and bleed power steering system.	P-2		X	X
11. Inspect for power steering fluid leakage; determine necessary action.	P-1	environmental issues	X	X
12. Remove, inspect, replace, and adjust power steering pump drive belt.	P-1		X	X
13. Remove and reinstall power steering pump.	P-2		X	

			AST TASK	MLR TASK
14. Remove and reinstall press fit power steering pump pulley; check pulley and belt	P-2	simple machines	X	
15. Inspect and replace power steering hoses and fittings.	P-2	hydraulics	X	X
16. Inspect and replace pitman arm, relay (centerlink/intermediate) rod, idler arm and mountings, and steering linkage damper.	P-2	friction and wear, harmonic effects	X	X
17. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps.	P-1	friction and wear	X	X
18. Test and diagnose components of electronically-controlled steering systems using a scan tool; determine necessary action.	P-3	electronic diagnosis		
19. Identify hybrid vehicle power steering system electrical circuits and safety precautions.	P-2	electronic diagnosis	X	X
20. Inspect electric power-assisted steering.	P-3	electronic diagnosis	X	X

IV. SUSPENSION AND STEERING

C. Suspension Systems Diagnosis and Repair

1. Diagnose short and long arm suspension system noises, body sway, and uneven ride height concerns; determine necessary action.	P-1		X	
2. Diagnose strut suspension system noises, body sway, and uneven ride height concerns; determine necessary action.	P-1	harmonic effects, aerodynamics	X	
3. Inspect, remove and install upper and lower control arms, bushings, shafts, and rebound bumpers.	P-3	friction and wear	X	X
4. Inspect, remove and install strut rods and bushings.	P-3	friction and wear	X	X
5. Inspect, remove and install upper and/or lower ball joints (with or without wear	P-2	friction and wear	X	X

			AST TASK	MLR TASK
6. Inspect, remove and install steering knuckle assemblies.	P-3	friction and wear	X	
7. Inspect, remove and install short and long arm suspension system coil springs and spring insulators.	P-3	friction and wear	X	
8. Inspect, remove and install torsion bars and mounts.	P-3	friction and wear	X	X
9. Inspect, remove and install front stabilizer bar (sway bar) bushings, brackets, and links.	P-3	friction and wear	X	X
10. Inspect, remove and install strut cartridge or assembly, strut coil spring, insulators (silencers), and upper strut bearing mount.	P-3	friction and wear	X	X
11. Inspect, remove and install track bar, strut rods/radius arms, and related mounts and bushings.	P-3	friction and wear	X	X
12. Inspect rear suspension system leaf spring(s), bushings, center pins/bolts, and mounts.	P-1	friction and wear	X	X

IV. SUSPENSION AND STEERING

D. Related Suspension and Steering Service

1. Inspect, remove, and replace shock absorbers; inspect mounts and bushings.	P-1	pneumatics	X	X
2. Remove, inspect, and service or replace front and rear wheel bearings.	P-1	coefficient of friction, bearing types	X	
3. Describe the function of the power steering pressure switch.	P-3	electrical fundamentals	X	X

IV. SUSPENSION AND STEERING

E. Wheel Alignment Diagnosis, Adjustment, and Repair

AST MLR
TASK TASK

1. Diagnose vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns; determine necessary action.	P-1	balancing of forces	X	
2. Perform prealignment inspection and measure vehicle ride height; perform necessary	P-1		X	X
3. Prepare vehicle for wheel alignment on alignment machine; perform four-wheel alignment by checking and adjusting front and rear wheel caster, camber and toe as required; center steering wheel.	P-1		X	
4. Check toe-out-on-turns (turning radius); determine necessary action.	P-2		X	
5. Check SAI (steering axis inclination) and included angle; determine necessary action.	P-2		X	
6. Check rear wheel thrust angle; determine necessary action.	P-1		X	
7. Check for front wheel setback; determine necessary action.	P-2		X	
8. Check front and/or rear cradle (subframe) alignment; determine necessary action.	P-3		X	
9. Reset steering angle sensor	P-2	electrical fundamentals	X	

IV. SUSPENSION AND STEERING

F. Wheels and Tires Diagnosis and Repair

1. Inspect tire condition; identify tire wear patterns; check for correct tire size and application (load and speed ratings) and adjust air pressure; determine necessary action.	P-1	material science, rubber and rubber compounds	X	X
2. Diagnose wheel/tire vibration, shimmy, and noise; determine necessary action.	P-2	harmonic effects	X	
3. Rotate tires according to manufacturer's recommendations.	P-1	friction and wear	X	X

			AST TASK	MLR TASK
4. Measure wheel, tire, axle flange, and hub runout; determine necessary action.	P-2		X	
5. Diagnose tire pull problems; determine necessary action.	P-2	balancing of forces	X	
6. Dismount, inspect, and remount tire on wheel; balance wheel and tire assembly (static and dynamic).	P-1	center of gravity	X	X
7. Dismount, inspect, and remount tire on wheel equipped with tire pressure monitoring system sensor.	P-2		X	X
8. Inspect tire and wheel assembly for air loss; perform necessary action.	P-1	rim corrosion	X	X
9. Repair tire using internal patch.	P-1	vulcanization	X	X
10. Identify and test tire pressure monitoring system (indirect and direct) for operation; calibrate system; verify operation of instrument panel lamps.	P-2	electronics diagnosis	X	X
11. Demonstrate knowledge of steps required to remove and replace sensors in a tire pressure monitoring system.	P-1	electronics diagnosis	X	X

V. BRAKES

A. General: Brake Systems Diagnosis

1. Identify and interpret brake system concerns; determine necessary action.	P-1	friction and wear	X	
2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.	P-1	EPA environmental issues	X	X
3. Describe procedure for performing a road test to check brake system operation; including an anti-lock brake system (ABS).	P-1		X	X
4. Install wheel and torque lug nuts.	P-1	torque and clamping force	X	X

V. BRAKES

B. Hydraulic System Diagnosis and Repair

			AST TASK	MLR TASK
1. Diagnose pressure concerns in the brake system using hydraulic principles (Pascal's	P-1	Pascal's Law	X	
2. Measure brake pedal height, travel, and free play (as applicable); determine necessary action.	P-1		X	X
3. Check master cylinder for internal/external leaks and proper operation; determine necessary action.	P-1	EPA environmental issues	X	X
4. Remove, bench bleed, and reinstall master cylinder.	P-1	fluids	X	
5. Diagnose poor stopping, pulling or dragging concerns caused by malfunctions in the hydraulic system; determine necessary action.	P-3	Pascal's Law	X	
6. Inspect brake lines, flexible hoses, and fittings for leaks, dents, kinks, rust, cracks, bulging, and wear; check for loose fittings and supports; determine necessary action.	P-1	chemistry of fluids (brake), corrosion of materials	X	X
7. Replace brake lines, hoses, fittings, and supports.	P-2		X	
8. Fabricate brake lines using proper material and flaring procedures (double flare and ISO types).	P-2	deformation of metal	X	
9. Select, handle, store, and fill brake fluids to proper level.	P-1	EPA and environmental issues	X	X
10. Inspect, test, and/or replace components of brake warning light system.	P-3	electrical fundamentals	X	
11. Identify components of brake warning light system.	P-2	electrical fundamentals	X	X
12. Bleed and/or flush brake system.	P-1	dynamics	X	X

			AST TASK	MLR TASK
13. Test brake fluid for contamination.	P-1	chemistry of fluids (brake)	X	X

V. BRAKES

C. Drum Brake Diagnosis and Repair

1. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging or pedal pulsation concerns; determine necessary action.	P-1	coefficient of friction, center of gravity, friction and wear, harmonic effects	X	
2. Remove, clean, inspect, and measure brake drum diameter; determine necessary action.	P-1	EPA environmental issues	X	X
3. Refinish brake drum and measure final drum diameter; compare with specifications.	P-1	metallurgy, coefficient of friction	X	X
4. Remove, clean, and inspect brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble.	P-1	EPA environmental issues, chemistry of bonding agents, chemistry of lubricants	X	X
5. Inspect wheel cylinders for leaks and proper operation; remove and replace as needed.	P-2	EPA environmental issues, fluid dynamics	X	X
6. Pre-adjust brake shoes and parking brake; install brake drums or drum/hub assemblies and wheel bearings; perform final checks and adjustments.	P-2		X	X

V. BRAKES

D. Disc Brake Diagnosis and Repair

1. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pulsation concerns; determine necessary action.	P-1	coefficient of friction, center of gravity, friction and wear, harmonic effects	X	
2. Remove and clean caliper assembly; inspect for leaks and damage/wear to caliper housing; determine necessary action.	P-1	friction and wear, EPA environmental issues	X	X

			AST TASK	MLR TASK
3. Clean and inspect caliper mounting and slides/pins for proper operation, wear, and damage; determine necessary action.	P-1	friction and wear, chemistry of bonding agents	X	X
4. Remove, inspect, and replace pads and retaining hardware; determine necessary action.	P-1		X	X
5. Lubricate and reinstall caliper, pads, and related hardware; seat pads and inspect for leaks.	P-1	chemistry of lubricants, EPA environmental issues	X	X
6. Clean and inspect rotor; measure rotor thickness, thickness variation, and lateral runout; determine necessary action.	P-1	EPA environmental, friction and wear, thermal effects on metals	X	X
7. Remove and reinstall rotor.	P-1		X	X
8. Refinish rotor on vehicle; measure final rotor thickness and compare with specifications.	P-1		X	X
9. Refinish rotor off vehicle; measure final rotor thickness and compare with specifications.	P-1	coefficient of friction	X	X
10. Retract and re-adjust caliper piston on an integrated parking brake system.	P-3	simple machines, leverage	X	X
11. Check brake pad wear indicator; determine necessary action.	P-2	coefficient of friction, wear	X	X
12. Describe importance of operating vehicle to burnish/break-in replacement brake pads according to manufacturer's recommendations.	P-1	coefficient of friction	X	X

V. BRAKES

E. Power-Assist Units Diagnosis and Repair

AST
TASK MLR
TASK

1. Check brake pedal travel with, and without, engine running to verify proper power booster operation.	P-2	vacuum principles	X	X
2. Check vacuum supply (manifold or auxiliary pump) to vacuum-type power booster.	P-1	review four stroke engine theory (intake)	X	X
3. Inspect vacuum-type power booster unit for leaks; inspect the check-valve for proper operation; determine necessary action.	P-1	vacuum principles	X	
4. Inspect and test hydraulically-assisted power brake system for leaks and proper operation; determine necessary action.	P-3	Pascal's Law, EPA environmental issues	X	
5. Measure and adjust master cylinder pushrod length.	P-3		X	

V. BRAKES

F. Miscellaneous (Wheel Bearings, Parking Brakes, Electrical, Etc.) Diagnosis and Repair

1. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; determine necessary action.	P-3	friction and wear, harmonics	X	
2. Remove, clean, inspect, repack, and install wheel bearings; replace seals; install hub and adjust bearings.	P-1	chemistry of lubricants, chemistry of materials (seals)	X	X
3. Check parking brake cables and components for wear, binding, and corrosion; clean, lubricate, adjust or replace as needed.	P-2	chemistry of lubricants, friction and wear, principles of corrosion	X	X
4. Check parking brake operation and parking brake indicator light system operation; determine necessary action.	P-1	electrical fundamentals	X	X
5. Check operation of brake stop light system.	P-1	electrical fundamentals	X	X

			AST TASK	MLR TASK
6. Replace wheel bearing and race.	P-2		X	X
7. Remove and reinstall sealed wheel bearing assembly.	P-2		X	
8. Inspect and replace wheel studs.	P-1	torque, metal fatigue, states of fasteners	X	X

V. BRAKES

G. Electronic Brake, Traction and Stability Control Systems Diagnosis and Repair

1. Identify and inspect electronic brake control system components; determine necessary action.	P-1	electronic diagnostics	X	
2. Identify traction control/vehicle stability control system components.	P-3	electronic diagnostics	X	X
3. Describe the operation of a regenerative braking system.	P-3	electronic diagnostics, energy transfer	X	X
4. Diagnose poor stopping, wheel lock-up, abnormal pedal feel, unwanted application, and noise concerns associated with the electronic brake control system; determine	P-2	wear and friction, chemistry of fluids, harmonic effects, electronic diagnostics		
5. Diagnose electronic brake control system electronic control(s) and components by retrieving diagnostic trouble codes, and/or using recommended test equipment; determine	P-2	electronic diagnostics		
6. Depressurize high-pressure components of an electronic brake control system.	P-3	Pascal's Law, electronic diagnostics		
7. Bleed the electronic brake control system hydraulic circuits.	P-1	EPA, Pascal's Law, electronic diagnostics		
8. Test, diagnose, and service electronic brake control system speed sensors (digital and analog), toothed ring (tone wheel), and circuits using a graphing multimeter (GMM)/digital storage oscilloscope (DSO) (includes output signal, resistance, shorts to voltage/ground, and frequency data).	P-3	electronic diagnostics		
9. Diagnose electronic brake control system braking concerns caused by vehicle modifications (tire size, curb height, final drive ratio, etc.).	P-3	electronic diagnostics, balancing of forces		

VI. ELECTRICAL/ELECTRONIC SYSTEMS

A. General: Electrical System Diagnosis

			AST TASK	MLR TASK
1. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.	P-1	Environmental Science	X	X
2. Demonstrate knowledge of electrical/electronic series, parallel, and series-parallel circuits using principles of electricity (Ohm's Law).	P-1	electrical fundamentals	X	X
3. Demonstrate proper use of a digital multimeter (DMM) when measuring source voltage, voltage drop (including grounds), current flow and resistance.	P-1	electrical fundamentals	X	X
4. Demonstrate knowledge of the causes and effects from shorts, grounds, opens, and resistance problems in electrical/electronic circuits.	P-1	electrical fundamentals	X	X
5. Check operation of electrical circuits with a test light.	P-1	electrical fundamentals	X	X
6. Check operation of electrical circuits with fused jumper wires.	P-1	electrical fundamentals	X	X
7. Use wiring diagrams during the diagnosis (troubleshooting) of electrical/electronic circuit problems.	P-1	electronic diagnosis	X	X
8. Diagnose the cause(s) of excessive key-off battery drain (parasitic draw); determine necessary action.	P-1	battery chemistry, electronic diagnostics	X	X
9. Inspect and test fusible links, circuit breakers, and fuses; determine necessary action.	P-1	thermodynamics in electricity	X	X
10. Inspect and test switches, connectors, relays, solenoid solid state devices, and wires of electrical/electronic circuits; determine necessary action.	P-1	electromagnetism	X	
11. Replace electrical connectors and terminal ends.	P-1	science of soldering	X	X
12. Repair wiring harness.	P-1	science of soldering	X	
13. Perform solder repair of electrical wiring.	P-1	science of soldering	X	X

14. Check electrical/electronic circuit waveforms; interpret readings and determine needed repairs.	P-2	electronic diagnosis
15. Repair CAN/BUS wiring harness.	P-1	

VI. ELECTRICAL/ELECTRONIC SYSTEMS

B. Battery Diagnosis and Service

1. Perform battery state-of-charge test; determine necessary action.	P-1	battery chemistry	X	X
2. Confirm proper battery capacity for vehicle application; perform battery capacity test; determine necessary action.	P-1	electronic diagnosis	X	X
3. Maintain or restore electronic memory functions.	P-1	electronic diagnosis	X	X
4. Inspect and clean battery; fill battery cells; check battery cables, connectors, clamps, and hold-downs.	P-1	battery chemistry, electronic diagnosis	X	X
5. Perform slow/fast battery charge according to manufacturer's recommendations.	P-1	charging principles	X	X
6. Jump-start vehicle using jumper cables and a booster battery or an auxiliary power	P-1		X	X
7. Identify high-voltage circuits of electric or hybrid electric vehicle and related safety precautions.	P-3	electronic diagnosis, personal protective equipment (PPE)	X	X
8. Identify electronic modules, security systems, radios, and other accessories that require reinitialization or code entry after reconnecting vehicle battery.	P-1	computer science	X	X
9. Identify hybrid vehicle auxiliary (12v) battery service, repair, and test procedures.	P-3	battery chemistry	X	X

VI. ELECTRICAL/ELECTRONIC SYSTEMS

C. Starting System Diagnosis and Repair

			AST TASK	MLR TASK
1. Perform starter current draw tests; determine necessary action.	P-1	electrical fundamentals	X	X
2. Perform starter circuit voltage drop tests; determine necessary action.	P-1	electrical fundamentals	X	X
3. Inspect and test starter relays and solenoids; determine necessary action.	P-2	electromagnetism	X	X
4. Remove and install starter in a vehicle.	P-1		X	X
5. Inspect and test switches, connectors, and wires of starter control circuits; determine necessary action.	P-2	electrical fundamentals	X	X
6. Differentiate between electrical and engine mechanical problems that cause a slow-crank or a no-crank condition.	P-2	electrical fundamentals, basic engine theory	X	

VI. ELECTRICAL/ELECTRONIC SYSTEMS

D. Charging System Diagnosis and Repair

1. Perform charging system output test; determine necessary action.	P-1	electromagnetic induction	X	X
2. Diagnose (troubleshoot) charging system for causes of undercharge, no-charge, or overcharge conditions.	P-1	principles of corrosion	X	
3. Inspect, adjust, or replace generator (alternator) drive belts; check pulleys and tensioners for wear; check pulley and belt alignment.	P-1		X	X
4. Remove, inspect, and re-install generator (alternator).	P-1		X	X
5. Perform charging circuit voltage drop tests; determine necessary action.	P-1	electrical fundamentals	X	X

VI. ELECTRICAL/ELECTRONIC SYSTEMS

E. Lighting Systems Diagnosis and Repair

AST MLR
TASK TASK

- | | | | | |
|--|-----|--|---|---|
| 1. Diagnose (troubleshoot) the causes of brighter-than-normal, intermittent, dim, or no light operation; determine necessary action. | P-1 | electrical fundamentals | X | |
| 2. Inspect interior and exterior lamps and sockets including headlights and auxiliary lights (fog lights/driving lights); replace as needed. | P-1 | electrical fundamentals | X | X |
| 3. Aim headlights. | P-2 | | X | X |
| 4. Identify system voltage and safety precautions associated with high-intensity discharge headlights. | P-2 | electrical fundamentals, electrical safety | X | X |

VI. ELECTRICAL/ELECTRONIC SYSTEMS

F. Gauges, Warning Devices, and Driver Information Systems Diagnosis and Repair

- | | | | | |
|---|-----|----------------------|---|--|
| 1. Inspect and test gauges and gauge sending units for causes of abnormal gauge readings; determine necessary action. | P-2 | electronic diagnosis | X | |
| 2. Diagnose (troubleshoot) the causes of incorrect operation of warning devices and other driver information systems; determine necessary action. | P-2 | electronic diagnosis | X | |

VI. ELECTRICAL/ELECTRONIC SYSTEMS

G. Horn and Wiper/Washer Diagnosis and Repair

- | | | | | |
|---|-----|----------------------|---|--|
| 1. Diagnose (troubleshoot) causes of incorrect horn operation; perform necessary action. | P-1 | electronic diagnosis | X | |
| 2. Diagnose (troubleshoot) causes of incorrect wiper operation; diagnose wiper speed control and park problems; perform necessary action. | P-2 | electronic diagnosis | X | |
| 3. Diagnose (troubleshoot) windshield washer problems; perform necessary action. | P-2 | electronic diagnosis | X | |

VI. ELECTRICAL/ELECTRONIC SYSTEMS

H. Accessories Diagnosis and Repair

			AST TASK	MLR TASK
1. Diagnose (troubleshoot) incorrect operation of motor-driven accessory circuits; determine necessary action.	P-2	electronic diagnosis	X	
2. Diagnose (troubleshoot) incorrect electric lock operation (including remote keyless entry); determine necessary action.	P-2	electronic diagnosis	X	
3. Diagnose (troubleshoot) incorrect operation of cruise control systems; determine necessary action.	P-3	electronic diagnosis	X	
4. Diagnose (troubleshoot) supplemental restraint system (SRS) problems; determine necessary action.	P-2	chemical reactions	X	
5. Disable and enable an airbag system for vehicle service; verify indicator lamp operation.	P-1		X	X
6. Remove and reinstall door panel.	P-1		X	X
7. Check for module communication errors (including CAN/BUS systems) using a scan tool.	P-2	computer science	X	
8. Describe the operation of keyless entry/remote-start systems.	P-3	electromagnetics, computer science	X	X
9. Verify operation of instrument panel gauges and warning/indicator lights; reset maintenance indicators.	P-1	electrical fundamentals	X	X
10. Verify windshield wiper and washer operation, replace wiper blades.	P-1	electro-mechanical	X	X
11. Diagnose (troubleshoot) radio static and weak, intermittent, or no radio reception; determine necessary action.	P-3	electromagnetic wave theory		

12. Diagnose (troubleshoot) body electronic system circuits using a scan tool; determine necessary action.	P-3	electronic diagnosis		
13. Diagnose the cause(s) of false, intermittent, or no operation of anti-theft systems.	P-3	electronic diagnosis, computer science		
14. Describe the process for software transfers, software updates, or flash reprogramming on electronic modules.	P-3	computer science		

VII. HEATING AND AIR CONDITIONING

A. General: A/C System Diagnosis and Repair

1. Identify and interpret heating and air conditioning problems; determine necessary action.	P-1		X	
2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.	P-1		X	X
3. Performance test A/C system; identify problems.	P-1	Refrigerant handling & EPA concerns (environmental science)	X	
4. Identify abnormal operating noises in the A/C system; determine necessary action.	P-2		X	
5. Identify refrigerant type; select and connect proper gauge set; record temperature and pressure readings.	P-1	Refrigerant handling & EPA concerns (environmental science)	X	
6. Leak test A/C system; determine necessary action.	P-1	EPA concerns (environmental science)	X	
7. Inspect condition of refrigerant oil removed from A/C system; determine necessary	P-2	Refrigerant handling & EPA concerns	X	
8. Determine recommended oil and oil capacity for system application.	P-1		X	
9. Using a scan tool, observe and record related HVAC data and trouble codes.	P-3	Electrical Fundamentals (Ohm's Law)	X	

VII. HEATING AND AIR CONDITIONING

B. Refrigeration System Component Diagnosis and Repair

AST
TASK

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TASK

1. Inspect and replace A/C compressor drive belts, pulleys, and tensioners; determine necessary action.	P-1	Simple Engines, Pullys, Levers etc..	X	X
2. Inspect, test, service or replace A/C compressor clutch components and/or assembly; check compressor clutch air gap; adjust as needed.	P-2		X	
3. Remove, inspect, and reinstall A/C compressor and mountings; determine recommended oil quantity.	P-2	Refrigerant handling & EPA concerns (environmental science)	X	
4. Identify hybrid vehicle A/C system electrical circuits and service/safety precautions.	P-2	Electrical Fundamentals (Ohm's Law), The Peltier effect	X	X
5. Determine need for an additional A/C system filter; perform necessary action.	P-3	Airflow Dynamics	X	
6. Remove and inspect A/C system mufflers, hoses, lines, fittings, O-rings, seals, and service valves; perform necessary action.	P-2		X	
7. Inspect A/C condenser for airflow restrictions; perform necessary action.	P-1	Airflow Dynamics	X	X
8. Remove, inspect, and reinstall receiver/drier or accumulator/drier; determine recommended oil quantity.	P-2	Chemical Reaction (Desiccant)	X	
9. Remove, inspect, and install expansion valve or orifice (expansion) tube.	P-1	Chemical Reaction (State Change)	X	
10. Inspect evaporator housing water drain; perform necessary action.	P-1		X	
11. Diagnose A/C system conditions that cause the protection devices (pressure, thermal, and PCM) to interrupt system operation; determine necessary action.	P-2	Thermodynamics, Airflow Dynamics, Electrical Fundamentals (Ohm's Law)		
12. Determine procedure to Remove and reinstall evaporator; determine required oil	P-2		X	

13. Remove, inspect, and reinstall condenser; determine required oil quantity.	P-2	Refrigerant handling & EPA concerns (environmental science)		
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VII. HEATING AND AIR CONDITIONING

C. Heating, Ventilation, and Engine Cooling Systems Diagnosis and Repair

1. Inspect engine cooling and heater systems hoses; perform necessary action.	P-1	Antifreeze chemistry, heat transfer, pressure vs. boiling point	X	X
2. Inspect and test heater control valve(s); perform necessary action.	P-2		X	
3. Diagnose temperature control problems in the heater/ventilation system; determine PCM) to interrupt system operation; determine necessary action.	P-2	Thermodynamics, Electrical Fundamentals (Ohm's Law)		
4. Determine procedure to remove, inspect, and reinstall heater core.	P-2	EPA concerns (environmental science)	X	

VII. HEATING AND AIR CONDITIONING

D. Operating Systems and Related Controls Diagnosis and Repair

1. Inspect and test A/C-heater blower motors, resistors, switches, relays, wiring, and protection devices; perform necessary action.	P-1	Electrical Fundamentals (Ohm's Law)	X	
2. Diagnose A/C compressor clutch control systems; determine necessary action.	P-2	Electrical Fundamentals (Ohm's Law)	X	
3. Diagnose malfunctions in the vacuum, mechanical, and electrical components and controls of the heating, ventilation, and A/C (HVAC) system; determine necessary action.	P-2	Simple Engines (levers), Electrical Fundamentals (Ohm's Law), Basic Engine Theory (Vacuum)	X	
4. Inspect and test A/C-heater control panel assembly; determine necessary action.	P-3	Electrical Fundamentals (Ohm's Law)	X	
5. Inspect and test A/C-heater control cables, motors, and linkages; perform necessary action.	P-3	Simple Engines (levers), Electrical Fundamentals (Ohm's Law), Basic Engine Theory (Vacuum)	X	

			AST TASK	MLR TASK
6. Inspect A/C-heater ducts, doors, hoses, cabin filters, and outlets; perform necessary action.	P-1	Airflow Dynamics, Electrical Fundamentals (Ohm's Law)	X	X
7. Identify the source of A/C system odors.	P-2	Chemical Reaction (Desiccant)	X	X
8. Check operation of automatic or semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary action.	P-2	Electrical Fundamentals (Ohm's Law)	X	

VII. HEATING AND AIR CONDITIONING

E. Refrigerant Recovery, Recycling, and Handling

1. Perform correct use and maintenance of refrigerant handling equipment according to equipment manufacturer's standards.	P-1	Refrigerant handling & EPA concerns (environmental science)	X	
2. Identify and recover A/C system refrigerant.	P-1	Refrigerant handling & EPA concerns (environmental science)	X	
3. Recycle, label, and store refrigerant.	P-1	Refrigerant handling & EPA concerns (environmental science)	X	
4. Evacuate and charge A/C system; add refrigerant oil as required.	P-1	Refrigerant handling & EPA concerns (environmental science)	X	

VIII. ENGINE PERFORMANCE

A. General: Engine Diagnosis

1. Identify and interpret engine performance concerns; determine necessary action.	P-1	Basic Engine Theory		
2. Research applicable vehicle and service information, vehicle service history, service precautions, and technical service bulletins.	P-1		X	X
3. Diagnose abnormal engine noises or vibration concerns; determine necessary action.	P-3	Basic Engine Theory, Personal Protection	X	

			AST TASK	MLR TASK
4. Diagnose the cause of excessive oil consumption, coolant consumption, unusual exhaust color, odor, and sound; determine necessary action.	P-2	Basic Engine Theory, Personal Protection, Antifreeze chemistry, heat transfer, pressure vs. boiling point, EPA concerns (environmental science)	X	
5. Perform engine absolute (vacuum/boost) manifold pressure tests; determine necessary action.	P-1	Basic Engine Theory	X	X
6. Perform cylinder power balance test; determine necessary action.	P-2	Fundamentals (Ohm's Law), Electronics Diagnostics	X	X
7. Perform cylinder cranking and running compression tests; determine necessary action.	P-1	Basic Engine Theory	X	X
8. Perform cylinder leakage test; determine necessary action.	P-1	Basic Engine Theory	X	X
9. Diagnose engine mechanical, electrical, electronic, fuel, and ignition concerns; determine necessary action.	P-2	Fundamentals (Ohm's Law), Electronics Diagnostics	X	
10. Verify engine operating temperature; determine necessary action.	P-1	Basic Engine Theory, Thermal Efficiencies	X	X
11. Verify correct camshaft timing.	P-1	Basic Engine Theory	X	

VIII. ENGINE PERFORMANCE

B. Computerized Controls Diagnosis and Repair

1. Retrieve and record diagnostic trouble codes, OBD monitor status, and freeze frame data; clear codes when applicable.	P-1	Computer Science, Electronics Diagnostics	X	X
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			AST TASK	MLR TASK
2. Access and use service information to perform step-by-step (troubleshooting) diagnosis.	P-1		X	
3. Perform active tests of actuators using a scan tool; determine necessary action.	P-2	Computer Science, Electrical Fundamentals (Ohm's Law), Electronics Diagnostics	X	
4. Describe the importance of running all OBDII monitors for repair verification.	P-1	Computer Science	X	X
5. Diagnose the causes of emissions or driveability concerns with stored or active diagnostic trouble codes; obtain, graph, and interpret scan tool data.	P-1	Electrical Fundamentals (Ohm's Law), Electronics Diagnostics, EPA concerns (environmental science)		
6. Diagnose emissions or driveability concerns without stored diagnostic trouble codes; determine necessary action.	P-1	Electrical Fundamentals (Ohm's Law), Electronics Diagnostics, EPA concerns (environmental science)		
7. Inspect and test computerized engine control system sensors, powertrain/engine control module (PCM/ECM), actuators, and circuits using a graphing multimeter (GMM)/digital storage oscilloscope (DSO); perform necessary action.	P-2	Computer Science, Electrical Fundamentals (Ohm's Law), Electronics Diagnostics		
8. Diagnose driveability and emissions problems resulting from malfunctions of interrelated systems (cruise control, security alarms, suspension controls, traction controls, A/C, automatic transmissions, non-OEM installed accessories, or similar systems); determine necessary action.	P-3	Computer Science, Electrical Fundamentals (Ohm's Law), Electronics Diagnostics, EPA concerns (environmental science)		

VIII. ENGINE PERFORMANCE

C. Ignition System Diagnosis and Repair

1. Diagnose (troubleshoot) ignition system related problems such as no-starting, hard starting, engine misfire, poor driveability, spark knock, power loss, poor mileage, and emissions concerns; determine necessary action.	P-2	Basic Engine Theory, Electrical Fundamentals (Ohm's Law), Electronics Diagnostics, EPA concerns (environmental science)	X	
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			AST TASK	MLR TASK
2. Inspect and test crankshaft and camshaft position sensor(s); perform necessary action.	P-1	Computer Science, Electromagnetic induction (Faraday's Law), Basic Engine Theory, Electro MechanicWave Theory	X	
3. Inspect, test, and/or replace ignition control module, powertrain/engine control module; reprogram as necessary.	P-3	Computer Science, Electrical Fundamentals (Ohm's Law), Electronics Diagnostics	X	
4. Remove and replace spark plugs; inspect secondary ignition components for wear and damage.	P-1	Electromagnetic induction (Faraday's Law), Principals of Corrosion	X	X

VIII. ENGINE PERFORMANCE

D. Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair

1. Diagnose (troubleshoot) hot or cold no-starting, hard starting, poor driveability, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems; determine necessary action.	P-2	Basic Engine Theory, Electrical Fundamentals (Ohm's Law), Electronics Diagnostics		
2. Check fuel for contaminants; determine necessary action.	P-2	Chemical reactions & accelerants, Personal Protection, EPA concerns (environmental science)	X	
3. Inspect and test fuel pumps and pump control systems for pressure, regulation, and volume; perform necessary action.	P-1	Fundamentals (Ohm's Law), Electronics Diagnostics	X	
4. Replace fuel filter(s).	P-1	EPA concerns (environmental science)	X	X
5. Inspect, service, or replace air filters, filter housings, and intake duct work.	P-1	Airflow Dynamics	X	X
6. Inspect throttle body, air induction system, intake manifold and gaskets for vacuum leaks and/or unmetered air.	P-2	Basic Engine Theory, Electronics Diagnostics, Dynamic Flow effects	X	

			AST TASK	MLR TASK
7. Inspect and test fuel injectors.	P-2	Computer Science, Electromagnetic induction (Faraday's Law), Basic Engine Theory, Electronics Diagnostics	X	
8. Verify idle control operation.	P-1	Electronics Diagnostics, Piezoelectric effect	X	
9. Inspect integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields; perform necessary action.	P-1	Basic Engine Theory, Dynamic Flow effects, Chemical Reaction (Catalyst)	X	X
10. Inspect condition of exhaust system hangers, brackets, clamps, and heat shields; repair or replace as needed.	P-1		X	X
11. Perform exhaust system back-pressure test; determine necessary action.	P-2	Basic Engine Theory, Dynamic Flow effects	X	
12. Check and refill diesel exhaust fluid (DEF).	P-3	Basic Engine Theory, Dynamic Flow effects, Chemical Reaction (Catalyst & Urea), EPA concerns (environmental science)	X	
13. Test the operation of turbocharger/supercharger systems; determine necessary action.	P-3	James Watt's Law of Horsepower, Physical Science, Thermal Efficiencies		

VIII. ENGINE PERFORMANCE

E. Emissions Control Systems Diagnosis and Repair

1. Diagnose oil leaks, emissions, and driveability concerns caused by the positive crankcase ventilation (PCV) system; determine necessary action.	P-3	Basic Engine Theory, Chemical Reaction (Catalyst), EPA concerns (environmental science)	X	
2. Inspect, test, and service positive crankcase ventilation (PCV) filter/breather cap, valve, tubes, orifices, and hoses; perform necessary action.	P-2	Basic Engine Theory, Chemical Reaction, EPA concerns (environmental science)	X	X

3. Diagnose emissions and driveability concerns caused by the exhaust gas recirculation (EGR) system; determine necessary action.	P-3	Basic Engine Theory, Dynamic Flow effects, Chemical Reaction, EPA concerns (environmental science)	X
4. Diagnose emissions and driveability concerns caused by the secondary air injection and catalytic converter systems; determine necessary action.	P-2	Computer Science, Chemical Reaction, EPA concerns (environmental science), Basic Engine Theory, Electronics Diagnostics	
5. Diagnose emissions and driveability concerns caused by the evaporative emissions control system; determine necessary action.	P-2	Computer Science, Chemical Reaction, EPA concerns (environmental science), Basic Engine Theory, Electronics Diagnostics	
6. Inspect and test electrical/electronic sensors, controls, and wiring of exhaust gas recirculation (EGR) systems; perform necessary action.	P-2	Computer Science, Chemical Reaction, EPA concerns (environmental science), Basic Engine Theory, Electronics Diagnostics, Piezoelectric effect	
7. Inspect, test, service, and replace components of the EGR system including tubing, exhaust passages, vacuum/pressure controls, filters, and hoses; perform necessary action.	P-2	Basic Engine Theory, Chemical Reaction, EPA concerns (environmental science)	
8. Inspect and test electrical/electronically-operated components and circuits of air injection systems; perform necessary action.	P-3	Computer Science, Chemical Reaction, EPA concerns (environmental science), Basic Engine Theory, Electronics Diagnostics, Piezoelectric effect	X
9. Inspect and test catalytic converter efficiency.	P-2	Basic Engine Theory, Chemical Reaction (Catalyst), EPA concerns (environmental science)	X
10. Inspect and test components and hoses of the evaporative emissions control system; perform necessary action.	P-1	Basic Engine Theory, Chemical Reaction, EPA concerns (environmental science)	X
11. Interpret diagnostic trouble codes (DTCs) and scan tool data related to the emissions control systems; determine necessary action.	P-3	Computer Science, Electronics Diagnostics, EPA concerns (environmental science)	X

	Grand Total - Tasks
P-1	186
P-2	131
P-3	79
REQUIRED SUPPLEMENTAL TASKS	26

REQUIRED SUPPLEMENTAL TASKS

Shop and Personal Safety

1. Identify general shop safety rules and procedures.
2. Utilize safe procedures for handling of tools and equipment.
3. Identify and use proper placement of floor jacks and jack stands.
4. Identify and use proper procedures for safe lift operation.
5. Utilize proper ventilation procedures for working within the lab/shop area.
6. Identify marked safety areas.
7. Identify the location and the types of fire extinguishers and other fire safety equipment; demonstrate knowledge of the procedures for using fire extinguishers and other fire safety equipment.
8. Identify the location and use of eye wash stations.
9. Identify the location of the posted evacuation routes.
10. Comply with the required use of safety glasses, ear protection, gloves, and shoes during lab/shop activities.
11. Identify and wear appropriate clothing for lab/shop activities.
12. Secure hair and jewelry for lab/shop activities.

13. Demonstrate awareness of the safety aspects of supplemental restraint systems (SRS), electronic brake control systems, and hybrid vehicle high voltage circuits.

14. Demonstrate awareness of the safety aspects of high voltage circuits (such as high intensity discharge (HID) lamps, ignition systems, injection systems, etc.).

15. Locate and demonstrate knowledge of material safety data sheets (MSDS).

Tools and Equipment

1. Identify tools and their usage in automotive applications.

2. Identify standard and metric designation.

3. Demonstrate safe handling and use of appropriate tools.

4. Demonstrate proper cleaning, storage, and maintenance of tools and equipment.

5. Demonstrate proper use of precision measuring tools (i.e. micrometer, dial-indicator, dial-caliper).

Preparing Vehicle for Service

1. Identify information needed and the service requested on a repair order.

2. Identify purpose and demonstrate proper use of fender covers, mats.

3. Demonstrate use of the three C's (concern, cause, and correction).

4. Review vehicle service history.

5. Complete work order to include customer information, vehicle identifying information, customer concern, related service history, cause, and correction.

Preparing Vehicle for Customer

1. Ensure vehicle is prepared to return to customer per school/company policy (floor mats, steering wheel cover, etc.).