Ohio CTE

Transportation Systems

Business Operations/21st Century Skills: Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field. 1

1 **Employability Skills: Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.** 1.1

1 Identify the knowledge, skills and abilities necessary to succeed in careers. 1.1.1

2 Identify the scope of career opportunities and the requirements for education, training, certification, licensure and experience. 1.1.2

3 Develop a career plan that reflects career interests, pathways and secondary and postsecondary options. 1.1.3

4 Describe the role and function of professional organizations, industry associations and organized labor and use networking techniques to develop and maintain professional relationships. 1.1.4

5 Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development). 1.1.5

6 Explain the importance of work ethic, accountability and responsibility and demonstrate associated behaviors in fulfilling personal, community and workplace roles. 1.1.6

7 Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions. 1.1.7

8 Identify the correlation between emotions, behavior and appearance and manage those to establish and maintain professionalism. 1.1.8

9 Give and receive constructive feedback to improve work habits. 1.1.9

10 Adapt personal coping skills to adjust to taxing workplace demands. 1.1.10

11 Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them. 1.1.11

12 Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior. 1.1.12

2 **Leadership and Communications: Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.** 1.2

1 Extract relevant, valid information from materials and cite sources of information. 1.2.1

Deliver formal and informal presentations. 1.2.2

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3 Identify and use verbal, nonverbal and active listening skills to communicate effectively. 1.2.3

4 Use negotiation and conflict-resolution skills to reach solutions. 1.2.4

5 Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose. 1.2.5

6 Use proper grammar and expression in all aspects of communication. 1.2.6

7 Use problem-solving and consensus-building techniques to draw conclusions and determine next steps. 1.2.7

8 Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships. 1.2.8

9 Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity). 1.2.9

10 Use interpersonal skills to provide group leadership, promote collaboration and work in a team. 1.2.10

11 Write professional correspondence, documents, job applications and resumés. 1.2.11

12 Use technical writing skills to complete forms and create reports. 1.2.12

13 Identify stakeholders and solicit their opinions. 1.2.13

14 Use motivational strategies to accomplish goals. 1.2.14

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3 **Business Ethics and Law: Analyze how professional, ethical and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.** 1.3

1 Analyze how regulatory compliance affects business operations and organizational performance. 1.3.1

2 Follow protocols and practices necessary to maintain a clean, safe and healthy work environment. 1.3.2

3 Use ethical character traits consistent with workplace standards (e.g., honesty, personal integrity, compassion, justice). 1.3.3

4 Identify how federal and state consumer protection laws affect products and services. 1.3.4

5 Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization. 1.3.5

6 Identify deceptive practices (e.g., bait and switch, identity theft, unlawful door-to-door sales, deceptive service estimates, fraudulent misrepresentations) and their overall impact on organizational performance. 1.3.6

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7 Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g., harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act [ADA], Fair Labor Standards Acts [FLSA], Equal Employment Opportunity Commission [EEOC]). 1.3.7

8 Verify compliance with computer and intellectual property laws and regulations. 1.3.8

9 Identify potential conflicts of interest (e.g., personal gain, project bidding) between personal, organizational and professional ethical standards. 1.3.9

4 **Knowledge Management and Information Technology: Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.** 1.4

1 Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems). 1.4.1

2 Select and use software applications to locate, record, analyze and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines). 1.4.2

3 Verify compliance with security rules, regulations and codes (e.g., property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway. 1.4.3

4 Use system hardware to support software applications. 1.4.4

5 Use information technology tools to maintain, secure and monitor business records. 1.4.5

6 Use an electronic database to access and create business and technical information. 1.4.6

7 Use personal information management and productivity applications to optimize assigned tasks (e.g., lists, calendars, address books). 1.4.7

8 Use electronic media to communicate and follow network etiquette guidelines. 1.4.8

5 **Global Environment: Evaluate how beliefs, values, attitudes and behaviors influence organizational strategies and goals.** 1.5

1 Describe how cultural understanding, cultural intelligence skills and continual awareness are interdependent. 1.5.1

2 Describe how cultural intelligence skills influence the overall success and survival of an organization. 1.5.2

3 Use cultural intelligence to interact with individuals from diverse cultural settings. 1.5.3

4 Recognize barriers in cross-cultural relationships and implement behavioral adjustments. 1.5.4

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Recognize the ways in which bias and discrimination may influence productivity and profitability. 1.5.5

6 Analyze work tasks for understanding and interpretation from a different cultural perspective. 1.5.6

7 Use intercultural communication skills to exchange ideas and create meaning. 1.5.7

8 Identify how multicultural teaming and globalization can foster development of new and improved products and services and recognition of new opportunities. 1.5.8

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6 **Business Literacy: Develop foundational skills and knowledge in entrepreneurship, financial literacy and business operations.** 1.6

1 Identify business opportunities. 1.6.1

2 Assess the reality of becoming an entrepreneur, including advantages and disadvantages (e.g., risk versus reward, reasons for success and failure). 1.6.2

3 Explain the importance of planning your business. 1.6.3

4 Identify types of businesses, ownership and entities (i.e., individual proprietorships, partnerships, corporations, cooperatives, public, private, profit, not-for-profit). 1.6.4

5 Describe organizational structure, chain of command, the roles and responsibilities of the organizational departments and interdepartmental interactions. 1.6.5

6 Identify the target market served by the organization, the niche that the organization fills and an outlook of the industry. 1.6.6

7 Identify the effect of supply and demand on products and services. 1.6.7

8 Identify the features and benefits that make an organization's product or service competitive. 1.6.8

9 Explain how the performance of an employee, a department and an organization is assessed. 1.6.9

10 Describe the impact of globalization on an enterprise or organization. 1.6.10

11 Describe how all business activities of an organization work within the parameters of a budget. 1.6.11

12 Describe classifications of employee benefits, rights, deductions and compensations. 1.6.12

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7 **Entrepreneurship/Entrepreneurs: Analyze the environment in which a business operates and the economic factors and opportunities associated with self-employment.** 1.7

1 Compare and contrast the four types of business ownership (i.e., individual proprietorships, partnerships, corporations, cooperatives). 1.7.1

2 Explain the role of profit as the incentive to entrepreneurs in a market economy. 1.7.2

` Identify the factors that contribute to the success and failure of entrepreneurial ventures. 1.7.3

4 Assess the roles of nonprofit and for-profit businesses. 1.7.4

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5 Develop a business plan. 1.7.5

6 Describe life cycles of an entrepreneurial business and an entrepreneur. 1.7.6

7 Create a list of personal strengths, weaknesses, skills and abilities needed to be successful as an entrepreneur. 1.7.7

8 Explain pathways used to become an entrepreneur. 1.7.8

9 Conduct a self-assessment to determine entrepreneurial potential. 1.7.9

10 Describe techniques for obtaining experience (e.g., apprenticeship, co-operative [co-op] education, work placement, internship, job shadowing) related to an entrepreneurial objective. 1.7.10

11 Identify initial steps in establishing a business (e.g., limited liability company [LLC], tax ID, permits, insurance, licensing). 1.7.11

12 Identify resources available to entrepreneurs (e.g., Small Business Administration, mentors, information resources, educational opportunities). 1.7.12

13 Protect intellectual property and knowledge (e.g., copyright, patent, trademark, trade secrets, processes). 1.7.13

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8 **Operations Management: Plan, organize and monitor an organization or department to maximize contribution to organizational goals and objectives.** 1.8

1 Forecast future resources and budgetary needs using financial documents (e.g., balance sheet, demand forecasting, financial ratios). 1.8.1

2 Select and organize resources to develop a product or a service. 1.8.2

3 Analyze the performance of organizational activities and reallocate resources to achieve established goals. 1.8.3

4 Identify alternative actions to take when goals are not met (e.g., changing goals, changing strategies, efficiencies). 1.8.4

5 Use inventory and control systems to purchase materials, supplies and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN). 1.8.5

6 Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability. 1.8.6

7 Collect information and feedback to help assess the organization's strategic planning and policymaking processes. 1.8.7

8 Identify routine activities for maintaining business facilities and equipment. 1.8.8

9 Develop a budget that reflects the strategies and goals of the organization. 1.8.9

10 Analyze how business management and environmental management systems (e.g., health, safety) contribute to continuous improvement and sustainability. 1.8.19

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9 **Financial Management: Use financial tools, strategies and systems to develop, monitor and control the use of financial resources to ensure personal and business financial well-being.** 1.9

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1. Create, analyze and interpret financial documents (e.g., budgets, income statements). 1.9.1
2. Identify tax obligations. 1.9.2
3. Review and summarize savings, investment strategies and purchasing options (e.g., cash, lease, finance, stocks, bonds). 1.9.3
4. Identify credit types and their uses in order to establish credit. 1.9.4
5. Identify ways to avoid or correct debt problems. 1.9.5
6. Explain how credit ratings and the criteria lenders use to evaluate repayment capacity affect access to loans. 1.9.6
7. Review and summarize categories (types) of insurance and identify how insurances can reduce financial risk. 1.9.7
8. Identify income sources and expenditures. 1.9.8
9. Compare and contrast different banking services available through financial institutions. 1.9.9

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10 Sales and Marketing: Manage pricing, place, promotion, packaging, positioning and public relations to improve quality customer service. 1.10

1. Identify how the roles of sales, advertising and public relations contribute to a company's brand. 1.10.1
2. Determine the customer's needs and identify solutions. 1.10.2
3. Communicate features, benefits and warranties of a product or service to the customer. 1.10.3
4. Identify the company policies and procedures for initiating product and service improvements. 1.10.4
5. Monitor customer expectations and determine product/services satisfaction by using measurement tools. 1.10.5
6. Discuss the importance of correct pricing to support a product's or service's positioning in the marketing mix. 1.10.6
7. Describe the importance and diversity of distribution channels (i.e., direct, indirect) to sell a product. 1.10.7
8. Use promotional techniques to maximize sales revenues (e.g., advertising, sales promotions, publicity, public relations). 1.10.8
9. Describe how product mix (e.g., product line, product items) maximize sales revenues, market, share and profit margin. 1.10.9
10. Demonstrate sales techniques. 1.10.10

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11 Principles of Business Economics: Examine and employ economic principles, concepts and policies to accomplish organizational goals and objectives. 1.11

1. Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services). 1.11.1

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2 Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior. 1.11.2

3 Use economic indicators to identify economic trends and conditions (e.g., inflation, interest rate fluctuations, unemployment rates). 1.11.3

4 Determine how the quality, quantity and pricing of goods and services are affected by domestic and international competition in a market economy. 1.11.4

5 Analyze factors that affect currency and exchange rates. 1.11.5

6 Explain how financial markets and government policies influence interest rates (credit ratings/debt ceiling), trade deficits and unemployment. 1.11.6

7 Describe how economic performance and culture are interdependent. 1.11.7

8 Identify the relationships between economy, society and environment that lead to sustainability. 1.11.8

9 Describe how laws and regulations influence domestic and international trade. 1.11.9

Safety, Tools and Maintenance: Learners apply principles of safety and use of tools to maintain equipment and the environment to prevent accidents and mitigate hazards. 2

1 **Facility Safety: Handle materials, prevent accidents and mitigate hazards.** 2.1

1 Use Occupational Safety and Health Administration (OSHA)-defined procedures for identifying employer and employee responsibilities, situations that require working in confined spaces and safety labeling. 2.1.1

2 Identify and communicate hazards associated with slippery surfaces and lighting. 2.1.2

3 Apply inspection, rejection criteria and load-handling practices used with slings and spreaders. 2.1.3

4 Use American National Standards Institute (ANSI) hand signals and symbols. 2.1.4

5 Identify the reason to use ground fault interrupter circuits (GFCIs), sources of electrical hazards and established shutdown and lock-out/tag-out procedures. 2.1.5

6 Identify and eliminate workplace clutter and maintain clearance and boundaries. 2.1.6

7 Identify symptoms of exposure to health-threatening environments (e.g., temperature; chemical; biological; noise, vibrations, harshness [NVH] hazards). 2.1.7

8 Identify procedures for handling, storage and disposal of hazardous materials. 2.1.8

9 Identify the locations of emergency flush showers, eyewash fountains, Material Safety Data Sheets (SDS), fire alarms and exits. 2.1.9

10 Describe the interactions of incompatible substances in measuring and mixing chemicals. 2.1.10

11 Select and operate fire extinguishers based on the class of fire. 2.1.11

12 Conduct safety inspection of a workspace. 2.1.12

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13 Identify the types of ergonomic workflow and the need for them. 2.1.13

14 Inspect air and exhaust systems, intake filters, fans and other mechanical components. 2.1.14

2 Personal Safety: Practice personal safety. 2.2

1 Interpret personal safety rights according to the employee Right-to-Know plan. 2.2.1

2 Describe the risk factors associated with working under the influence of drugs, alcohol and stimulants and how it increases the risk of accident, lowers productivity, raises insurance costs and reduces profits. 2.2.2

3 Select, use, maintain and dispose of Personal Protective Equipment (PPE) appropriate to job tasks, conditions and materials. 2.2.3

4 Identify workplace risk factors associated with repetitive motion and lifting, operating and moving heavy objects. 2.2.4

5 Demonstrate appropriate body mechanics in lifting and moving heavy objects. 2.2.5

3 Tool and Equipment Preventive Maintenance: Identify, use, clean, maintain and perform planned preventive maintenance on tools and equipment. 2.3

1 Identify the types of hand tools, power tools and stationary equipment and describe their function. 2.3.1

2 Identify potential hazards and limitations related to the use of hand tools, power tools and stationary equipment. 2.3.2

3 Operate power tools and stationary equipment in accordance with established procedures and safety standards. 2.3.3

4 Ensure the presence and functionality of safety systems and hardware. 2.3.4

5 Clean, lubricate and adjust power tools and stationary equipment. 2.3.5

6 Identify, select and maintain fluids and filters. 2.3.6

7 Inspect and maintain fluid conveyance and storage components (e.g., hoses and lines, valves, nozzles). 2.3.7

8 Identify the requirements for calibrating metering, monitoring and sensing equipment. 2.3.8

4 General Maintenance: Provide general maintenance to mechanical systems. 2.4

1 Inspect for leakage at seals, gaskets and bushings. 2.4.1

2 Inspect fluid levels and fluid conditions on all mechanical systems. 2.4.2

3 Select engine, powertrain, power steering and brake system fluids based on characteristics and applications. 2.4.3

4 Describe characteristics of engine fuels and fuel additives. 2.4.4

Perform engine oil and filter change. 2.4.5

Replace fuel filters. 2.4.6

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7 Flush and fill the engine cooling system. 2.4.7

8 Inspect, service, or replace air filters, filter housings and intake ductwork. 2.4.8

9 Drain and replace drivetrain fluids and filters. 2.4.9

10 Flush, fill and bleed the power steering system and replace filters. 2.4.10

11 Flush, fill and bleed the brake system. 2.4.11

12 Store mechanical systems fluids and waste products. 2.4.12

13 Inspect and replace drive belts. 2.4.13

14 Identify the sources of air conditioner (A/C) system odors. 2.4.14

15 Inspect and service the battery and battery cables, connectors, clamps and hold downs. 2.4.15

16 Inspect interior and exterior lamps and sockets. 2.4.16

17 Verify operation of instrument panel gauges and warning/indicator lights and reset maintenance indicators. 2.4.17

18 Verify windshield wiper and washer operations, replace wiper blades and refill the washer reservoir (where applicable). 2.4.18

19 Inspect, repair to industry standards and rotate tires and reset the tire pressure monitor system (TPMS). 2.4.19

20 Lubricate all suspension and chassis grease fittings and body lubrication points. 2.4.20

21 Test, inspect and service fifth wheel mounting bolts, air lines and locks. 2.4.21

22 Inspect, repair or replace fasteners. 2.4.22

Engine Adjustments and Repair: Learners apply principles of computerized engine controls, two- and four-stroke cycle combustion, emission controls, cooling systems, cylinder head and block assemblies and lubrication systems to diagnose and repair malfunctions in recreational vehicles, automobiles and medium and heavy equipment. 3

1 **Engine Cylinder Head and Block Assemblies: Remove, disassemble and repair components in engine cylinder head and block assemblies.** 3.1

1 Describe the physical and mechanical principles of engine operation (i.e., motion, friction, thermodynamics). 3.1.1

2 Calculate displacement and compare and contrast displacement, horsepower and torque. 3.1.2

3 Describe two-cycle and four-cycle engines and their operating principles. 3.1.3

4 Describe the features, benefits and application of engine types. 3.1.4

5 Inspect an engine assembly for fuel, oil, coolant and other leaks and determine potential causes. 3.1.5

6 Identify engine noises and vibrations and potential causes. 3.1.6

7 Verify the engine operating temperature. 3.1.7

8 Describe potential causes of excessive oil consumption and unusual exhaust color and sound. 3.1.8

Perform engine tests for vacuum, power balance, compression and leakage. 3.1.9

0 Inspect, adjust and replace drive belts and chains. 3.1.10

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11 Remove, disassemble and rebuild and reinstall and engine assembly. 3.1.11

2 **Computerized Engine Controls: Perform diagnosis and repair of computerized engine controls.** 3.2

1 Retrieve and record stored on-board diagnostics (OBD) trouble codes and clear codes where applicable. 3.2.1

2 Follow published diagnostic procedures to identify the causes of emissions or drivability concerns resulting from malfunctions in the computerized engine control system with stored diagnostic trouble codes. 3.2.2

3 Identify module communication errors (e.g., controller area network [CAN], bus systems). 3.2.3

4 Inspect and test computerized engine control system sensors, powertrain control modules (PCM), actuators and circuits. 3.2.4

5 Diagnose drivability and emissions problems resulting from malfunctions of interrelated systems. 3.2.5

3 **Ignition System: Perform ignition system diagnosis and repair.** 3.3

1 Explain basic ignition system theory. 3.3.1

2 Interpret basic ignition system schematics. 3.3.2

3 Identify potential causes of ignition system problems (i.e., no starting, hard starting, engine misfire, poor drivability, spark knock, power loss, poor mileage, emissions concerns). 3.3.3

4 Identify causes of cranks but fails to start, hard starting and starts but does not continue to run problems. 3.3.4

5 Identify causes of surging, rough operation, misfiring, low power, slow deceleration, slow acceleration and shutdown problems. 3.3.5

6 Inspect and test ignition primary and secondary circuit wiring and pickup sensor or triggering devices. 3.3.6

7 Check ignition system timing, timing advance and retard. 3.3.7

8 Explain basic compression ignition theory. 3.3.8

4 **Fuel, Air Induction and Exhaust System: Perform fuel, air induction and exhaust system inspection and repair.** 3.4

1 Explain principles of exhaust, intake and turbocharger design and operations. 3.4.1

2 Identify conditions of hot or cold no starting, hard starting, incorrect idle speed, poor idle, flooding, hesitation, surging, engine misfire, power loss, stalling, poor mileage, dieseling and emissions problems. 3.4.2

3 Check fuel for contaminants and quality. 3.4.3

4 Test fuel pumps and pump control systems for pressure, regulation and volume. 3.4.4

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5 Inspect and test the coolant temperature sensor or cold enrichment system and components. 3.4.5

6 Inspect the air induction system, intake manifold and gaskets for vacuum leaks or unmetered air. 3.4.6

7 Inspect and service governor systems, speed or rev limiters. 3.4.7

8 Explain fuel injection theory. 3.4.8

9 Inspect and test fuel injectors. 3.4.9

10 Inspect the exhaust manifold, exhaust pipes, mufflers, catalytic converters, resonators, tail pipes and heat shields. 3.4.10

11 Perform an exhaust system backpressure test. 3.4.11

12 Evaluate and repair exhaust gas recirculation and exhaust gas treatment systems. 3.4.12

13 Identify positive crankcase ventilation systems. 3.4.13

14 Identify the parts and functions of evaporative emissions controls systems. 3.4.14

15 Check and refill the diesel exhaust fluid (DEF) and service diesel particulate filter (DPF). 3.4.15

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5 Lubrication and Cooling Systems: Inspect lubrication and cooling systems operation. 3.5

1 Explain principles of engine lubrication and cooling. 3.5.1

2 Perform lubrication, cooling system and pressure and sensor tests. 3.5.2

3 Perform oil sampling and consumption tests. 3.5.3

4 Inspect the oil pump gears or rotors, housing, pressure relief devices and pump drive. 3.5.4

5 Inspect and test the radiator, pressure cap, coolant recovery tank and hose, cooling and heater system hoses and water pump. 3.5.5

6 Remove and replace radiator, pressure cap, coolant recovery tank and hose, cooling and heater system hoses. 3.5.6

7 Inspect, test and replace the thermostat and gasket. 3.5.7

8 Measure coolant concentration using a refractometer. 3.5.8

9 Identify types of coolants and their applications. 3.5.9

10 Test, drain, flush and refill coolant and bleed the cooling system. 3.5.10

11 Remove and replace the water pump. 3.5.11

12 Inspect mechanical and electrical fans, fan clutches, fan shrouds and air dams. 3.5.12

Systems Performance: Le pri systems, electrical and

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1 Hydraulic Brake Systems: Identify, inspect and replace hydraulic components of rake systems. 4.1

electronic systems and heating, ventilation and air conditioning (HVAC) systems to diagnose and repair malfunctions. 4

1 Identify pressure concerns in the brake system using hydraulic principles (Pascal's Law). 4.1.1

2 Identify poor stopping, pulling, or dragging concerns caused by malfunctions in the hydraulic system. 4.1.2

3 Measure brake pedal height and test pedal free play. 4.1.3

4 Check the master cylinder for internal and external leaks and proper operations. 4.1.4

5 Remove, bench bleed and reinstall the master cylinder. 4.1.5

6. Inspect brake lines for damage and wear. 4.1.6

7 Fabricate rigid fluid lines. 4.1.7

8 Install rigid and flexible fluid lines and fittings. 4.1.8

9 Identify brake pressure valves. 4.1.9

10 Check power assist operations (e.g., manifold or auxiliary pump vacuum supply to a vacuum-type power booster). 4.1.10

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2 **Drum and Disc: Identify, inspect and replace mechanical components of drum and disc brake systems.** 4.2

1 Identify brake components, poor stopping, noise, vibration, premature wear, pulling, grabbing, dragging, or pedal pulsation concerns. 4.2.1

2 Inspect caliper assembly, inspect and measure disc brake pads. 4.2.2

3 Remove the caliper assembly, clean inspect for leaks, pad condition and damage, and replace. 4.2.3

4 Remove, clean, inspect and measure drums and rotors. 4.2.4

5 Refinish drums and rotors. 4.2.5

6 Remove, inspect and replace wheel cylinders. 4.2.6

7 Clean, inspect and lubricate brake shoes, retaining hardware and adjustment hardware. 4.2.7

8 Remove and replace brake shoes, retaining hardware and adjustment hardware.v 4.2.8

9 Pre-adjust brake shoes, seat the pads and adjust the parking brake system. 4.2.9

10 Lubricate drum and disc brake assembly components, reinstall and inspect for leaks. 4.2.10

11 Check the condition and operation of the parking brake, indicator light and brake stop light systems. 4.2.11

12 Clean, lubricate, or replace the parking brake as needed. 4.2.12

13 Inspect and adjust an integral parking brake system. 4.2.13

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ir Brake Systems: Identify, inspect and replace air brake systems. 4.3

Identify poor stopping, air leaks, premature wear, pulling, grabbing, or dragging problems caused by supply and service system malfunctions. 4.3.1

2 Inspect and test a tractor protection valve. 4.3.2

3 Inspect and test emergency (spring) brake control and modulator valves, low pressure warning devices, wiring and connectors. 4.3.3

4 Inspect and test air pressure gauges, lines and fittings and replace as needed. 4.3.4

5 Check the air system buildup time. 4.3.5

6 Drain air reservoir tanks and check for oil, water and foreign material. 4.3.6

7. Inspect, adjust and align compressor drive belts, pulleys and tensioners. 4.3.7

8 Inspect, repair, or replace the compressor, air cleaner and air supply, oil supply and coolant lines, fittings and mounting brackets. 4.3.8

9 Inspect and test system pressure controls (i.e., governor, unloader assembly valves, intake screens, filters, lines, hoses, fittings). 4.3.9

10 Inspect air system lines, hoses, fittings and couplings. 4.3.10

11 Inspect and test air tank relief (safety) valves, one-way check valves, two-way check valves and manual and automatic drain valves. 4.3.11

12 Inspect and clean air dryer systems, filters, valves, heaters, wiring and connectors. 4.3.12

13 Inspect and test air pressure gauges, lines and fittings. 4.3.13

14 Repair mechanical and foundation brakes. 4.3.14

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4 Antilock Brakes: Identify, inspect and replace antilock brake systems (ABS). 4.4

1 Identify and inspect ABS components. 4.4.1

2 Identify poor stopping, wheel lock-up, abnormal pedal feel or pulsation and noise concerns caused by the ABS. 4.4.2

3 Identify ABS braking concerns caused by vehicle modifications (e.g., tire size, curb height, final drive ratio). 4.4.3

4 Identify ABS electronic controls and components. 4.4.4

5 Depressurize high-pressure components and bleed front and rear hydraulic circuits. 4.4.5

6 Remove and install ABS electrical and/or electronic and hydraulic components. 4.4.6

7 Describe the output signal, resistance charts to voltage/ground and frequency data. 4.4.7

8 Identify traction control and vehicle stability control system components. 4.4.8

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5 Electrical and Electronic Systems: Diagnose the electrical and electronic integrity of series, parallel and series-parallel circuits using principles of electricity (e.g., Ohm's Law, Watt's Law). 4.5

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1 Describe basic electrical theory. 4.5.1

2 Interpret wiring diagrams of electrical circuits. 4.5.2

3 Describe static (open circuit) and dynamic (closed circuit) testing principles. 4.5.3

4 Measure the source voltage and perform voltage drop and current draw tests in electrical and electronic circuits. 4.5.4

5 Measure current, continuity and resistance. 4.5.5

6 Describe the principles of capacitance and inductance. 4.5.6

7 Identify and describe the functions of non-suppressed, suppressed, and bistable relays. 4.5.7

8 Inspect and test switches, connectors, relays, solenoid and wires of electrical and electronic circuits. 4.5.8

9 Remove, identify manufacturer, and repair or replace terminal connectors. 4.5.9

10 Perform solder repair of electrical wiring. 4.5.10

11 Locate shorts, grounds, opens and resistance problems in electrical and electronic circuits. 4.5.11

12 Measure and diagnose the causes of excessive key-off battery drain (parasitic draw). 4.5.12

13 Inspect, test and replace or reset fusible links, circuit breakers and fuses. 4.5.13

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6 Batteries: Diagnose and service batteries. 4.6

1 Identify battery construction and principles of operation. 4.6.1

2 Test battery performance using state-of-charge and conductance tests and record results. 4.6.2

3 Confirm proper battery capacity for vehicle application and perform a battery capacity test. 4.6.3

4 Maintain or restore electronic memory functions. 4.6.4

5 Perform a battery charge. 4.6.5

6 Start a vehicle using jumper cables and a battery or auxiliary power supply using manufacturer's jumping techniques and precautions. 4.6.6

7. Perform battery maintenance and repairs. 4.6.7

8 Remove and replace a battery. 4.6.8

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7 Starting and Charging Systems: Identify, inspect and replace starting and charging system components. 4.7

1 Differentiate between electrical and engine mechanical problems that cause a slow crank or no crank condition. 4.7.1

2 Inspect, test and replace low and high current side components. 4.7.2

3 Perform charging system output tests to identify causes of undercharge, no charge and overcharge conditions. 4.7.3

Inspect and adjust or replace alternator drive belts, pulleys and tensioners and check pulley and belt alignment. 4.7.4

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5 Remove, inspect and install an alternator and starter. 4.7.5

6 Identify the high voltage circuit of electric or hybrid electric vehicles and related safety precautions. 4.7.6

8 Lighting and Accessories: Identify, inspect and replace electrical and electronic components of lighting systems and accessories. 4.8

1 Identify the cause of brighter than normal, intermittent, dim, or no light operation. 4.8.1

2 Inspect, replace and aim headlights and bulbs. 4.8.2

3 Identify and inspect incorrect turn signal or hazard light operation. 4.8.3

4 Identify and inspect brake light circuit switches, wiring and connectors. 4.8.4

5 Identify system voltage and safety precautions associated with high-intensity discharge headlights. 4.8.5

6 Inspect and test gauges and gauge sending units for causes of abnormal gauge readings. 4.8.6

7 Identify incorrect horn operation. 4.8.7

8 Identify incorrect wiper and washer operation and replace. 4.8.8

9 Identify incorrect operation of motor-driven accessories. 4.8.9

10 Identify incorrect heated glass, mirror, or seat operation and repair. 4.8.10

11 Identify incorrect electric lock operation and repair. 4.8.11

12 Identify airbag supplemental restraint system (SRS) concerns. 4.8.12

13 Identify safety concerns for disarming and enabling the airbag system for vehicle service. 4.8.13

14 Identify advanced driver assistance systems (ADAS) and recommended procedures before inspecting or replacing components. 4.8.14

9 Heating, Ventilation and Air Conditioning Systems: Diagnose and repair heating, ventilation and air conditioning (HVAC) system components and controls. 4.9

1 Describe the components and operation of the HVAC system. 4.9.1

2 Perform pressure and leak testing. 4.9.2

3 Handle, identify, recover and recycle refrigerant. 4.9.3

4 Describe contaminant testing of refrigerants for hybrid and non-hybrid vehicles. 4.9.4

5 Evacuate and charge the A/C system. 4.9.5

Drivetrain: Learners apply principles of transmissions and tra dri steering and

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1 Automatic Transmission and Transaxle Performance: Identify, inspect, adjust and replace automatic transmissions and transaxles. 5.1

Research applicable vehicle and service information (e.g., transmission and transaxle system operation, fluid type, vehicle service history, service precautions, technical service bulletins). 5.1.1

suspension, drive shafts and wheels to diagnose and repair malfunctions in recreational vehicles, automobiles and medium and heavy equipment to manufacturer's specifications. 5

2 Locate and interpret vehicle and major component identification numbers (i.e., vehicle identification number [VIN], vehicle certification labels, calibration decals). 5.1.2

3 Investigate fluid loss and condition concerns. 5.1.3

4 Inspect powertrain mounts. 5.1.4

5 Inspect and service the transmission, transaxle and torque converter. 5.1.5

6 Inspect for leaks on cooler lines and fittings. 5.1.6

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2 Manual Transmission and Transaxle: Identify, inspect and replace manual transmissions and transaxles. 5.2

1 Identify the major components of manual transmissions, their function and the overall operation of manual transmissions. 5.2.1

2 Inspect, test and replace transmission and transaxle sensors and switches. 5.2.2

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3 Clutches: Identify and inspect clutches. 5.3

1 Identify clutch noise, binding, slippage, pulsation and chatter. 5.3.1

2 Inspect the clutch pedal linkage, cables, automatic adjuster mechanisms, brackets, bushings, pivots and springs. 5.3.2

3 Inspect the hydraulic clutch slave and master cylinders, lines and hoses. 5.3.3

4 Inspect the clutch pressure plate assembly and clutch disc. 5.3.4

5 Bleed the clutch hydraulic system. 5.3.5

6 Inspect and measure the flywheel runout, crankshaft endplay and ring gear for wear and cracks. 5.3.6

7 Inspect and adjust the clutch master cylinder levels and check for leaks. 5.3.7

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4 Drive Axle Universal and Differentials: Identify, inspect and replace drive axle and differential components. 5.4

1 Identify and inspect drive axle and differential assemblies for noise, vibration and fluid leakage. 5.4.1

2 Service and replace the shaft, yokes, boots and joints. 5.4.2

3 Replace drive axle seals, bearings and retainers. 5.4.3

4 Inspect and replace drive axle housing cover plates, gaskets, sealants, vents, plugs and seals. 5.4.4

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5 Steering: Identify, inspect and replace steering system components. 5.5

1 Disable and enable the supplemental restraint system (SRS). 5.5.1

2 Remove and replace the steering wheel and center and time the SRS coil (clock spring). 5.5.2

` Inspect steering shaft universal joints and flexible couplings. 5.5.3

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4 Remove, inspect, replace and adjust the power steering pump belt, power steering pump, power steering pump pulley, hoses and fittings and check pulley and belt alignment. 5.5.4

5 Inspect and replace the pitman arm, relay rod (center link/intermediate), idler arm and mountings and steering linkage damper. 5.5.5

6 Inspect, replace and adjust tie rod ends (sockets), tie rod sleeves and clamps. 5.5.6

7 Inspect and replace rack and pinion steering systems. 5.5.7

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6 Suspension: Remove, inspect and install front and rear suspension. 5.6

1 Describe short arm and long arm suspension system components. 5.6.1

2 Describe strut suspension system components. 5.6.2

3 Remove, inspect and install upper and lower control arms, bushings, shafts, upper and lower ball joints and rebound bumpers. 5.6.3

4 Remove, inspect and install strut rods (compression and tension) and bushings. 5.6.4

5 Remove, inspect and install steering knuckle assemblies. 5.6.5

6 Remove, inspect and install short arm and long arm suspension system coil springs and spring insulators. 5.6.6

7 Remove, inspect, install and adjust suspension system torsion bars and stabilizer bar bushings, brackets and links and inspect mounts. 5.6.7

8 Remove, inspect and install a strut assembly, strut coil spring, insulators (silencers) and upper strut bearing mount. 5.6.8

9 Remove and install control arms bushing and mounts. 5.6.9

10 Remove, inspect and install leaf springs, leaf spring insulators (silencers), shackles, brackets, bushings and mounts. 5.6.10

11 Inspect, remove and replace shock absorbers. 5.6.11

12 Check cab mounting and adjust ride height. 5.6.12

13 Inspect and replace front axle beam and mounting hardware. 5.6.13

14 Inspect and replace walking beams, center (cross) tube, bushings, mounts, load pads, brackets, caps and mounting hardware. 5.6.14

15 Measure front and rear vehicle ride heights; determine needed adjustments or repairs. 5.6.15

16 Inspect, test and replace air suspension springs (bags), mounting plates and main support beams/springs, pressure regulator and height control valves, linkages, lines, hoses and fittings. 5.6.16

17 Diagnose, inspect and replace auxiliary lift axle components and controls. 5.6.17

18 Check axle load distribution problems on rear suspensions; check axle seat planing angles and pinion angles. 5.6.18

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9 Inspect frame and frame members for cracks, breaks, distortion, elongated holes, looseness and damage; determine needed repairs. 5.6.19

20 Inspect, install or repair frame hangers, brackets, crossmembers and fasteners in accordance with manufacturer's recommended procedures. 5.6.20

21 Inspect, install, repair or replace pintle hooks and draw bars. 5.6.21

7 Wheel Alignment: Inspect and adjust wheel alignment. 5.7

1 Inspect mounts and bushings. 5.7.1

2 Identify vehicle wander, drift, pull, hard steering, bump steer, memory steer, torque steer, ride height and steering return concerns. 5.7.2

3 Check and adjust wheel caster, camber and toe and center the steering wheel. 5.7.3

8 Wheels and Tires: Identify, inspect and replace wheel and tire components and assemblies. 5.8

1 Identify tire wear patterns and tire construction. 5.8.1

2 Identify bearing noises and wheel vibration, shimmy and noise. 5.8.2

3 Inspect and repair or replace front and rear wheel bearings. 5.8.3

4 Measure wheel, tire, axle and hub runout. 5.8.4

5 Balance wheel and tire assembly. 5.8.5

6 Remove, inspect, repair or replace, rotate and reinstall the tire and wheel assembly and calibrate the tire pressure monitoring system. 5.8.6

7 Inspect and replace wheel studs. 5.8.7

Body and Frames: Learners apply principles of vehicle structural and nonstructural components, materials joining and cutting, surface reconstruction and cleaning and preparation and application of coatings and paints. 6

1 Structural: Inspect and repair full frame and unibody structural damage. 6.1

1 Measure the extent of direct and indirect structural damage and the direction of impact. 6.1.1

2 Identify sideway, twist and diamond frame damage. 6.1.2

3 Remove and replace damaged structural components according to original equipment manufacturer specifications. 6.1.3

4 Identify and analyze components that can cause vibration, steering and wheel alignment problems. 6.1.4

5 Describe the process of straightening and aligning the cowl assembly, roof rails and headers, and hinge and lock pillars. 6.1.5

6 Straighten and align vehicle openings, floor pans and rocker panels. 6.1.6

7 Straighten and align quarter panels, wheelhouse assemblies and rear body sections. 6.1.7

8 Straighten and align front end sections. 6.1.8

2 Nonstructural: Analyze and repair damage to nonstructural components. 6.2

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Determine the extent of the direct and indirect non-structural damage and the direction of impact. 6.2.1

2 Inspect, remove, label, store and replace exterior and interior trim, moldings, nonstructural body panels, door panels and components. 6.2.2

3 Inspect, remove, store and replace damaged vehicle mechanical and electrical components. 6.2.3

4 Protect panels, glass, parts and vehicle interior within the repair area. 6.2.4

5 Remove corrosion protection, undercoatings, sealers and other protective coatings necessary to perform repairs. 6.2.5

6 Inspect, adjust and repair or replace window regulators, run channels, glass, power mechanisms and related controls. 6.2.6

7 Describe the removal and installation of fixed glass (heated and non-heated) and modular glass. 6.2.7

8 Inspect and repair water leaks, dust leaks and wind noises and inspect, repair and replace weather stripping. 6.2.8

9 Inspect, adjust and repair or replace removable, manual or power-operated roof panel and hinges, latches, guides, handles and sunroof retainer and controls. 6.2.9

10 Describe the removal, installation and alignment of a convertible top and related mechanisms. 6.2.10

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3 Joining and Cutting Metals: Join and cut aluminum, high-strength steel and other steels. 6.3

1 Determine the weld and joint type, wire diameter and gas based on original equipment manufacturer specifications. 6.3.1

2 Set up and adjust the welder. 6.3.2

3 Store, handle and install high pressure gas cylinders. 6.3.3

4 Locate and protect computers and other electronic control modules according to original equipment and manufacturer specifications. 6.3.4

5 Clean, prepare, align and secure the metal to be welded. 6.3.5

6 Perform continuous, stitch, tack, plug, butt and pinch welds with and without backing and fillet welds. 6.3.6

7 Perform a visual test on each weld type and describe causes of defects. 6.3.7

8 Perform cutting processes (e.g., mechanical, electrical, gas) on different materials, body and frame locations. 6.3.8

9 Attach nonstructural components through riveting and original equipment manufacturer adhesives. 6.3.9

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4 Plastics and Adhesives: Replace or repair plastic components and adhesives. 6.4

1 Identify types of plastics, determine repairability and repair procedures (i.e., chemical, weld). 6.4.1

2 Clean and prepare the surface of plastic parts. 6.4.2

3 Replace rigid, semi-rigid and flexible plastic panels. 6.4.3

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4 Replace bonded and non-bonded rigid exterior composite body panels and straighten or align panel supports. 6.4.4

5 Inspect, remove and replace repairable plastics and other components recommended for off-vehicle repair. 6.4.5

5 Surface Preparation: Remove paint and coatings and prepare surfaces for refinishing. 6.5

1 Remove paint from the damaged area of a body panel. 6.5.1

2 Locate and reduce surface irregularities on a damaged body panel. 6.5.2

3 Heat shrink stretched panel areas to proper contour. 6.5.3

4 Cold shrink stretched panel areas to proper contour. 6.5.4

5 Mix and apply body filler, apply body and finishing fillers and shape during curing. 6.5.5

6 Rough sand cured body filler to contour and finish sand. 6.5.6

7. Inspect, remove, label, store and replace exterior trim and components necessary for surface preparation. 6.5.7

8 Inspect and identify substrate, type of finish, surface condition and film thickness. 6.5.8

9 Dry sand or wet sand and featheredge damaged areas. 6.5.9

10 Apply suitable metal treatment or primer. 6.5.10

11 Mask and protect other areas that will not be refinished. 6.5.11

12 Select, mix and apply primers and primer surfacers/sealers. 6.5.12

13 Remove dust and clean areas to be refinished. 6.5.13

14 Apply stone chip and corrosion-resistant coatings, caulking and seam sealers to repaired areas. 6.5.14

15 Repair minor dents using paintless dent repair (PDR) techniques. 6.5.15

6 Paint Preparation and Application: Mix, match, apply and identify defects in paint. 6.6

1 Determine the type and color of paint already on the vehicle by the manufacturer's vehicle information label. 6.6.1

2 Identify and mix paint and tint colors using a formula to achieve a blendable match and identify poor hiding colors. 6.6.2

3 Demonstrate pressure spray equipment operation. 6.6.3

4 Inspect, clean, and determine condition of spray guns and related equipment (air hoses, regulators, air lines, air source, and spray environment). 6.6.4

5 Select spray gun setup (fluid needle, nozzle, and cap) for product being applied. 6.6.5

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6 Test and adjust spray gun using fluid, air and pattern control valves. 6.6.6

7 Shake, stir, reduce, catalyze or activate and strain paint. 6.6.7

8 Apply selected products on a test and letdown panel to check for color match. 6.6.8

9 Apply single stage, top coat, base coat and clear coat. 6.6.9

10 Denib, buff and polish finishes. 6.6.10

11 Apply multistage coats for panel blending and overall refinishing. 6.6.11

12 Identify, determine cause and correct paint defects. 6.6.12

13 Measure mil thickness. 6.6.13

Aviation and Aeronautics: The learner applies principles of aerodynamics, meteorology, electricity, schematics, materials and processes to perform ground operations, traffic control functions, communications and flight operations. 7

1 Aviation: Describe the airspace system and aviation industry. 7.1

1 Describe aviation technology from its inception to the current industry, including future trends. 7.1.1

2 Describe contributions and barriers to the development of aviation. 7.1.2

3 Describe social and economic impacts that contribute to the movement of people and goods. 7.1.3

4 Describe the major legislative acts that have impacted aviation. 7.1.4

5 Describe the role and function of the Federal Aviation Administration (FAA). 7.1.5

6 Describe the major Federal Aviation Administration (FAA) categories of aircraft. 7.1.6

7 Describe the function of the fixed base operator (FBO) and its role in general aviation. 7.1.7

8 Differentiate between general and commercial aviation. 7.1.8

9 Describe classes of airspace and associated requirements and limitations. 7.1.9

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2 Basic Electricity Concepts: Assess basic electricity. 7.2

1 Determine the relationship between voltage, current and resistance in electrical circuits. 7.2.1

2 Calculate and measure electrical power. 7.2.2

3 Measure voltage, current, resistance and continuity. 7.2.3

4 Calculate and measure capacitance and inductance. 7.2.4

5 Read and interpret aircraft electrical circuit diagrams (e.g., solid state devices and logic functions). 7.2.5

6 Inspect and service batteries. 7.2.6

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3 Mathematics and Physical Principles: Apply mathematics concepts and physical principles. 7.3

1 Extract roots and raise numbers to a given power. 7.3.1

2 Determine the area and volume of geometrical shapes. 7.3.2

3 Solve ratio, proportion and percentage problems. 7.3.3

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4 Perform algebraic operations involving the addition, subtraction, multiplication and division of positive and negative numbers. 7.3.4

5 Apply the principles of simple machines; sound, fluid and heat dynamics; basic aerodynamics; aircraft structure; and theory of flight. 7.3.5

6 Employ the principles of simple machines. 7.3.6

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4 Aerodynamics: Describe and define aerodynamics based on scientific concepts. 7.4

1 Compare and contrast aeronautics and aerodynamics. 7.4.1

2 Describe the forces of flight and the three axes of motion. 7.4.2

3 Define Newton's Laws of Motion and Bernoulli's Principle. 7.4.3

4 Identify the parts of an airfoil and describe how airfoil works. 7.4.4

5 Describe how aircraft configuration affects performance. 7.4.5

6 Discuss the role of thrust and the relationship between lift and drag. 7.4.6

7 Describe the lateral and directional stability and the parts of the aircraft that control the aircraft. 7.4.7

8 Describe how the distribution of weight affects center of gravity. 7.4.8

9 Describe the effects of loading, weight and balance on center of gravity and aircraft performance. 7.4.9

10 Describe the design and power features that affect aircraft stability, performance and limitations. 7.4.10

11 Describe the purpose of the vertical and horizontal stabilizers and how they affect the path of an aircraft. 7.4.11

12 Identify the effects of torque (P-factor). 7.4.12

13 Describe the effects of gyroscopic precession. 7.4.13

14 Describe the effects of asymmetrical thrust on flight 7.4.14

15 Describe the effect of drag and lift on glide. 7.4.15

16 Define load factor and G-forces. 7.4.16

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5 Airport Environments: Identify airport environments. 7.5

1 Describe the different types of controlled and uncontrolled airports within the United States. 7.5.1

2 Differentiate between towered and non-towered airports. 7.5.2

3 Identify features of airports and directional traffic patterns and interpret runway markings. 7.5.3

4 Identify lighting systems and explain their function. 7.5.4

5 Describe weather patterns and their impact on airport operations. 7.5.5

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6 Describe noise abatement strategies and procedures. 7.5.6

6 **Meteorology: Identify and describe concepts of meteorology.** 7.6

1 Describe the atmospheric layers and their composition. 7.6.1

2 Describe how atmospheric properties of pressure, condensation, evaporation, precipitation and humidity affect atmospheric conditions and stability. 7.6.2

3 Explain the effects of temperature on weather. 7.6.3

4 Describe the effects of gravity, friction and centripetal force on wind. 7.6.4

5 Explain the causes of atmospheric circulation. 7.6.5

6 Identify wind patterns based on weather systems. 7.6.6

7 Describe factors related to stability (e.g., clouds, fronts, air masses, precipitation). 7.6.7

8 Describe the causes and effects of temperature inversions. 7.6.8

9 Describe weather system formation, including air masses and fronts. 7.6.9

10 Describe cycles of moisture and associated precipitation and temperature related phenomena. 7.6.10

11 Describe the types, conditions and factors of turbulence. 7.6.11

12 Describe the types and impact of thunderstorms, tornados, microbursts and hurricanes. 7.6.12

13 Describe wind and wind effects (i.e., crosswind, tailwind, windshear, mountain wave). 7.6.13

14 Describe the types of icing and their effect on aviation. 7.6.14

7 **Air Traffic Control and Communication: Identify, describe and apply concepts of air traffic control and communication.** 7.7

1 Describe the principles of radar. 7.7.1

2 Describe the components of secondary radar. 7.7.2

3 Control aircraft departure, arrivals and ground operations from an airport tower. 7.7.3

4 Sequence aircraft approaches and departures with approach control radar. 7.7.4

5 Interpret weather for departures and arrivals. 7.7.5

6 Define the very high frequency (VHF) and ultra-high frequency (UHF) radio bands and how to access. 7.7.6

7 Describe radio communication, phraseology and light signals. 7.7.7

8 Describe the function of transponders. 7.7.8

9 Describe causes of lost communication and lost communication procedures. 7.7.9

8 **Human Factors: Describe the impact of aviation and flight environment.** 7.8

Describe the extent of human factors in aircraft accidents. 7.8.1

Identify hazardous attitudes of flight. 7.8.2

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3 Identify flight problems associated with aviation physiology. 7.8.3

4 Describe the effects of hypoxia and carbon monoxide. 7.8.4

5 Identify the rules of supplemental oxygen. 7.8.5

6 Describe the decision-making process in flight and steps to break the chain of poor judgement. 7.8.6

7. Describe the impact of cockpit standardization on accident prevention. 7.8.7

8 Describe the impact of cockpit automation on human error. 7.8.8

9 Describe the role of the National Transportation Safety Board (NTSB) in accident investigations. 7.8.9

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9 Small Unmanned Aircraft Systems: Describe and apply concepts of operating Small Unmanned Aircraft Systems (UAS). 7.9

1 Describe regulatory requirements for certification, rating, inspection, reporting and compliance for small unmanned aircraft systems. 7.9.1

2 Describe registration requirements for small unmanned aircraft systems. 7.9.2

3 Describe operating rules for small unmanned aircraft systems. 7.9.3

4 Describe operating limitations for small unmanned aircraft systems. 7.9.4

5 Describe small unmanned aircraft waiver policy and requirements. 7.9.5

6 Determine required crew roles (e.g., Crew Resource Management [CRM], Single-Pilot Resource Management [SRM]). 7.9.6

7 Describe the purpose of visual observers, control stations and autonomous operations. 7.9.7

8 Describe pre-flight, in-flight and post-flight communications procedures. 7.9.8

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10 Geographic Information Systems (GIS): Employ GIS computer applications to interpret data, maps and land use. 7.10

1 Interpret and evaluate the accuracy of digital imagery and aerial photography. 7.10.1

2 Define remote sensing. 7.10.2

3 Describe GIS applications for remote sensing. 7.10.3

4 Explain map projections and the use of scales. 7.10.4

5 Describe GIS data structures, (e.g., vector, grid, triangulated irregular network [TIN]). 7.10.5

6 Explain digital elevation methods (e.g., digital elevation model [DEM], global positioning system [GPS]). 7.10.6

7 Interpret spatial interpolation and two- and three-dimensional functional spatial analyses. 7.10.7

8 Demonstrate ranging methods. 7.10.8

9 Identify sources of errors in GIS and formulate corrections and solutions. 7.10.9

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10 Determine one's position on the earth using global positioning systems (GPS). 7.10.10

11 Integrate global positioning system (GPS) data into GIS applications. 7.10.11

11 Preflight Preparation: Describe the necessary actions prior to engaging in flight. 7.11

1 Describe pilot qualifications. 7.11.1

2 Explain airworthiness requirements. 7.11.2

3 Describe weather and environmental obstructions to visibility (e.g., smoke, haze, volcanic ash). 7.11.3

4 Describe weather products and resources required for preflight planning, current and forecast weather for departure, enroute, and arrival phases of flight. 7.11.4

5 Describe potential flight hazards. 7.11.5

6 Describe the Notice to Air Missions (NOTAM) system and its use. 7.11.6

7 Create cross-country flight plans. 7.11.7

8 Define and describe piloting requirements for special use airspace (SUA), special flight rules areas (SFRA), temporary flight restrictions (TFR) and other airspace areas. 7.11.8

9 Calculate performance and limitations. 7.11.9

10 Determine performance and limitations by using charts, tables and data. 7.11.10

11 Describe atmospheric conditions affecting performance. 7.11.11

12 Describe how pilot techniques and airport environment affect aircraft performance and limitations. 7.11.12

13 Describe operation of systems. 7.11.13

14 Perform and analyze a preflight assessment. 7.11.14

15 Describe flight deck management. 7.11.15

16 Demonstrate proper engine starting. 7.11.16

17 Describe safe taxiing (ASEL, AMEL). 7.11.17

18 Perform a before takeoff check. 7.11.18

12 Takeoff and Landing: Define, determine and navigate aspects of takeoff and landing. 7.12

1 Describe takeoffs, landings and go-arounds. 7.12.1

2 Demonstrate a normal takeoff and climb. 7.12.2

3 Demonstrate a normal approach and landing. 7.12.3

4 Demonstrate soft-field takeoff and climb procedures (ASEL). 7.12.4

5 Demonstrate soft-field approach and landing procedures (ASEL). 7.12.5

Skip to main content

6 Demonstrate short-field takeoff and maximum performance climb (ASEL, AMEL). 7.12.6

7 Demonstrate short-field approach and landing (ASEL, AMEL). 7.12.7

8 Describe a forward slip to a landing (ASEL, ASES). 7.12.8

9 Assess the need for a go-around/rejected landing. 7.12.9

10 Demonstrate postflight procedures. 7.12.10

11 Apply concepts of after landing, parking and securing (ASEL, AMEL). 7.12.11

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13 Flight Environment: Define, determine and navigate aspects of the flight environment. 7.13

1 Define and differentiate visual flight rules (VFR) and instrument flight rules (IFR). 7.13.1

2 Determine right of way and describe minimum safe altitude rules. 7.13.2

3 Demonstrate performance and ground reference maneuvers. 7.13.3

4 Demonstrate steep turns. 7.13.4

5 Demonstrate pilotage and dead reckoning. 7.13.5

6 global positioning system (GPS) 7.13.6

7 Formulate a diversion plan. 7.13.7

8 Apply concepts of lost procedures. 7.13.8

9 Navigate slow flight and stalls. 7.13.9

10 Describe maneuvering during slow flight. 7.13.10

11 Describe power-on and power-off stalls. 7.13.11

12 Identify conditions causing potential spin. 7.13.12

13 Perform basic instrument maneuvers. 7.13.13

14 Demonstrate straight-and-level flight. 7.13.14

15 Demonstrate constant airspeed climbs. 7.13.15

16 Demonstrate constant airspeed descents. 7.13.16

17 Demonstrate turns to headings. 7.13.17

18 Describe recovery from unusual flight attitudes. 7.13.18

19 Demonstrate situational awareness using radio communications, navigation systems/facilities, and radar services. 7.13.19

20 Analyze the challenges of night operations. 7.13.20

21 Describe night preparation procedures. 7.13.21

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14 Emergency Operations: Define, determine and navigate aspects of emergency flight operations. 7.14

1 Describe emergency operations. 7.14.1

2 Demonstrate emergency descent. 7.14.2

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3 Solve non-routine problems during emergency approach and landing (ASEL, ASES). 7.14.3

4 Describe systems and equipment malfunctions. 7.14.4

5 Describe emergency equipment and survival gear. 7.14.5

6 Describe engine failure during takeoff before VMC. 7.14.6

7 Assess engine failure after liftoff (AMEL, AMES). 7.14.7

8 Hypothesize approach and landing with an inoperative engine (AMEL, AMES). 7.14.8

9 Define multiengine operations. 7.14.9

10 Describe maneuvering with one engine inoperative (AMEL, AMES). 7.14.10

11 Demonstrate VMC operations. 7.14.11

12 Describe navigation with one engine inoperative (solely by reference to instruments) during straight-and-level flight and turns (AMEL, AMES). 7.14.12

13 Describe instrument approach and landing with an inoperative engine (solely by reference to instruments) (AMEL, AMES). 7.14.13

14 Describe characteristics and potential hazards of batteries or other fuel sources. 7.14.14

15 Describe loss of aircraft control link and fly-aways. 7.14.15

16 Describe loss of Global Positioning System (GPS) signal during flight and potential consequences. 7.14.16

Aircraft Maintenance Technician: Learners apply regulations, concepts and mechanical principles to the inspection and repair of aircraft systems. 8

1 Mechanics: Exercise and explain privileges and limitations. 8.1

1 Explain the knowledge, skill, experience and requirements to exercise the privileges of the aviation mechanic. 8.1.1

2 Exercise mechanics' privileges within the limitations prescribed by Part 65 of Federal Aviation Regulations. 8.1.2

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2 Drawings: Use aircraft drawings. 8.2

1 Use aircraft drawings, symbols and system schematics. 8.2.1

2 Draw sketches of repairs and alterations. 8.2.2

3 Use technical documentation and blueprint information. 8.2.3

4 Use graphs and charts. 8.2.4

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3 Materials and Processes: Evaluate materials and perform processes. 8.3

1 Identify and select appropriate nondestructive testing methods. 8.3.1

2 Perform dye penetrant, eddy current, ultrasonic and magnetic particle inspections. 8.3.2

Describe basic heat-treating processes. 8.3.3

Identify and select aircraft hardware and materials. 8.3.4

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5 Fabricate and install rigid and flexible fluid lines and fittings. 8.3.5

6 Perform precision measurements. 8.3.6

7 Weigh aircraft. 8.3.7

8 Perform a complete weight and balance check and record data. 8.3.8

9 Inspect and check welds. 8.3.9

4 Operations and Services: Perform ground operations and services. 8.4

1 Start, ground operate, move, service and secure aircraft and identify typical ground operation hazards. 8.4.1

2 Identify and select fuels. 8.4.2

3 Identify and select cleaning materials. 8.4.3

4 Inspect, identify, remove and treat aircraft corrosion and perform aircraft cleaning. 8.4.4

Airframe Structures: Learners apply regulations, concepts and mechanical principles to the inspection and repair of airframe systems. 9

1 Airframe: Maintain airframe structures. 9.1

1 Inspect and identify wood defects. 9.1.1

2 Service and repair wood structures. 9.1.2

3 Select and apply fabric. 9.1.3

4 Inspect, test and repair fabric and fiberglass. 9.1.4

5 Apply trim, letters and touch up paint. 9.1.5

6 Identify and select aircraft finishing materials. 9.1.6

7 Demonstrate proper surface preparation. 9.1.7

8 Apply finishing materials. 9.1.8

9 Inspect finishes and identify defects. 9.1.9

2 Sheet Metal and Non-Metallic Structures: Evaluate and repair sheet metal and non-metallic structures. 9.2

1 Select, install and remove special fasteners for metallic bonded and composite structures. 9.2.1

2 Inspect bonded structures. 9.2.2

3 Inspect, test and repair fiberglass, plastics, honeycomb, composite and laminated primary and secondary structures. 9.2.3

4 Inspect, check, service and repair windows, doors and interior furnishings. 9.2.4

5 Inspect and repair sheet metal structures. 9.2.5

6 Install conventional rivets. 9.2.6

7 Form, lay out and bend sheet metals 9.2.7

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Metal Components: Join airframe metal components. 9.3

1. Weld magnesium and titanium. 9.3.1
2. Solder metal components. 9.3.2
3. Fabricate tubular structures. 9.3.3
4. Solder, braze, gas weld and arc weld steel. 9.3.4
5. Weld aluminum and stainless steel. 9.3.5

4. **Assembly and Rigging Operations: Demonstrate assembly and rigging operations.** 9.4
   1. Rig rotary wing aircraft. 9.4.1
   2. Rig fixed wing aircraft. 9.4.2
   3. Check alignment of structures. 9.4.3
   4. Assembly aircraft components (e.g., flight control surfaces). 9.4.4
   5. Balance, rig and inspect movable primary and secondary flight control surfaces. 9.4.5
   6. Jack aircraft. 9.4.6
   7. Perform airframe conformity and airworthiness inspections. 9.4.7

Airframe Systems and Components: Learners apply regulations, concepts and mechanical principles to the inspection and repair of aircraft systems and components. 10

1. **Landing Gear Systems: Evaluate and repair aircraft landing gear systems.** 10.1
   1. Identify the major types of landing gears and explain how they function. 10.1.1
   2. Inspect and check landing gear, retraction systems, shock struts, brakes, wheels, tires and steering systems. 10.1.2
   3. Service and repair landing gear, retraction systems, shock struts, brakes, wheels, tires and steering systems. 10.1.3

2. **Power Systems: Evaluate and repair hydraulic and pneumatic power systems.** 10.2
   1. Describe the function of the aircraft hydraulic system. 10.2.1
   2. Identify and select hydraulic fluids. 10.2.2
   3. Inspect, repair and test hydraulic and pneumatic power systems and components. 10.2.3

3. **Control Systems: Evaluate and service cabin atmospheric control systems.** 10.3
   1. Describe basic cabin atmospheric principles and components. 10.3.1
   2. Inspect, service and repair heating, cooling, air conditioning and pressurization systems and air cycle machines. 10.3.2
   3. Inspect, check, troubleshoot, service and repair oxygen systems. 10.3.3

4. **Instrument, Communication and Navigation Systems: Evaluate and service nstrument, communication and navigation systems.** 10.4

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1. Explain mechanics' privileges and limitations associated with aircraft instrument systems. 10.4.1
2. Inspect, service and repair electronic flight instrument systems. 10.4.2
3. Install instruments and perform a static pressure system leak test. 10.4.3
4. Inspect, service and repair autopilot, servos and approach coupling systems. 10.4.4
5. Inspect, service and repair aircraft electronic communications and navigation systems. 10.4.5
6. Inspect and repair antenna and electronic equipment installations. 10.4.6

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5 Fuel Systems: Evaluate and service airframe fuel systems. 10.5

1. Describe engine fuel system theory 10.5.1
2. Inspect and service fuel dump systems. 10.5.2
3. Perform fuel management transfer and defueling. 10.5.3
4. Inspect, service and repair pressure fueling systems. 10.5.4
5. Inspect, service and repair aircraft fuel system components. 10.5.5
6. Inspect and repair fluid quantity indicating systems. 10.5.6
7. Troubleshoot, service and repair fluid pressure and temperature warning system. 10.5.7
8. Inspect, service and repair aircraft fuel systems. 10.5.8

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6 Electrical Systems: Evaluate and service airframe electrical systems. 10.6

1. Describe major components of the electrical system. 10.6.1
2. Inspect and repair aircraft electrical system components, crimp and splice wiring to manufacturer's specifications. 10.6.2
3. Install, check and service airframe electrical wiring, controls, switches, indicators and protective devices. 10.6.3
4. Inspect, troubleshoot, service and repair alternating current (AC) and direct current (DC) electrical systems. 10.6.4
5. Inspect and troubleshoot power plant electrical and constant speed and integrated speed drive generators. 10.6.5

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7 Position, Warning and Hazard Control Systems: Evaluate and service position, warning and hazard control systems. 10.7

1. Inspect and service speed and configuration warning systems, electrical brake controls and antiskid systems. 10.7.1
2. Inspect, troubleshoot and service landing gear position indicator and warning systems. 10.7.2

Describe operation of typical anti-icing and de-icing systems. 10.7.3

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4 Demonstrate preventative maintenance for typical anti-icing and de-icing systems. 10.7.4

5 Inspect, service and repair airframe ice and rain control systems. 10.7.5

6 Inspect, service, troubleshoot and repair aircraft fire detection and extinguishing systems. 10.7.6

Powerplant System and Components: Learners apply regulations, concepts and mechanical principles to the inspection and repair of aircraft powerplant systems and components. 11

1 Engines: Evaluate and service reciprocating, radial and turbine engines. 11.1

1 Identify the major types of aircraft engines. 11.1.1

2 Inspect and repair radial engines. 11.1.2

3 Remove, teardown, inspect and troubleshoot reciprocating engines. 11.1.3

4 Service and repair reciprocating engines and engine installations. 11.1.4

5 Install reciprocating engines. 11.1.5

6 Explain turbine engine theory (e.g., propulsion, turbo prop, turbo jet, turbo fan). 11.1.6

7 Remove, teardown, inspect and troubleshoot turbine engines. 11.1.7

8 Service and repair turbine engines and turbine engine installations. 11.1.8

9 Install turbine engines. 11.1.9

10 Perform power plant conformity and airworthiness inspections. 11.1.10

2 Instrument Systems: Evaluate and service engine instrument systems. 11.2

1 Explain mechanics' privileges and limitations associated with engine instrument systems. 11.2.1

2 Troubleshoot, service and repair electrical and mechanical fluid rate-of-flow indicating systems. 11.2.2

3 Inspect, service and repair electrical and mechanical engine temperature, pressure and revolutions per minute (rpm) indicating systems. 11.2.3

3 Fuel Metering Systems: Evaluate and service fuel and fuel metering systems. 11.3

1 Describe fuel metering system theory. 11.3.1

2 Troubleshoot and adjust turbine engine fuel metering systems and electronic engine fuel controls. 11.3.2

3 Overhaul carburetors. 11.3.3

4 Inspect, service and repair reciprocating and turbine engine fuel metering systems and components. 11.3.4

5 Inspect, service and repair engine fuel systems and components. 11.3.5

4 Induction and Exhaust Systems: Evaluate and service induction and exhaust systems. 11.4

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1 Describe induction and engine airflow system theory. 11.4.1

2 Inspect, service and repair engine ice and rain control systems. 11.4.2

3 Inspect, service and repair heat exchangers, superchargers and turbine engine airflow and temperature control systems. 11.4.3

4 Inspect, service and repair carburetor air intake and induction manifolds. 11.4.4

5 Describe how the exhaust system functions. 11.4.5

6 Inspect, service and repair engine exhaust systems. 11.4.6

7 Inspect, service and repair engine thrust reverser systems and related components. 11.4.7

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5 Propellers: Evaluate and service propellers. 11.5

1 Describe propeller theory and operations. 11.5.1

2 Inspect, service and repair propeller synchronizing and ice control systems. 11.5.2

3 Identify and select propeller lubricants. 11.5.3

4 Balance propellers. 11.5.4

5 Repair propeller control system components. 11.5.5

6 Inspect, service and repair fixed-pitch, constant-speed feathering propellers and propeller governing systems. 11.5.6

7 Install, troubleshoot and remove propellers. 11.5.7

8 Repair aluminum alloy propeller blades. 11.5.8

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6 Unducted Fans and Auxiliary Power Units: Evaluate and service unducted fans and auxiliary power units. 11.6

1 Inspect and troubleshoot unducted fan systems and components. 11.6.1

2 Inspect and service turbine-driven auxiliary power units. 11.6.2

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7 Fire Protection Systems: Evaluate and service engine fire protection systems. 11.7

1 Inspect, check and service smoke and carbon monoxide detection systems. 11.7.1

2 Service, troubleshoot and repair engine fire detection and extinguishing systems. 11.7.2

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8 Electrical, Ignition and Starting Systems: Evaluate and service engine electrical, ignition and starting systems. 11.8

1 Explain ignition and starting systems theory. 11.8.1

2 Repair engine electrical system components. 11.8.2

3 Install, check and service engine electrical wiring and components. 11.8.3

4 Teardown and inspect a magneto and ignition harness. 11.8.4

5 Inspect, service and repair reciprocating and turbine engine electrical starting and ignition systems and components. 11.8.5

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6 Inspect, service and troubleshoot turbine engine pneumatic starting systems. 11.8.6

9 **Lubrication and Cooling Systems: Evaluate and service lubrication and cooling systems.** 11.9

1 Identify and select lubricants. 11.9.1

2 Repair engine lubrication system components. 11.9.2

3 Inspect, check, service, troubleshoot and repair engine lubrication systems. 11.9.3

4 Describe how the cooling system functions. 11.9.4

5 Repair engine cooling system components. 11.9.5

6 Inspect, service and repair engine cooling systems. 11.9.6

Vehicle Diagnostic and Estimating: Learners apply methods of vehicle analysis, diagnosis and estimating. 12

1 **Vehicle Analysis: Identify and document vehicle information, history and current condition.** 12.1

1 Identify differences between computer generated and manually written estimates. 12.1.1

2 Identify and record vehicle identification number (VIN) information, including nation of origin, make, model, restraint system, body type, production date, engine type, build data and assembly plant. 12.1.2

3 Identify and document illuminated dash malfunction indicator lamp(s) (MIL). 12.1.3

4 Identify and record vehicle mileage and options, including trim level, paint code, transmission, accessories and modifications. 12.1.4

5 Verify customer complaint, perform visual inspection and/or road test vehicle. 12.1.5

6 Research applicable vehicle and service information, such as engine management system operation, vehicle service history, warranties, service contracts, service precautions, recalls and technical service bulletins. 12.1.6

2 **Vehicle Inspection and Diagnosis: Inspect vehicle current condition and determine repair requirements.** 12.2

1 Position the vehicle for inspection under proper lighting and document current condition and repairs needed. 12.2.1

2 Identify and record pre-existing damage. 12.2.2

3 Identify components to be removed to access repair areas. 12.2.3

4 Perform visual inspection of components. 12.2.4

5 Diagnose noises and/or vibration problems related to engine performance; determine needed action. 12.2.5

6 Diagnose the cause of unusual exhaust color, odor and sound; determine needed action. 12.2.6

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7 Perform engine manifold vacuum or pressure tests; determine needed action. 12.2.7

8 Perform cylinder power balance test; determine needed action. 12.2.8

9 Perform cylinder cranking, relative and running compression tests; interpret test results; determine needed action. 12.2.9

10 Perform cylinder leakage/leak-down test; determine needed action. 12.2.10

11 Diagnose engine mechanical, electrical, electronic, fuel and ignition problems with an oscilloscope, engine analyzer and/or scan tool; determine needed action. 12.2.11

12 Identify damage using measuring tools and equipment. 12.2.12

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3 **Estimating: Determine material, parts and labor requirements and costs to repair vehicle.** 12.3

1 Determine parts, components, material type(s) and procedures necessary for a proper repair. 12.3.1

2 Determine appropriate methods for overall repairs. 12.3.2

3 Identify add-on accessories and modifications. 12.3.3

4 Identify safety systems and advanced driver assistance systems; determine precautions, inspections and replacement items. 12.3.4

5 Determine and apply appropriate estimating sequence. 12.3.5

6 Use estimating procedure pages 12.3.6

7 Apply estimating footnotes, headnotes and line notes. 12.3.7

8 Identify operations requiring labor value judgment. 12.3.8

9 Select appropriate labor code for each operation. 12.3.9

10 Select and price original equipment manufacturer (OEM) parts, optional parts, aftermarket parts, recyclable/used parts, remanufactured, rebuilt and reconditioned parts; verify availability, compatibility and condition. 12.3.10

11 Determine necessary sublet operations. 12.3.11

12 Determine included and non-included operations and miscellaneous items. 12.3.12

13 Recognize and apply overlap deductions. 12.3.13

14 Determine additional material and charges. 12.3.14

15 Apply appropriate estimating and parts nomenclature (terminology). 12.3.15

16 Apply math skills to establish charges and totals. 12.3.16

17 Recognize the cost effectiveness of the repair and determine the approximate vehicle retail and repair value. 12.3.17

18 Recognize the differences in estimating platforms when using different information provider systems. 12.3.18

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19 Review estimate to determine appropriate methods for overall repair; communicate with team members to verify accuracy and resolve discrepancies. 12.3.19

20 Verify accuracy of estimate compared to the actual repair and replacement operations. 12.3.20