# Automotive Technician Standards and Skills



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## Health & Safety Standards

### Standard 1: Health and Safety in an Automotive Technicians Work Environment

Students will prioritize safety by adhering to OSHA and EPA regulations, demonstrating proper use of personal protective equipment (PPE), and effectively identifying and mitigating workplace hazards.

* Aligned Industry Recognized Credentials: OSHA10 – General Industry, ASE Entry-Level Certifications - All

#### Skills:

1. Identify, describe, and demonstrate the effective use of Safety Data Sheets (SDS) to meet documentation requirements.
2. Locate emergency equipment, first aid kit, and emergency action and response plan, including labels and signage that follow OSHA Hazard Communication Program (HAZCOM).
3. Demonstrate proper use of personal protective equipment (PPE), including gloves, eye protection, earplugs, footwear, and additional safety gear relevant to specific tasks such as welding, cutting, or handling hazardous materials.
4. Demonstrate safe body mechanics, including appropriate lifting techniques and ergonomics aimed at minimizing injury.
5. Demonstrate the safe use, maintenance, and storage of hand and power tools following manufacturer guidelines.
6. Demonstrate safety procedures for operating automotive lifts according to industry standards.
7. Demonstrate safe use, placement, and storage of floor jacks and jack stands.
8. Demonstrate safety procedures when servicing high-pressure systems, including fuel, brakes, air conditioning, suspension, and hydraulic systems.
9. Demonstrate welding and cutting safety precautions, including fire-resistant barriers, ventilation, and proper handling of oxygen/acetylene torches and electric welding equipment.
10. Demonstrate safety procedures related to electrical circuits and systems, particularly for electric and hybrid vehicles.
11. Identify vehicle systems that pose safety hazards during service and repair, such as supplemental restraint systems (SRS), electronic brake control systems, stop/start systems, and remote start systems, and safely disable them as required.
12. Identify vehicle systems which pose a safety hazard during service and repair due to high voltage such as hybrid/electric drivetrain, lighting systems, ignition systems, A/C systems, injection systems, etc.
13. Apply safe procedures for handling, charging, disconnecting, and reconnecting vehicle batteries.
14. Identify and apply safe storage and handling of flammable and combustible materials.
15. Identify and comply with environmental regulations for refrigerants and coolants in accordance with EPA and OSHA standards.
16. Demonstrate proper handling, storage, and disposal of hazardous chemicals (fuels, oils, solvents, etc.) and apply spill containment and cleanup procedures to prevent contamination.
17. Understand and apply fire safety protocols, including fire extinguisher use and evacuation procedures.

## Technical & Integrated Academic Standards

### Standard 2: Role of Automotive Technicians in Society

Students will demonstrate an understanding of the responsibilities, challenges, and opportunities within the automotive field by analyzing historical developments, industry improvements, and the impact of key regulations and technological advancements.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications - All

#### Skills:

1. Examine the impact of major industry improvements, including the shift from mechanical to electronic systems and the introduction of computerized diagnostic tools and advanced safety features, and assess how these advancements have influenced technician training, certification, and their role in maintaining vehicle reliability and performance.
2. Analyze the role of automotive technicians in maintaining vehicle safety and performance in compliance with Massachusetts vehicle inspection regulations by identifying key components of the annual safety and emissions testing requirements.
3. Identify significant historical legislation that has shaped the automotive repair industry, including the Clean Air Act and the Massachusetts Lemon Law, and explain how these laws have improved consumer protection and vehicle safety standards.

### Standard 3: Tools, Instrumentation, and Equipment

Students will demonstrate proficiency in the identification, use, and maintenance of tools, fasteners, diagnostic and measurement instruments used in automotive technology, with a focus on safety and precision in alignment with industry standards.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications - All

#### Skills:

1. Identify and apply the proper use and techniques for hand tools including screwdrivers, pliers, combination wrenches, metal working tools, surface prep tools, and holding tools.
2. Demonstrate the safe use and maintenance of both corded and cordless electric power tools, including electric drills, soldering irons, bench grinders, and drill presses.
3. Identify and demonstrate the proper use of an electric drill, including selecting the appropriate drill bits, understanding the differences in drilling speeds for various metals, and drilling holes accurately to specifications.
4. Demonstrate appropriate use of electric soldering irons, explain their application, and identify suitable types of solder for electrical components.
5. Demonstrate safe use of pneumatic power tools, including impact wrenches and impact sockets, according to industry standards.
6. Demonstrate the proper use of precision measuring tools including vernier calipers, inside and outside micrometers, depth micrometers, feeler gauges, and dial indicators.
7. Demonstrate use of low precision measuring tools such as inside and outside calipers, hole gauges, steel rules, tape measures, and combination squares.
8. Identify and explain bolt head markings and bolt grading.
9. Compare SAE and metric dimensional fasteners and explain their significance.
10. Identify and describe the function of common nuts, washers, lock washers, and snap rings.
11. **Explain the concept of fastener torque, torque sequence, the use of torque specification charts, and the application of torque angle gauges.**
12. **Describe the types of torque wrenches, demonstrate their proper use in fastener installation, and utilize torque angle gauges for precise tightening procedures.**
13. Demonstrate the proper use and application of diagnostic tools, including oscilloscopes, diagnostic scanners, digital multimeters, compression testers, fuel pressure testers, injector testers, vibration analyzers, smoke machines, and thermal imagers.

### Standard 4: Vehicle Service Information and Documentation

Students will utilize available vehicle service information and diagnostic data to perform accurate service, maintenance, and repair tasks on all vehicle systems, documenting all services and repairs to ensure compliance with shop procedures, manufacturer guidelines, and the proper handling of advanced technologies such as ADAS.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications - All

#### **Skills:**

1. Identify and analyze the information needed on a repair order, including the service requested, customer concerns, and vehicle details.
2. Research and analyze vehicle service information, including fluid types, service history, service precautions, technical service bulletins, and recalls, particularly for vehicles equipped with advanced driver assistance systems (ADAS).
3. Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels, calibration decals).
4. Perform a vehicle walk-around inspection, identify existing vehicle conditions, e.g., body damage, paint damage, windshield damage, and document findings accurately.
5. Conduct a multi-point vehicle inspection and complete a vehicle inspection report with attention to detail.
6. Apply the three C’s (concern, cause, and correction) to formulate a clear and structured approach to vehicle diagnostics and repair planning.
7. Retrieve, interpret, and record DTCs, OBD monitor status, freeze frame data to assess identified system performance, and clear codes and data as necessary.
8. Demonstrate the proper use of vehicle protection equipment, e.g., fender covers, mats, seat covers, and steering wheel covers, to ensure vehicle safety during service.
9. Complete a detailed work order, including customer information, vehicle identification, customer concern, service history, cause, and corrective actions taken.
10. Ensure the vehicle is prepared to return to the customer in accordance with school/company policy, including the removal of protective equipment and checking for cleanliness.

### Standard 5: Wheel and Tire Systems Diagnosis and Repair

Students will demonstrate the skills necessary for tire inspection, diagnosis, and repair by evaluating tire condition, using diagnostic tools, and applying proper repair techniques, including tire pressure monitoring systems.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Suspension and Steering, Maintenance and Light Repair (MLR), and Auto Service Technology (AST)

#### Skills:

1. Inspect and analyze tire condition and age, identifying wear patterns while checking for correct tire size, application (service class, load, and speed ratings), and air pressure according to the tire information placard.
2. Measure wheel, tire, axle flange, and hub runout, and assess the required actions based on measurements.
3. Demonstrate proper tire rotation techniques according to the manufacturer’s recommendations, including vehicles equipped with tire pressure monitoring systems (TPMS).
4. Dismount, inspect, and remount tires on wheels (with/without TPMS), and balance the wheel and tire assembly to ensure proper performance.
5. Inspect the tire and wheel assembly for air loss and determine the necessary corrective actions.
6. Repair tires following manufacturer-approved procedures, ensuring compliance with industry standards.
7. Identify and differentiate between indirect and direct tire pressure monitoring systems (TPMS) and calibrate/relearn the system while verifying the operation of instrument panel lamps.  
   Demonstrate the steps required to remove and replace sensors in a TPMS according to OEM and sensor manufacturer specifications.
8. Perform road force balancing and match mounting to optimize tire performance.
9. Demonstrate the use of wheel balancing equipment to simultaneously measure loaded runout and tire rigidity.
10. Diagnose wheel/tire vibrations, shimmy, and noise and determine appropriate corrective actions.
11. Diagnose tire pull problems and determine the necessary actions to resolve the issue.

### Standard 6: Suspension Systems Diagnosis and Repair

Demonstrate the ability to diagnose, inspect, and repair suspension system components, applying vehicle service information and techniques to ensure proper functionality and safety in accordance with manufacturer specifications.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Suspension and Steering, MLR, and AST

#### Skills:

1. Identify and describe suspension and steering system components and configurations.
2. Disable and enable the supplemental restraint system (SRS) and verify the operation of the indicator lamp.
3. Analyze and diagnose long arm, strut, and leaf spring suspension system noises, body sway, and uneven ride height concerns to determine necessary corrective actions.
4. Demonstrate lubrication of suspension and steering systems in accordance with manufacturer recommendations.
5. Inspect, remove, and replace key suspension components, including: upper and lower control arms, bushings, shafts, and rebound/jounce bumpers.
6. Inspect, remove, and install strut rods (compression/tension), radius arms, bushings, and mounts.
7. Inspect, remove, and install upper and lower ball joints (with or without wear indicators).
8. Inspect, remove, and install coil springs, torsion bars, leaf springs, and spring insulators.
9. Inspect, remove, and install steering knuckle assemblies.
10. Inspect, remove, and install stabilizer bar bushings, brackets, and links.
11. Inspect, remove, and install strut cartridges or assemblies, strut coil springs, insulators, and upper strut bearings/mounts.
12. Inspect, remove, and install leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings, and mounts.
13. Inspect, remove, and/or replace shock absorbers; inspect mounts and bushings.
14. **Service and maintain** wheel bearings by inspecting, cleaning, and replacing as needed, including seals, hubs, and spindles.
15. Inspect, remove, and replace self-leveling suspension components.
16. Describe the function of electronically controlled suspension and steering systems and components, (i.e., active suspension and stability control).

### Standard 7: Steering Systems Diagnosis and Repair

Students will be able to evaluate and perform advanced diagnostic procedures on manual, power, and electric steering systems, identifying and addressing steering system concerns to ensure optimal vehicle performance.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Suspension and Steering, MLR, and AST

#### Skills:

1. Analyze power steering concerns such as gear binding, uneven turning effort, looseness, hard steering, and fluid leakage; determine necessary corrective actions.
2. Inspect and evaluate power steering fluid levels and condition to identify potential service requirements.
3. Flush, refill, and bleed the power steering system, ensuring the use of manufacturer-recommended fluid types to maintain optimal steering performance.
4. Diagnose power steering fluid leakage by conducting a thorough inspection of hoses, fittings, and seals; identify the source of the leak and implement necessary repairs.
5. Remove, inspect, replace, and adjust the power steering pump drive belt to maintain proper alignment and tension, ensuring the pump operates efficiently.
6. Remove and reinstall the power steering pump, assessing pump condition and performance, and reinstalling it in accordance with manufacturer specifications.
7. Inspect and replace power steering hoses and fittings, ensuring all components are free of damage or wear, and install new parts to prevent future leaks.
8. Identify and test electric power steering components, diagnosing issues such as failure or malfunction and determining necessary repair or replacement actions.
9. Identify and test hybrid/EV vehicle power steering system electrical circuits and apply related safety precautions.
10. Remove and replace manual or power steering gear while inspecting associated mounting bushings and brackets for wear or damage; reinstall components following manufacturer specifications.
11. Inspect and replace manual or power rack and pinion steering gear inner tie rod ends and bellows boot, ensuring proper operation and eliminating wear-related steering issues.
12. Diagnose and repair steering linkage components, including pitman arm, centerlink/intermediate rod, idler arm, mountings, and steering linkage dampener; ensure proper function and alignment.
13. Inspect, replace, and adjust tie rod ends (sockets), tie rod sleeves, and clamps on both rack and pinion and non-rack systems, ensuring proper alignment and wear prevention.
14. Inspect and test rack and pinion steering gear for binding, looseness, and hard steering, identifying issues related to the gear mechanism and implementing corrective actions.
15. Remove and replace the steering wheel and center/time the supplemental restraint system (SRS) coil (clock spring), verifying proper alignment and system operation.
16. Diagnose and resolve steering column issues, including noises, looseness, and binding in tilt/telescoping mechanisms, and determine necessary corrective actions.
17. Remove and reinstall the rack and pinion steering gear, inspecting mounting bushings and brackets for wear or damage, and aligning components for proper function.
18. Test power steering system pressure using diagnostic tools, evaluate the system’s performance, and determine the necessary repairs or adjustments to ensure optimal pressure levels.
19. Remove and reinstall press-fit power steering pump pulleys, checking for proper pulley and belt alignment to prevent future steering concerns.

### Standard 8: Wheel Alignment

Students will be able to diagnose and perform pre-alignment inspections, wheel alignment adjustments, and post-alignment calibration, ensuring optimal vehicle handling, steering geometry, and tire wear prevention.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Suspension and Steering, MLR, and AST

#### Skills:

1. Conduct and evaluate a pre-alignment inspection and prepare the vehicle for alignment by measuring ride height, setting it up on the alignment machine, and ensuring all suspension components are in proper working order.
2. Analyze and explain four-wheel alignment angles (camber, caster, and toe) and their effects on vehicle handling, steering response, and tire wear.
3. Differentiate between steering and suspension concerns and diagnose related issues, such as vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, and steering return concerns to determine necessary corrective actions.
4. Perform a four-wheel alignment by measuring and adjusting front and rear caster, camber, and toe, ensuring the steering wheel is centered.
5. Measure and assess toe-out-on-turns (turning radius) to evaluate vehicle steering accuracy and determine necessary corrective actions.
6. Measure and adjust caster to optimize vehicle stability and steering return, improving overall driving dynamics.
7. Measure and adjust front and rear camber, ensuring proper tire contact with the road to reduce uneven tire wear and improve vehicle handling.
8. Measure and adjust front and rear wheel toe, ensuring precise alignment for improved handling, steering response, and even tire wear.
9. Check and confirm steering wheel centering, ensuring proper alignment and straight-line tracking after adjustments.
10. Check and analyze steering axis inclination (SAI) and the included angle to determine necessary corrective actions for proper steering geometry and handling.
11. Evaluate and measure rear wheel thrust angle, ensuring rear wheel alignment and correcting any deviations that could affect vehicle tracking and stability.
12. Inspect and measure front wheel setback, identifying any misalignment or offset in the front suspension system, and determine necessary corrective actions.
13. Identify and correct front and/or rear cradle (subframe) misalignment, ensuring the structural integrity and alignment of the vehicle's suspension components.
14. Reset the steering angle sensor, ensuring the electronic systems are properly calibrated for correct vehicle handling and safety.
15. Perform post-alignment calibration procedures according to manufacturer specifications, ensuring the vehicle's electronic and mechanical systems are fully synchronized.

### Standard 9: Automotive Basic Maintenance

Students will perform routine vehicle maintenance, including fluid inspections, oil changes, lubrication, and component assessments, ensuring proper vehicle performance and safety according to manufacturer guidelines.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications - All

#### Skills:

1. Execute oil and filter changes efficiently, ensuring components are replaced and disposed of according to industry standards, and reset the maintenance reminder light where applicable.
2. Inspect and evaluate all relevant fluid levels, including transmission/transaxle and front and rear differential fluids, determining necessary actions based on findings.
3. Lubricate suspension and steering system components as per manufacturer specifications, enhancing performance and longevity.
4. Inspect air, cabin filters, and cooling system hoses, assessing their condition and determining necessary actions for cleaning, replacement, or repair.
5. Replace a serviceable fuel filter, ensuring proper function of the fuel system.
6. Inspect the exhaust system and undercarriage, identifying any issues and determining necessary corrective actions.
7. Inspect automotive drive belts, determining necessary actions to prevent potential failures.

### Standard 10: Brake Systems and Hydraulic Brake Diagnosis and Repair

Students will be able to analyze, diagnose, and repair various brake system issues using diagnostic tools, hydraulic principles, and safety procedures to ensure the safe and efficient operation of vehicle braking systems, including those equipped with advanced driver assistance systems (ADAS).

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Brakes, MLR, and AST

#### Skills:

1. Evaluate brake system components and configurations to accurately identify functionality and performance issues.
2. Explain the procedures for performing road tests to assess brake system operation, including ABS functionality, and determine necessary actions based on results.
3. Diagnose brake system concerns, including poor stopping, noise, pulling, grabbing, dragging, and pedal pulsation; determine corrective measures.
4. Install wheels and torque lug nuts to manufacturer specifications as part of the brake service process.
5. Apply hydraulic principles, e.g., Pascal’s Law, to diagnose pressure concerns and recommend necessary repairs or adjustments.
6. Measure brake pedal height, travel, and free play; determine adjustments or repairs required to ensure optimal brake function.
7. Inspect master cylinder for internal and external leaks and proper operation; determine corrective actions, and remove, bench bleed, and reinstall the master cylinder as needed.
8. Examine brake lines, flexible hoses, and fittings for leaks, dents, rust, cracks, bulging, or wear; tighten fittings and supports, and determine necessary repairs or replacements.
9. Select and properly handle brake fluids according to manufacturer specifications; store and fill to appropriate levels, and test for contamination.
10. Diagnose hydraulic brake system malfunctions related to poor stopping, pulling, or dragging; determine the necessary corrective action.
11. Fabricate and/or install brake lines (using double flare or ISO types), and replace hoses, fittings, and supports as required.
12. Inspect and test components of the brake warning light system; replace defective components to ensure proper function.
13. Perform various methods of brake bleeding (gravity, manual, pressure, vacuum) and flush and fill hydraulic braking systems to maintain optimal brake performance.

### Standard 11: Drum and Disc Brake Systems Diagnosis and Repair

Students will be able to diagnose, service, and repair drum and disc brake systems, applying industry-standard practices to ensure the safe and effective functioning of vehicle brake systems.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Brakes, MLR, and AST

#### Skills:

1. Demonstrate removing, cleaning, and inspection of brake drum; measure brake drum diameter; and determine serviceability.
2. Demonstrate refinishing brake drum and measuring final drum diameter; compare with specification.
3. Remove, clean, inspect, and/or replace brake shoes, springs, pins, clips, levers, adjusters/self-adjusters, other related brake hardware, and backing support plates; lubricate and reassemble.
4. Inspect wheel cylinders for leaks and proper operation; remove and replace as needed.
5. Perform pre-adjusment of brake shoes and parking brake; install brake drums or drum/hub assemblies and wheel bearings; and perform final checks and adjustments.
6. Diagnose poor stopping, noise, vibration, pulling, grabbing, dragging, or pedal pulsation concerns; determine needed action.
7. Demonstrate installing wheel and torque wheel fasteners and make final checks and adjustments.
8. Evaluate caliper assemblies for leaks, damage, and wear to assess functionality and determine necessary actions.
9. Assess caliper mounting and slide pins for proper operation, wear, and damage, and recommend appropriate corrective measures.
10. Analyze brake pads and retaining hardware to determine condition and necessary replacements to maintain system integrity.
11. Apply proper lubrication techniques and reinstall calipers, brake pads, and related hardware to ensure smooth operation.
12. Measure rotor thickness, thickness variation, and lateral runout, and compare against specifications to determine maintenance needs.
13. Determine the correct procedure for removing, reinstalling, or replacing rotors to restore braking system functionality.
14. Refinish rotors on or off the vehicle and validate final thickness to ensure they meet manufacturer specifications.
15. Adjust caliper pistons on integrated parking brake systems to maintain effective braking performance.
16. Explain the process and importance of burnishing or breaking in replacement brake pads as recommended by manufacturers.
17. Diagnose braking issues such as poor stopping, noise, vibration, pulling, grabbing, dragging, or pulsation, and propose appropriate solutions.

### Standard 12: Power Assist Units and Related Systems Diagnosis and Repair

Students will demonstrate the ability to evaluate, diagnose, and repair power assist units and related brake systems, ensuring proper operation and safety through inspection, testing, and servicing of system components.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Brakes, MLR, and AST

#### Skills:

1. Evaluate brake pedal travel with and without the engine running to verify proper power booster operation.
2. Identify components of the brake power assist system, including vacuum, hydraulic, and electric systems.
3. Inspect vacuum-type power booster units for leaks and test the check-valve for proper operation; assess vacuum supply (manifold or auxiliary pump) to the vacuum-type power booster to determine necessary actions.
4. Test and inspect hydraulically assisted power brake systems for leaks and proper operation; diagnose necessary actions.
5. Examine electric power booster units and determine the necessary actions for service or repair.
6. Demonstrate removing, cleaning, inspecting, repacking or replacing, and installing wheel bearings; remove and install bearing races; replace seals; and adjust bearings after hub installation.
7. Inspect parking brake system components for wear, binding, and corrosion; clean, lubricate, adjust, and/or replace components as necessary to ensure proper function.
8. Evaluate parking brake operation, including electric parking brakes, and assess the parking brake indicator light system; determine necessary corrective actions.
9. Test the operation of the brake stop light system to ensure proper functionality.
10. Inspect and replace wheel studs to restore secure wheel installation.
11. Demonstrate removing, reinstalling, or replacing sealed wheel bearing assemblies to ensure proper wheel operation.
12. Diagnose wheel bearing noises, wheel shimmy, and vibration concerns; identify and recommend appropriate corrective actions.

### Standard 13: Electronic Brake Control Systems Diagnosis and Repair

Students will demonstrate the ability to diagnose, service, and repair electronic brake control systems (ABS, TCS, and ESC) by identifying components, analyzing diagnostic trouble codes, and testing circuits to ensure optimal brake performance and safety.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Brakes, MLR, and AST

#### Skills:

1. Identify and inspect electronic brake control system components including Antilock Brake (ABS), Traction Control (TCS), and Electronic Stability Control (ESC) and describe their function; determine the necessary actions for proper system operation.
2. Explain the operation of a regenerative braking system, including its role in energy recovery.
3. Explain test procedures for hybrid/EV regenerative braking systems.
4. Demonstrate bleeding the electronic brake control system hydraulic circuits to maintain brake fluid integrity and system performance.
5. Diagnose poor stopping, wheel lock-up, abnormal pedal feel, unwanted application, and noise concerns related to the electronic brake control system; determine the appropriate corrective actions.
6. Retrieve and analyze diagnostic trouble codes (DTCs) from electronic brake control system components using recommended test equipment; identify necessary repairs.
7. Depressurize high-pressure components of an electronic brake control system following proper safety procedures.
8. Test, diagnose, and service electronic brake control system speed sensors (both digital and analog), toothed ring (tone wheel), and circuits using a graphing multimeter (GMM) or digital storage oscilloscope (DSO); interpret signal, resistance, voltage, and frequency data.
9. Diagnose braking concerns in electronic brake control systems caused by vehicle modifications, such as changes in tire size, curb height, or final drive ratio; determine necessary adjustments.

### Standard 14: Electrical and Electronic Systems Diagnosis and Repair

Students will demonstrate the skills and knowledge to diagnose, repair, and maintain electrical and electronic systems in vehicles, including understanding circuit types, utilizing diagnostic tools, and ensuring the functionality of related components, while adhering to manufacturer specifications.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Electrical/Electronic Systems, MLR, and AST

#### Skills:

1. Identify and describe electrical/electronic system components and configurations.
2. Demonstrate an understanding of the different types of electrical/electronic circuits, specifically series, parallel, and series parallel circuits, by applying the principles of electricity, including Ohm’s Law.
3. Demonstrate proper use of a digital multimeter (DMM) to measure source voltage, voltage drop (including grounds), current flow, and resistance.
4. Analyze the causes and effects of shorts, grounds, opens, and resistance problems in electrical/electronic circuits.
5. Describe types of test lights and utilize an appropriate test light to check the operation of electrical circuits per service information.
6. Employ fused jumper wires to check the operation of electrical circuits in accordance with service information.
7. Utilize wiring diagrams to diagnose electrical/electronic circuit problems effectively.
8. Diagnose the cause(s) of excessive key-off battery drain (parasitic draw) and determine necessary actions.
9. Inspect and test fusible links, circuit breakers, and fuses to determine necessary actions.
10. Inspect, test, repair, and/or replace components, connectors, terminals, harnesses, and wiring in electrical/electronic systems, including solder repairs, to determine necessary actions.
11. Test and measure circuits using an oscilloscope and/or graphing multimeter (GMM), interpret results, and determine necessary actions.
12. Perform a state-of-charge test on the battery to determine necessary actions for optimal performance.
13. Confirm the proper battery capacity, size, type, and application for the vehicle; conduct a battery capacity and load test to determine needed actions.
14. Maintain or restore electronic memory functions in accordance with manufacturer recommendations.
15. Inspect and clean the battery, fill battery cells (if applicable), and check battery cables, connectors, clamps, and hold-downs for functionality.
16. Charge the battery following manufacturer’s recommendations to ensure effective operation.
17. Execute a jump-start of the vehicle using jumper cables and a booster battery or an auxiliary power supply.
18. Identify electrical and electronic modules, security systems, radios, and other accessories that require reinitialization or code entry after reconnecting the vehicle battery.
19. Identify and explain service, repair, and testing procedures for hybrid/EV auxiliary (12v) batteries.

### Standard 15: Starting and Charging Systems Diagnosis and Repair

Students will be able to diagnose, repair, and maintain starting and charging systems in vehicles by performing essential tests, evaluating system components, and determining necessary corrective actions to ensure optimal vehicle performance and reliability.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Electrical/Electronic Systems, MLR, and AST

#### Skills:

1. Perform a starter current draw test and determine necessary actions based on results.
2. Conduct starter circuit voltage drop tests and determine necessary actions based on findings.
3. Inspect and test starter relays and solenoids and determine necessary actions for repair or replacement.
4. Remove and install a starter in a vehicle, ensuring proper installation procedures are followed.
5. Inspect the fly wheel and ring gear for wear and cracks.
6. Inspect and test switches, connectors, and wires in starter control circuits and determine necessary corrective actions.
7. Demonstrate knowledge of an automatic idle-stop/start system, explaining its operation and benefits.
8. Differentiate between electrical and engine mechanical issues that result in slow-crank or no-crank conditions.
9. Evaluate charging system output and determine necessary corrective actions based on test results.
10. Inspect, adjust, and/or replace generator (alternator) drive belts while checking pulleys and tensioners for wear and alignment; determine necessary actions.
11. Remove, inspect, and/or replace the generator (alternator) and determine necessary actions for service or repair.
12. Perform charging circuit voltage drop tests and determine necessary corrective actions based on findings.
13. Diagnose the charging system for causes of undercharge, no-charge, or overcharge conditions and determine necessary corrective actions.

### Standard 16: Electrical Accessories Diagnosis and Repairs

Students will demonstrate the ability to diagnose, evaluate, and repair electrical accessory systems in vehicles, as well as electrical circuits in hybrid vehicles, including lighting, instrumentation, safety, and convenience features, ensuring optimal functionality and safety.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Electrical/Electronic Systems, MLR, and AST

#### Skills:

1. Evaluate the condition of interior and exterior lamps and sockets, including headlights and auxiliary lights, to determine necessary corrective actions.
2. Identify system voltage and safety precautions associated with high intensity discharge headlights.
3. Demonstrate proper techniques for aiming headlights to ensure optimal visibility and safety.
4. Analyze and diagnose the causes of abnormal light operation, including brighter-than-normal, intermittent, dim, or no illumination, and recommend appropriate corrective actions.
5. Evaluate the operation of instrument panel gauges and warning/indicator lights and reset maintenance indicators as required.
6. Inspect and test gauges and gauge sending units to identify causes of abnormal readings and determine necessary corrective actions.
7. Analyze and diagnose the causes of incorrect operation in warning devices and other driver information systems and recommend appropriate actions.
8. Demonstrate the ability to remove and reinstall a door panel, ensuring proper installation procedures are followed.
9. Diagnose the operation of security and anti-theft systems and related circuits, including theft deterrent, door locks, remote keyless entry, remote start, and starter/fuel disable, and recommend necessary actions.
10. Explain the disabling and enabling procedures for the supplemental restraint system (SRS) and verify the operation of the indicator lamp.
11. Assess the operation of windshield wipers and washers and perform the replacement of wiper blades as needed.
12. Analyze the operation of entertainment systems and related circuits, including radio, DVD, remote CD changer, navigation, amplifiers, speakers, antennas, and voice-activated accessories and determine necessary corrective actions.
13. Diagnose the operation of motor-driven accessory circuits, including heated glass, electric lock, and cruise control systems; determine necessary action.
14. Diagnose the operation of safety systems and related circuits, including horn, airbags, seat belt pretensioners, occupancy classification, wipers, washers, speed control/collision avoidance, heads-up display, parking assist, and back-up camera and recommend appropriate actions.
15. Identify and explain hybrid/EV electrical circuits.
16. Utilize a scan tool to diagnose body electronic systems circuits, checking for module communication errors in data communication bus systems, and determine necessary actions.
17. Describe the process for software transfer, software updates, or reprogramming of electronic modules, ensuring understanding of manufacturer protocols.

### Standard 17: General Engine Diagnostics and Repair

Students will be able to diagnose and resolve engine performance issues by analyzing diagnostic data, evaluating key systems, and performing necessary repairs and reinstallation in line with manufacturer specifications.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Repair, MLR, and AST

#### Skills:

1. Assess the operation of the instrument panel engine warning indicators to ensure proper functionality.
2. Conduct a comprehensive inspection of the engine assembly to identify fuel, oil, coolant, and other leaks; formulate and implement a plan for necessary actions based on findings.
3. Interpret engine performance concerns, including abnormal engine noise, vibration, or exhaust color, odor, and sound; determine necessary corrective actions.
4. Inspect and test the mechanical and electrical fuel pumps and pump control systems for pressure, regulation, and volume; perform the necessary adjustments or replacements.
5. Verify engine mechanical timing through systematic checks of camshaft and crankshaft alignment, making adjustments as needed to ensure optimal engine performance.
6. Perform oil pressure tests to assess engine lubrication and pressure levels; determine the necessary course of action if abnormalities are detected.
7. Execute cylinder power balance tests, compression tests, and cylinder leakage tests to evaluate engine performance; determine and implement necessary corrective measures.
8. Inspect and test the integrity of the catalytic converter and heat shield(s); perform repairs or replacements as needed to maintain proper exhaust function.
9. Identify engine mechanical, electrical, fuel, and ignition concerns using advanced engine diagnostic equipment and techniques.
10. Perform absolute (vacuum/boost) manifold pressure tests to assess engine intake pressure and determine the necessary actions to correct performance issues.
11. Inspect, remove, and/or replace engine mounts, applying critical thinking to assess the condition, stability, and effectiveness of mounts.
12. Install engine covers using appropriate gaskets, seals, and sealers, ensuring proper alignment and sealing for effective operation.
13. Execute the removal and reinstallation of engines in vehicles equipped with OBD systems; reconnect all attaching components and restore the vehicle to a fully operational condition, ensuring compliance with manufacturer specifications.
14. Identify and analyze service precautions pertinent to the internal combustion engine of hybrid electric vehicles to mitigate risks during service procedures.

### Standard 18: Cylinder Head and Valve Train Diagnosis and Repair

Students will demonstrate the ability to diagnose, inspect, and repair cylinder head and valve train components by utilizing appropriate tools and techniques.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Repair, MLR, and AST

#### Skills:

1. Identify the components and configurations of cylinder heads and valve trains to facilitate effective diagnosis and repair.
2. Remove the cylinder head, inspect the gasket condition, and install the cylinder head and gasket while tightening according to manufacturer specifications and procedures.
3. Clean and visually inspect a cylinder head for cracks, and check gasket surface areas for warpage and surface finish, as well as assess the condition of passages.
4. Inspect valve actuating mechanisms for wear, bending, cracks, looseness, and blocked oil passages (orifices), and determine necessary actions based on findings.
5. Adjust valves using mechanical or hydraulic lifters to ensure proper operation.
6. Inspect and replace the camshaft and drive belt/chain, which includes checking for 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, while verifying correct camshaft timing.
7. Inspect valve springs for squareness and free height comparison and determine necessary actions based on inspection results.
8. Replace valve stem seals on an assembled engine, inspect valve spring retainers, locks/keepers, and valve lock/keeper grooves and determine necessary actions.
9. Inspect valve guides for wear, check valve stem-to-guide clearance, and determine needed actions based on findings.
10. Inspect valves and valve seats and determine necessary actions for maintenance or repair.
11. Check valve spring assembled height and valve stem height and determine necessary actions based on measurements.
12. Inspect valve lifters and hydraulic lash adjusters and determine necessary actions based on wear or malfunction.
13. Inspect and/or measure the camshaft for runout, journal wear, and lobe wear to assess its condition.
14. Inspect camshaft bearing surfaces for wear, damage, out-of-roundness, and alignment, and determine necessary actions for repair or replacement.

### Standard 19: Engine Block Assembly Diagnosis and Repair

Students will demonstrate the ability to diagnose, inspect, and repair engine block assemblies by utilizing appropriate tools and techniques, ensuring proper assembly and functionality in accordance with manufacturer specifications.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Repair, MLR, and AST

#### Skills:

1. Identify the components and configurations of engine block assemblies to facilitate effective diagnosis and repair.
2. Remove, inspect, and/or replace the crankshaft vibration damper (harmonic balancer) as necessary for engine performance.
3. Disassemble the engine block, clean, and prepare components for inspection and reassembly to ensure quality repair.
4. Inspect the engine block for visible cracks, passage condition, core and gallery plug condition, and surface warpage, and determine necessary actions based on findings.
5. Inspect and measure cylinder walls/sleeves for damage, wear, and ridges and determine necessary actions to restore functionality.
6. Perform deglazing and cleaning of cylinder walls to prepare for reassembly and ensure proper sealing.
7. Inspect and measure camshaft bearings for wear, damage, out-of-roundness, and alignment and determine necessary actions based on assessment.
8. Inspect the crankshaft for straightness, journal damage, keyway damage, thrust flange and sealing surface condition, visual surface cracks, and oil passage condition; measure end play and journal wear; check crankshaft position sensor reluctor ring (where applicable); and determine necessary actions.
9. Inspect main and connecting rod bearings for damage and wear and determine necessary actions based on inspection results.
10. Identify piston and bearing wear patterns that indicate connecting rod alignment and main bearing bore problems and determine necessary actions for correction.
11. Inspect and measure piston skirts and ring lands and determine necessary actions based on measurements.
12. Determine piston-to-bore clearance to ensure proper fit and operation.
13. Inspect, measure, and install piston rings to maintain optimal engine performance.
14. Inspect, measure, and reinstall auxiliary shaft(s) (balance, intermediate, idler, counterbalance, and/or silencer) and support bearings for damage and wear; determine necessary actions and time accordingly.
15. Assemble the engine block using proper techniques to ensure reliable engine function.

### Standard 20: Lubrication and Cooling Systems Diagnostics and Repair

Students will be able to diagnose, inspect, and repair lubrication and cooling system components by utilizing diagnostic tools, performing system tests, and applying manufacturer specifications to ensure optimal engine performance and prevent overheating.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Repair, MLR, and AST

#### Skills:

1. Identify the components and configurations of lubrication and cooling systems, including forced air induction systems, to support accurate diagnostics and repairs.
2. Verify engine operating temperature using appropriate diagnostic tools; determine the necessary corrective action based on manufacturer specifications.
3. Perform cooling system pressure and dye tests to identify leaks; inspect and test the condition and level of coolant, radiator, pressure cap, coolant recovery tank, heater core, and galley plugs; formulate and implement necessary repairs.
4. Identify and analyze the causes of engine overheating by evaluating system components and vehicle data.
5. Inspect, replace, and adjust drive belts, tensioners, and pulleys; check pulley and belt alignment to ensure proper functioning of the system.
6. Inspect, test, and replace mechanical/electrical fans, fan clutches (electrical or mechanical), fan shroud/ducting, air dams, and fan control devices; perform necessary actions to maintain efficient airflow and cooling.
7. Inspect coolant for contamination or degradation; drain, recover, and flush the cooling system; refill the system with the recommended coolant type per manufacturer specifications and bleed air from the system as required.
8. Remove, inspect, and replace the thermostat and gasket/seal to ensure proper regulation of engine temperature.
9. Remove and replace the water pump and radiator to restore the cooling system's functionality and prevent overheating.
10. Inspect auxiliary coolers and determine the necessary action to ensure optimal performance.
11. Perform engine oil and filter changes, using the proper fluid type according to manufacturer specifications, and reset maintenance reminders as required.
12. Inspect, test, and/or replace oil temperature and pressure switches, sensors, oil pump gears/rotors, housing, pressure relief devices, and pump drive; determine and implement needed action to maintain proper lubrication system performance.
13. Perform oil pressure tests to evaluate the engine's lubrication system and determine necessary repairs or adjustments.

### Standard 21: Ignition Systems Diagnostics and Repair

Students will diagnose, inspect, and repair ignition systems to resolve engine performance issues in accordance with industry and manufacturer standards.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Performance, MLR, and AST

#### Skills:

1. Identify ignition system components and configurations, including primary and secondary circuits, to develop a comprehensive understanding of system operation.
2. Inspect and test ignition primary circuit wiring and components, including sensors and triggering devices; diagnose issues and perform necessary actions to restore proper function.
3. Inspect, test, and/or replace ignition coils, ensuring optimal operation and effective spark delivery.
4. Remove and replace spark plugs; inspect secondary ignition components such as wires, boots, and terminals for wear and damage; and determine necessary actions to maintain efficient combustion.
5. Diagnose ignition system-related problems such as no-start, hard-starting, engine misfire, poor drivability, spark knock, power loss, poor fuel mileage, and emissions concerns; analyze diagnostic data to determine corrective actions.
6. Inspect and test crankshaft and camshaft position sensors for proper functionality; determine necessary repairs or replacements.
7. Inspect, test, and/or replace the ignition control module and/or powertrain/engine control module (PCM/ECM); reprogram or initialize the module as required to ensure accurate system control.
8. Identify ignition system-related issues in electronic ignition systems (both distributor and distributor-less), including engine misfire, spark knock, and power loss; perform the appropriate diagnostic and repair actions.

### Standard 22: Emissions Control Systems

Students will analyze and diagnose emission control system issues, evaluate system performance, and perform necessary repairs to resolve emissions and drivability concerns in compliance with industry standards.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Performance, MLR, and AST

#### Skills:

1. Analyze emission control system components and configurations to identify potential concerns.
2. Inspect, test, and service the positive crankcase ventilation (PCV) filter, valve, tubes, orifices, and hoses; evaluate their condition and determine the necessary corrective action.
3. Diagnose oil leaks, emissions, and drivability concerns caused by malfunctions in the PCV system; implement appropriate repairs.
4. Evaluate emissions and drivability concerns caused by the exhaust gas recirculation (EGR) system; inspect, test, and repair electrical/electronic sensors, controls, wiring, tubing, exhaust passages, vacuum/pressure controls, filters, and hoses as necessary.
5. Inspect and test electrical/electronic components and circuits of the secondary air injection system; assess system performance and determine needed action.
6. Diagnose catalytic converter system malfunctions that cause emissions or drivability issues; analyze performance and apply the appropriate corrective measures.
7. Evaluate emissions and drivability concerns related to the evaporative emissions control (EVAP) system; diagnose and repair malfunctioning components and hoses.
8. Interpret diagnostic trouble codes (DTCs) and scan tool data related to emission control systems; synthesize data to determine necessary repairs and adjustments.

### Standard 23: Drivetrain and Clutch Assembly Diagnosis and Repair

Students will demonstrate diagnostic and repair techniques for manual drivetrain and clutch assembly systems, ensuring optimal vehicle performance and reliability.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Manual Drive Train and Axles, MLR, and AST

#### Skills:

1. Identify and differentiate between manual drive train and axle components and configurations to ensure accurate diagnostics and repairs.
2. Assess fluid condition and inspect for leaks in the manual drive train; determine and apply the necessary corrective actions.
3. Inspect, remove, and replace constant velocity (CV) axles, ensuring proper operation and alignment.
4. Evaluate power train mounts for wear or damage; remove and replace as necessary to maintain structural integrity.
5. Demonstrate draining and refiling manual transmission/transaxle using the correct fluid type according to manufacturer specifications.
6. Diagnose manual drive train concerns and evaluate the system to determine the appropriate action for repair.
7. Inspect the flywheel and ring gear for wear or cracks; analyze their condition and replace if necessary to ensure reliable engine operation.
8. Lubricate and inspect shift linkage bushings for proper function, performing maintenance as needed to ensure smooth gear shifting.
9. Clean and inspect differential housing vents, ensuring they are free of debris and operating properly.
10. Inspect and adjust the clutch master cylinder fluid level; check for leaks; and use the proper fluid type per manufacturer specifications.
11. Diagnose clutch issues including noise, binding, slippage, pulsation, and chatter; determine necessary actions for resolution.
12. Evaluate clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots, and springs; perform necessary actions based on findings.
13. Inspect and replace the clutch pressure plate assembly, clutch disc, release (throw-out) bearing, linkage, and pilot bearing/bushing as applicable.
14. Bleed the clutch hydraulic system to ensure proper function.
15. Assess the flywheel and ring gear for wear, cracks, and discoloration; determine necessary actions.
16. Measure flywheel runout and crankshaft end play; determine necessary actions for adjustment.
17. Describe the operation and service of a dual mass flywheel system, including its function and benefits.

### Standard 24: Transmission and Transaxle Diagnosis and Repair

Students will demonstrate proficiency in diagnosing, inspecting, and repairing transmission and transaxle systems, including electronically controlled and continuously variable transmissions, by applying industry standards and manufacturer specifications to ensure optimal vehicle performance.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Manual Drive Train and Axles, MLR, and AST

#### Skills:

1. Explain the operational characteristics of electronically controlled manual transmissions/transaxles and continuously variable transmissions (CVT) to ensure accurate diagnostics.
2. Inspect, adjust, lubricate, and/or replace shift linkages, brackets, bushings, cables, pivots, and levers to maintain optimal transmission performance.
3. Diagnose noise, vibration, and fluid loss concerns by applying transmission/transaxle power flow principles and performing pressure tests; determine and perform the necessary actions.
4. Diagnose hard shifting, gear reduction/multiplication issues, and jumping out of gear concerns using driving, driven, and held member (power flow) principles; apply corrective measures.
5. Disassemble, inspect, clean, and reassemble internal transmission/transaxle components, ensuring each part meets manufacturer specifications for proper operation.
6. Diagnose electronic transmission/transaxle control systems using appropriate testing procedures; analyze data from electrical/electronic components and circuits including solenoids, sensors, relays, and switches.
7. Inspect, test, adjust, repair, or replace external seals, gaskets, bushings, and electrical/electronic components, including computers, terminals, connectors, and harnesses, ensuring proper function and preventing leaks.
8. Remove and reinstall transmission/transaxle and torque converter, inspecting components such as engine core plugs, rear crankshaft seal, dowel pins, and mating surfaces for wear or damage; perform necessary repairs.
9. Inspect, leak test, and flush or replace the transmission/transaxle oil cooler, lines, and fittings to ensure proper fluid flow and prevent overheating.
10. Inspect converter flex (drive) plate, attaching bolts, pilot surfaces, and converter end play; replace components as needed to ensure proper converter operation.
11. Perform stall tests and lock-up converter system tests to evaluate transmission performance; determine necessary repairs.
12. Check and maintain fluid levels in transmissions or transaxles not equipped with a dipstick, ensuring correct operation.

### Standard 25: Manual Transmission and Drivetrain Diagnosis and Repair

Students will demonstrate appropriate techniques for servicing hubs, joints, shafts, and yokes to effectively diagnose and repair drive shaft and half shaft components, as well as universal and constant-velocity (CV) joints, ensuring optimal performance.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Manual Drive Train and Axles, MLR, and AST

#### Skills:

1. Inspect, remove, and replace bearings, hubs, and seals to maintain system integrity and performance.
2. Inspect, service, and replace shafts, yokes, boots, and universal/CV joints, ensuring proper function and alignment.
3. Inspect, remove, and replace front wheel drive (FWD) bearings, hubs, and seals.
4. Check for leaks at drive assembly and transfer case seals; assess vents and fluid levels; use the proper fluid type per manufacturer specifications.
5. Diagnose constant-velocity (CV) joint noise and vibration concerns; determine and implement necessary corrective actions.
6. Diagnose universal joint noise and vibration issues; perform necessary actions to restore proper function.
7. Evaluate shaft balance and phasing; measure shaft runout; and calculate and adjust driveline angles for optimal performance**.**

### Standard 26: Differential and Drive Axles Diagnosis and Repair

Students will demonstrate skills in diagnosing and servicing differential systems, applying appropriate service and repair techniques to ensure optimal performance and reliability.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Manual Drive Train and Axles, MLR, and AST

#### Skills:

1. Inspect the differential housing for wear and leaks; check the housing vent for proper function.
2. Assess and adjust the differential housing fluid level, ensuring to use the proper fluid type per manufacturer specifications.
3. Drain and refill the differential housing with the correct fluid type as per manufacturer specifications.
4. Inspect and replace the companion flange and/or pinion seal; measure the companion flange runout to determine its condition.
5. Evaluate the ring gear condition and measure its runout; determine necessary corrective action based on findings.
6. Diagnose noise and vibration concerns related to the differential; determine and implement appropriate actions for resolution.
7. Remove, inspect, reinstall, or replace the drive pinion and ring gear, along with spacers, sleeves, and bearings.
8. Measure and adjust the drive pinion depth to ensure proper alignment and function.
9. Measure and adjust the drive pinion bearing preload for optimal performance.
10. Measure and adjust side bearing preload and assess ring and pinion gear total backlash and backlash variation on a differential carrier assembly (threaded cup or shim types).
11. Check ring and pinion tooth contact patterns; determine and implement necessary adjustments based on findings.
12. Disassemble, inspect, measure, adjust, and/or replace differential pinion gears (spiders), shaft, side gears, side bearings, thrust washers, and case.
13. Reassemble and reinstall the differential case assembly; measure runout and determine necessary actions to ensure reliability.
14. Diagnose noise, slippage, and chatter concerns in limited slip differentials; determine needed action.
15. Measure rotating torque in limited slip differentials; determine needed action.

### Standard 27: Drive Axles and Four-Wheel Drive Diagnosis and Repair

Students will demonstrate the ability to effectively inspect, service, and repair drive axles and four-wheel drive systems, utilizing appropriate techniques and tools to ensure optimal performance, reliability, and safety.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Manual Drive Train and Axles, MLR, and AST

#### Skills:

1. Inspect and replace drive axle wheel studs to ensure safety.
2. Remove and replace drive axle shafts to maintain driveline integrity.
3. Inspect and replace drive axle shaft seals, bearings, and retainers to prevent fluid leakage.
4. Measure drive axle flange runout and shaft end play; determine necessary corrective action based on findings.
5. Diagnose drive axle shafts, bearings, and seals for noise, vibration, and fluid leakage concerns; determine appropriate corrective actions.
6. Inspect, adjust, and repair transfer cases and locking hubs to ensure reliability in four-wheel drive systems.
7. Inspect, adjust, and repair shifting controls (mechanical, electrical, and vacuum), bushings, mounts, levers, and brackets to maintain effective operation.
8. Inspect axle locking mechanisms; determine necessary actions for proper engagement and disengagement.
9. Check for leaks at drive assembly and transfer case seals; assess vents and fluid levels; and use the correct fluid type as specified by the manufacturer.
10. Diagnose noise, vibration, and unusual steering concerns; determine necessary corrective actions based on diagnosis.
11. Diagnose, test, adjust, and replace electrical/electronic components of four-wheel drive/all-wheel drive systems to ensure reliable operation.
12. Disassemble, service, and reassemble transfer case and components; check for leaks, vents, and proper lubricant levels to maintain functionality.

### Standard 28: Heating, Ventilation, and Air Conditioning System Diagnosis and Repair

Students will apply diagnostic techniques and repair methods to HVAC and engine cooling systems, ensuring optimal vehicle performance and passenger comfort.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Heating, Ventilation, and Air Conditioning (HVAC), MLR, and AST

#### Skills:

1. Identify and differentiate HVAC components and configurations to facilitate effective diagnostics.
2. Perform A/C system performance tests; interpret results and determine necessary actions for resolution.
3. Identify abnormal operating noises in the A/C system; assess and determine appropriate corrective actions.
4. Conduct leak tests on the A/C system; evaluate results and determine necessary actions for repair.
5. Analyze and interpret heating and air conditioning problems; determine necessary actions for resolution.
6. Identify refrigerant types; test for sealant; select and connect the appropriate gauge set/test equipment; and record temperature and pressure readings according to current industry standards.
7. Inspect the condition and quantity of refrigerant oil removed from the A/C system; determine necessary actions for maintenance.
8. Determine recommended oil type and oil capacity for system application and component(s) replacement.
9. Inspect and test heater control valves; perform necessary actions to ensure proper operation.
10. Inspect and test A/C-heater blower motors, resistors, switches, relays, wiring, and protection devices; determine necessary actions for repair or replacement.
11. Diagnose A/C compressor clutch control systems; determine necessary actions for restoration.
12. Diagnose malfunctions in the vacuum, mechanical, and electrical components and controls of the HVAC system; implement corrective actions as necessary.
13. Inspect and test A/C-heater control panel assembly; determine necessary actions for repair.
14. Inspect and test A/C-heater control cables, motors, and linkages; perform necessary actions to ensure proper function.
15. Inspect A/C-heater ducts, doors, hoses, cabin filters, and outlets; perform necessary actions to maintain system efficiency.
16. Diagnose temperature control problems in the heater/ventilation system; determine necessary actions for resolution.
17. Check operation of automatic or semi-automatic heating, ventilation, and air-conditioning (HVAC) control systems; determine necessary actions for improvement.
18. Inspect engine cooling and heater system hoses and pipes; determine necessary actions for repair or replacement.
19. Evaluate and test heater control valve(s); identify required actions for optimal performance.
20. Diagnose temperature control problems in the HVAC system related to the engine cooling system, including electric heating; determine necessary corrective actions.
21. Determine the procedure to remove, inspect, reinstall, and/or replace the heater core; ensure proper system refill and functionality.

### Standard 29: Refrigeration System Component Diagnosis and Repair

Students will demonstrate appropriate techniques for diagnosing and repairing refrigeration system components, ensuring efficient operation of the air conditioning system.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: HVAC, MLR, and AST

#### Skills:

1. Inspect A/C compressor drive belts, pulleys, and tensioners; determine needed actions for maintenance or replacement.
2. Evaluate A/C condenser airflow; determine necessary actions to ensure proper airflow.
3. Inspect evaporator housing condensation drain; identify necessary actions for effective drainage.
4. Test A/C compressor clutch components and assembly; determine required actions for repair or replacement.
5. Remove, inspect, and reinstall the A/C compressor and its mountings; recommend the appropriate oil type and quantity for optimal performance.
6. Remove and inspect A/C system mufflers, hoses, lines, fittings, O-rings, seals, and service valves; determine needed actions for repair or replacement.
7. Remove, inspect, and replace the receiver/drier or accumulator/drier; recommend the correct oil type and quantity.
8. Remove, inspect, and install the expansion valve or orifice (expansion) tube; determine necessary actions for proper installation.
9. Diagnose A/C system conditions that cause protection devices (pressure, thermal, and/or control module) to interrupt system operation; determine needed actions for resolution.
10. Determine the procedure to remove and reinstall the evaporator; specify the required oil type and quantity for the system.
11. Remove, inspect, and reinstall the condenser; determine the required oil type and quantity for proper functionality.

### Standard 30: Refrigerant Recovery, Recycling, and Handling

Students will demonstrate the knowledge and skills necessary for the safe and effective recovery, recycling, and handling of refrigerants, adhering to Massachusetts regulations and industry standards to ensure environmental protection and compliance.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: HVAC, MLR, and AST

#### Skills:

1. Understand the importance of recovering, recycling, and handling refrigerants using proper equipment and procedures.
2. Utilize and maintain refrigerant handling equipment in accordance with the manufacturer’s standards to ensure effective operation and safety.
3. Identify the type of refrigerant used in A/C systems; test for the presence of sealants; recover, evacuate, and charge the A/C system; and add refrigerant oil as required to maintain system integrity.
4. Recycle, label, and store refrigerant in compliance with Massachusetts regulations to promote environmental responsibility.
5. Examine the guidelines set forth by the Massachusetts Department of Environmental Protection (MassDEP) regarding the safe handling, recovery, and recycling of refrigerants, highlighting key practices and procedures.
6. Analyze the federal regulations outlined in EPA Section 608, specifically the technician certification requirements and the implications for refrigerant management in Massachusetts.

### Standard 31: Engine Performance Diagnosis and Repair

Students will demonstrate the ability to diagnose engine performance issues by utilizing advanced diagnostic tools and techniques, ensuring optimal vehicle functionality and compliance with industry standards.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Performance, MLR, and AST

#### Skills:

1. Verify proper engine cooling system operation and determine necessary actions for any identified issues.
2. Verify correct camshaft timing, including on engines equipped with variable valve timing (VVT) systems, and determine necessary corrective actions.
3. Identify and interpret engine performance concerns, such as excessive oil or coolant consumption, unusual exhaust characteristics (color, odor, sound), and determine required actions for resolution.
4. Diagnose abnormal engine noises or vibration concerns and determine necessary actions to address them.
5. Perform engine manifold pressure tests (vacuum/boost) and determine necessary actions based on the results.
6. Perform a cylinder power balance test and determine necessary actions to rectify identified issues.
7. Perform cylinder cranking and running compression tests; determine necessary actions for any identified deficiencies.
8. Perform cylinder leakage tests and determine necessary actions based on the findings.
9. Diagnose engine mechanical, electrical, electronic, fuel, and ignition concerns, including issues with no diagnostic trouble codes (DTC), and determine necessary actions for repair.

### Standard 32: Computerized Controls Diagnosis and Repair

Students will demonstrate the ability to diagnose and understand the function of computerized control systems in vehicles by identifying components, utilizing diagnostic tools, interpreting data from On-Board Diagnostics (OBD), and analyzing advanced driver assist and autonomous system functionalities to address emissions, drivability, and safety concerns.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Performance, MLR, and AST

#### Skills:

1. Identify the components and configurations of computerized control systems to facilitate effective diagnosis.
2. Access and utilize service information to perform systematic step-by-step troubleshooting diagnosis of computerized control systems.
3. Perform active tests of actuators with a scan tool, assessing functionality and determining necessary actions based on results.
4. Describe the role of On-Board Diagnostics (OBD) monitors in repair verification, articulating their importance in the diagnostic process.
5. Inspect and test the sensors, powertrain/engine control module (PCM/ECM), actuators, and circuits of computerized engine control systems using a graphing multimeter (GMM), digital storage oscilloscope (DSO), and/or scan tool, determining needed actions based on the findings.
6. Explain the process for reprogramming or recalibrating the powertrain/engine control module (PCM/ECM), including necessary precautions and procedures.
7. Diagnose emissions or drivability concerns linked to stored or active diagnostic trouble codes (DTC), obtaining, graphing, and interpreting scan tool data to identify the root causes.
8. Diagnose emissions or drivability issues in the absence of stored or active diagnostic trouble codes, determining appropriate corrective actions based on symptoms and performance data.
9. Analyze and diagnose drive ability and emissions problems stemming from malfunctions of interrelated systems, such as cruise control, security alarms, suspension controls, traction controls, HVAC, automatic transmissions, and non-OEM installed accessories, determining necessary actions for resolution.
10. Identify and describe the operation and functionality of driver assist technologies, such as adaptive cruise control, lane departure warning systems, and blind spot monitoring.
11. Access diagnostic information and interpret data for autonomous systems and explain their impact on vehicle drivability and safety.
12. Analyze the operation of autonomous braking systems using scan tools, identifying any performance concerns or malfunctions.
13. Identify and explain the role of adaptive lighting systems and their integration with other vehicle control systems, ensuring their functionality through diagnostic assessment.
14. Describe and diagnose potential malfunctions in parking aid systems and assess their impact on vehicle safety.
15. Interpret data from in-vehicle Wi-Fi systems to determine connectivity or performance issues, assessing potential impacts on other vehicle systems.

### Standard 33: Fuel, Air Induction, and Exhaust Systems Diagnosis and Repair

Students will demonstrate the ability to diagnose and repair fuel, air induction, and exhaust systems in vehicles to ensure efficient engine performance and compliance with environmental standards.

* Aligned Industry Recognized Credentials: ASE Entry-Level Certifications: Engine Performance, MLR, and AST

#### Skills:

1. Identify fuel, air induction, and exhaust system components and configurations to facilitate effective diagnosis and repair.
2. Replace fuel filter(s) as applicable to maintain system integrity and performance.
3. Inspect, service, or replace air filters, filter housings, and intake duct work to ensure optimal airflow and engine efficiency.
4. Inspect the integrity of the exhaust manifold, exhaust pipes, muffler(s), catalytic converter(s), resonator(s), tail pipe(s), and heat shields, determining needed actions for repair or replacement.
5. Assess the condition of exhaust system hangers, brackets, clamps, and heat shields, and determine appropriate actions based on inspection findings.
6. Check and refill diesel exhaust fluid (DEF) as necessary to meet emissions standards.
7. Evaluate fuel quality, composition, and contamination levels, and determine necessary actions for remediation.
8. Inspect and test fuel pump(s) and pump control systems for pressure, regulation, and volume, determining required actions based on test results.
9. Inspect the throttle body, air induction system, intake manifold, and gaskets for vacuum leaks and/or unmetered air to ensure proper operation.
10. Inspect, test, and/or replace fuel injectors in both low- and high-pressure systems to maintain optimal fuel delivery.
11. Verify proper idle speed and determine actions needed to correct any discrepancies.
12. Perform exhaust system back-pressure tests, interpreting results to inform necessary corrective actions.
13. Diagnose a range of performance issues, including hot or cold no-starting, hard starting, poor drivability, incorrect idle speed, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling, and emissions problems; determine appropriate resolutions.
14. Test the operation of turbocharger/supercharger systems, analyzing performance and determining necessary actions for repair or adjustment.

## Employability Standards

### Standard 34: Employability Skills

Students will understand and demonstrate the roles of professional communication, critical thinking, problem solving, professionalism, teamwork, and collaboration within the context of automotive technology careers.

#### Skills:

1. Demonstrate effective communication and interpersonal skills to provide exceptional customer service across various platforms, including face-to-face interactions, telephone conversations, and written and electronic correspondence.
2. Analyze complex problems and develop effective solutions, applying critical thinking and problem-solving techniques relevant to the automotive technology field.
3. Exhibit active listening skills by giving full attention to others, understanding their points of view, and asking appropriate questions to meet job expectations and improve production methods.
4. Collaborate effectively in teams to achieve common goals, demonstrating coordination and cooperation with other professionals in the automotive technology field.
5. Apply effective time management techniques, including task prioritization, deadline management, and efficient workload handling.
6. Demonstrate ethical behavior and adhere to industry standards, ensuring safety, compliance, and integrity in all professional activities.

## Entrepreneurship Standards

### Standard 35: Entrepreneurship

Students will be able to describe opportunities for entrepreneurship and be able to evaluate the value proposition of business ownership in the automotive technology field.

#### Skills

1. Understand and be able to explain the needs of startup automotive repair services company (including initial equipment and staffing needs, a marketing/business development plan, and a basic revenue management strategy).
2. Describe the concept of professional networking and demonstrate personal introductions and an “elevator speech” appropriate for other automotive repair technicians, dealership management, and other potential business partners.
3. Evaluate the licensing, regulatory, and tax implications of self-employment and business ownership as an automotive repair technician compared to W-2 employment.

## Digital Literacy & Computer Science Standards

### Standard 36: Digital Literacy and Computer Science

Students will be able to demonstrate the use of common software and information technology in a modern automotive repair environment.

#### Skills:

1. Use email, messaging platforms, and collaborative tools for clear communication with team members, suppliers, and customers.
2. Describe the use of online resources in certification and professional development as an automotive repair technician.
3. Demonstrate the use of common ticketing, scheduling, resource management, and/or customer relationship management systems for automotive repair services.
4. Utilize software to accurately record, analyze, and manage vehicle service history and maintenance records.
5. Operate and interpret data from diagnostic scan tools and software for troubleshooting vehicle issues.
6. Execute online research to access technical resources, service bulletins, and industry updates relevant to automotive technology.
7. Apply strategies for using digital tools and technology to drive business and commerce.