

Unit 157

Knowledge of Diagnosis and Rectification of Light Vehicle Engine Faults

UAN:	F/601/3733
Level:	Level 3
Credit value:	6
GLH:	45
Relationship to NOS:	This unit is linked to LV07 Diagnose and Rectify Motor Vehicle Engine and Component Faults.
Assessment requirements specified by a sector or regulatory body:	This unit was developed by IMI, the Sector Skills Council for the automotive retail industry.
Aim:	This unit enables the learner to develop an understanding of diagnosis and rectification of engine mechanical, electrical, hydraulic and fluid systems. It also covers light vehicle engine systems and the evaluation of their performance.

Learning outcome	The learner will:
	1. Understand how the light vehicle engine systems operate
Assessment criteria	
	The learner can: 1.1. Explain the construction and operation of light vehicle engine systems to include: a. SI fuel systems b. CI fuel systems c. ignition systems d. engine management e. valve mechanisms f. pressure charged induction systems g. exhaust emission reduction systems h. heating, ventilation and cooling 1.2. Explain the interaction between electrical, electronic and mechanical components within light vehicle engine systems 1.3. Explain how electrical systems interlink and interact, including multiplexing and fibre optics 1.4. Compare light vehicle engine system components and assemblies against alternatives to identify differences in construction and operation 1.5. Identify the engineering principles that are related to light vehicle

- engine systems
 - a. volumetric efficiency
 - b. flame travel, pre ignition and detonation
 - c. fuel properties
 - d. composition of carbon fuels
 - e. combustion process
 - f. legal requirements for exhaust emissions.

Learning outcome	The learner will:
2.	Understand how to diagnose and rectify faults in light vehicle engine systems
Assessment criteria	
The learner can:	
2.1. Describe how to analyse symptoms and causes of faults found in light vehicle engine systems to include: <ul style="list-style-type: none"> a. engine mechanical components b. ignition systems c. fuel systems d. engine management system e. pressure charged induction systems f. heating, ventilation and cooling 	
2.2. Explain systematic diagnostic techniques used in identifying engine system faults	
2.3. Explain how to examine, measure and make suitable adjustments to the components including: <ul style="list-style-type: none"> a. settings b. input and output values c. voltages d. current consumption e. resistance f. output patterns with oscilloscope g. pressures h. condition i. wear and performance 	
2.4. Explain how to carry out the diagnosis and rectification activities in order to correct the faults in the light vehicle engine systems	
2.5. Explain how to select, prepare and use diagnostic and rectification equipment for light vehicle engine systems	
2.6. Explain how to evaluate and interpret test results found in diagnosing light vehicle engine system faults against vehicle manufacturer specifications and settings	
2.7. Explain how to evaluate the operation of components and systems following diagnosis and repair to confirm system performance.	

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Supporting information

Evidence requirements

The evidence requirements are shown in full in the assessment documentation.

Single and Multi-Point Petrol Injection Systems

a. The operation and construction of single and multi-point injection systems including:

- i. types of air flow sensor
- ii. fuel supply system
- iii. fuel pump
- iv. filter
- v. fuel regulator
- vi. injectors
- vii. sequential injection
- viii. continuous injection
- ix. semi-continuous injection
- x. electronic control unit (ECU)
- xi. injector pulse width
- xii. sensors

b. The operation of each system under various operating conditions including:

- i. cold starting
- ii. warm up
- iii. hot starting
- iv. acceleration
- v. deceleration
- vi. cruising
- vii. full load

c. Engine speed limiting and knock sensing.

Engine Management

a. The function and purpose of engine management systems.

b. The difference between analogue, digital, programmable and non-programmable systems.

c. Open loop and closed loop control, types of input and output devices.

d. The function and operation of digital components and systems.

e. The operation of engine management systems under various conditions.

Valve Mechanisms

- a. The reasons for variable valve timing and multi-valve arrangements and the effect on performance.
- b. Layout of multi-valve arrangements, components, operation and drive arrangements.
- c. Construction features and operation of variable valve timing engines and electronic control.

Pressure Charged Induction Systems

- a. The meaning of volumetric efficiency; explain the effect of volumetric efficiency on engine performance, torque and power.
- b. The methods used to improve volumetric efficiency:
 - i. variable valve timing
 - ii. turbo-charging
 - iii. supercharging
 - iv. intercoolers
- c. The operation of turbo-chargers and the purpose of:
 - i. turbo-charging
 - ii. supercharging
 - iii. intercoolers
 - iv. waste gates
 - v. exhaust gas recirculation
- d. Advantages and disadvantages of pressure charging induction systems.

Terms Associated with Combustion

- a. Flame travel, pre-ignition and detonation.
- b. Fuel properties:
 - i. octane rating
 - ii. flash point
 - iii. fire point
 - iv. volatility
 - v. composition of petrol and diesel fuels
 - vi. hydro-carbon content
- c. Composition of carbon fuels (petrol and diesel):
 - i. % hydrogen and carbon
 - ii. composition of air
 - iii. % oxygen
 - iv. % nitrogen
- d. Combustion process for spark ignition and compression ignition engines:
 - i. air fuel ratio
 - ii. lambda ratio
 - iii. stoichiometric ratio
- e. The by-products of combustion for different engine conditions and fuel mixtures:
 - i. CO
 - ii. CO₂
 - iii. O
 - iv. N
 - v. H₂O

- vi. NOx
- f. Describe the legal requirements for exhaust emissions;
 - i. MOT requirements
 - ii. EURO 3
 - iii. 4 & 5 regulations

Assessment, Repair and Restoration of Mechanical Engine Components

- a. How engine mechanical components are assessed and measured for wear and serviceability:
 - i. cylinder bores
 - ii. cylinder heads
 - iii. crankshaft journals
 - iv. valve faces
 - v. valve guides
 - vi. valve seats
 - vii. camshafts
- b. The methods used for the repair and restoration of engine components.

Cooling, Heating and Ventilation

- a. The components, operating principles, and functions of engine cooling systems
- b. Procedures used to remove, replace and adjust cooling system components
 - i. cooling fans and control devices
 - ii. header tanks, radiators and pressure caps
 - iii. heater matrix's and temperature control systems
 - iv. expansion tanks hoses, clips and pipes
 - v. thermostats impellers and coolant
 - vi. ventilation systems
- c. The preparation and method of use of appropriate specialist equipment used to evaluate system performance following component replacement
 - i. system pressure testers
 - ii. pressure cap testers
 - iii. hydrometer, or anti-freeze testing equipment
 - iv. chemical tests for the detection of combustion gas
- d. The layout and construction of internal heater systems.
- e. The controls and connections within internal heater system.
- f. Symptoms and faults associated with cooling systems:
 - i. water leaks
 - ii. water in oil
 - iii. internal heating system: efficiency, operation, leaks, controls, air filtration, air leaks and contamination
 - iv. excessively low or high coolant temperature
- g. The procedures used when inspecting
 - i. internal heating system
 - ii. cooling system

Air Conditioning Systems

- a. The operation of air conditioning components including:
 - i. compressors

- ii. condensers
 - iii. receivers
 - iv. dryers
 - v. connections
 - vi. valves
 - vii. hoses
 - viii. thermostats
 - ix. refrigerants
- b The layout and operation of air conditioning systems.

Climate Control Systems

- a. Identify components used in climate control systems including:
- i. sensors
 - ii. speed controls
 - iii. control systems
 - iv. servomotors
 - v. electronic components
- b. The layout of climate control systems.
- c. The operation of climate control system.

Symptoms and Faults in Engine Mechanical Systems and Components

- a. Symptoms and faults related to:
- i. worn cylinders
 - ii. cylinder liners
 - iii. pistons
 - iv. piston rings
 - v. crankshaft
 - vi. camshaft
 - vii. bearings
 - viii. cylinder head and gasket
 - ix. valves
 - x. valve seats and valve guides
 - xi. cambelts
 - xii. lubrication system and components
 - xiii. oil pump
 - xiv. relief valve
 - xv. filter
 - xvi. turbo-charger
 - xvii. supercharger

Diagnosis of Faults in Engine Mechanical Systems and Components

- a. Interpret information for:
- i. diagnostic tests
 - ii. manufacturer's vehicle and equipment specifications
 - iii. use of equipment
 - iv. testing procedures
 - v. test plans
 - vi. legal requirements

- b. The preparation of tools and equipment for use in diagnostic testing and assessment.
 - c. Systematic assessment, testing and inspection of engine components and systems including:
 - i. mechanical system & component condition
 - ii. engine balance
 - iii. power balance
 - iv. performance and operation
 - v. wear
 - vi. run out
 - vii. alignment
 - d. Use of appropriate tools and equipment including:
 - i. compression gauges
 - ii. leakage testers
 - iii. cylinder balance tester
 - iv. pressure gauges
 - v. micrometers
 - vi. vernier gauges
 - e. Evaluate and interpret test results from diagnostic testing.
 - f. Compare test result and values with vehicle manufacturer's specifications and settings.
 - g. The procedures for dismantling, components and systems and the use of appropriate equipment and procedures.
 - h. Assess, examine and measure components including:
 - i. settings
 - ii. values
 - iii. condition
 - iv. wear and performance of components and systems
 - i. Probable faults
 - i. malfunctions
 - ii. incorrect settings
 - iii. wear
 - j. Rectification or replacement procedures.
- Evaluate operation of components and systems following diagnosis and repair to confirm system performance.

Faults and Symptoms in Ignition Systems

- a. Ignition system failure or malfunctions including:
 - i. no spark
 - ii. misfiring
 - iii. backfiring
 - iv. cold or hot starting problems
 - v. poor performance
 - vi. pre-ignition
 - vii. detonation
 - viii. exhaust emission levels
 - ix. fuel consumption
 - x. low power
 - xi. unstable idle speed

Faults and Symptoms in Electronic Petrol and Diesel Injection Systems

- a. Petrol and diesel injection system failures or malfunctions including:
 - i. cold or hot starting problems
 - ii. poor performance
 - iii. exhaust emissions
 - iv. high fuel consumption
 - v. erratic running
 - vi. low power
 - vii. unstable idle speed

Faults and Symptoms in Engine Management Systems

- a. Engine management system failure or malfunctions including:
 - i. misfiring
 - ii. backfiring
 - iii. cold or hot starting problems
 - iv. poor performance
 - v. pre-ignition
 - vi. detonation
 - vii. exhaust emission levels
 - viii. fuel consumption
 - ix. low power
 - x. unstable idle speed

Diagnosis of Faults in Electronic Ignition, Petrol and Diesel Injection and Engine Management Systems

- a. Locate and interpret information for:
 - i. diagnostic tests
 - ii. manufacturer's vehicle and equipment specifications
 - iii. use of equipment
 - iv. testing procedures
 - v. test plans
 - vi. fault codes
 - vii. legal requirements
- b. The preparation of tools and equipment for use in diagnostic testing and assessment.
- c. Conduct systematic assessment, testing of engine systems including:
 - i. component condition and performance
 - ii. component settings
 - iii. component values
 - iv. electrical and electronic values
 - v. system performance and operation
 - vi. use of appropriate tools and equipment including gauges
 - vii. multi-meter
 - viii. breakout box
 - ix. oscilloscope
 - x. diagnostic tester
 - xi. manufacturer's dedicated equipment
 - xii. exhaust gas analyser

- xiii. fuel flow meter
- xiv. pressure gauges
- d. Evaluate and interpret test results from diagnostic testing.
- e. Compare test result, values and fault codes with vehicle manufacturer's specifications and settings.
- f. The procedures for dismantling, components and systems using appropriate equipment.
- g. Assess, examine and measure components including:
 - i. settings
 - ii. input and output values
 - iii. voltages
 - iv. current consumption
 - v. resistance
 - vi. output patterns with oscilloscope
 - vii. condition
 - viii. wear and performance of components and systems
- h. Identify probable faults and indications of:
 - i. faults
 - ii. malfunctions
 - iii. incorrect settings
 - iv. wear
 - v. values
 - vi. inputs and outputs
 - vii. fault codes
- i. Rectification or replacement procedures.
- j. Evaluation and the operation of components and systems following diagnosis and repair to confirm system performance.

Faults and Symptoms in Vehicle Comfort Systems

- a. System failure, malfunction or ineffectiveness of internal heating system, air conditioning system or climatic control system including:
 - i. leaks
 - ii. abnormal noise
 - iii. ineffective operation
 - iv. failure to operate
 - v. control faults
 - vi. inadequate operation

Diagnosis of Faults in Vehicle Comfort Systems

- a. Locate and interpret information for:
 - i. diagnostic tests
 - ii. manufacturer's vehicle and equipment specifications
 - iii. use of equipment
 - iv. testing procedures
 - v. test plans
 - vi. fault codes
 - vii. legal requirements
- b. The preparation of tools and equipment for use in diagnostic testing and assessment.
- c. Conduct systematic assessment and testing of comfort systems including:

- i. component condition and performance
- ii. component settings
- iii. component values
- iv. electrical and electronic values
- v. system performance and operation
- vi. drive belts
- vii. controls
- viii. compressors
- ix. condensers
- x. receivers
- xi. dryers
- xii. connections
- xiii. valve
- xiv. hoses
- xv. thermostats and refrigerants
- xvi. sensors
- xvii. speed controls
- xviii. control systems
- xix. servomotors
- d. Use of appropriate tools and equipment including:
 - i. pressure gauges
 - ii. multi-meter
 - iii. breakout box
 - iv. oscilloscope
 - v. diagnostic tester
 - vi. manufacturer's dedicated equipment
 - vii. flow meter
- e. Evaluate and interpret test results from diagnostic testing.
- f. Compare test result, values and fault codes with vehicle manufacturer's specifications and settings
- g. How to dismantle, components and systems using appropriate equipment and procedures
- h. How to assess, examine and measure components including: settings, input and output values, voltages, current consumption, resistance, output patterns with oscilloscope, pressures, condition, wear and performance of components and systems
- i. Identification of probable faults and indications of faults, malfunctions, incorrect settings, wear, values, inputs and outputs, fault codes, pressures and leaks
- j. Rectification or replacement procedures
- k. Evaluation and operation of components and systems following diagnosis and repair to confirm system performance