Unit 157  Knowledge of diagnosis and rectification of light vehicle engine faults

UAN: F/601/3733
Level: No Level
Credit value: 6
GLH: 45

Relationship to NOS: This unit is linked to LV07 Diagnose and Rectify Light Vehicles Engine and Component Faults.

Assessment requirements specified by a sector or regulatory body: This unit was developed by the IMI, the sector skills council for the automotive retail industry. All assessments have been developed in accordance with the IMI Assessment Requirements for VRQs.

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.

<table>
<thead>
<tr>
<th>Learning outcome</th>
<th>The learner will:</th>
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<tr>
<td>1.</td>
<td>understand how the light vehicle engine systems operate</td>
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<thead>
<tr>
<th>Assessment criteria</th>
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<tbody>
<tr>
<td>The learner can:</td>
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<tr>
<td>1.1</td>
<td>explain the construction and operation of light vehicle engine systems to include:</td>
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<tr>
<td>a.</td>
<td>SI fuel systems</td>
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<td>b.</td>
<td>CI fuel systems</td>
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<td>c.</td>
<td>ignition systems</td>
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<td>d.</td>
<td>engine management</td>
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<td>e.</td>
<td>valve mechanisms</td>
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<td>f.</td>
<td>pressure charged induction systems</td>
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<td>g.</td>
<td>exhaust emission reduction systems</td>
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<td>h.</td>
<td>heating, ventilation and cooling</td>
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<td>1.2</td>
<td>explain the interaction between electrical, electronic and mechanical components within light vehicle engine systems</td>
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<td>1.3</td>
<td>explain how electrical systems interlink and interact, including multiplexing and fibre optics</td>
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<td>1.4</td>
<td>compare light vehicle engine system components and assemblies against alternatives to identify differences in construction and operation</td>
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</table>
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.

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<tr>
<td>2.</td>
<td>understand how to diagnose and rectify faults in light vehicle engine systems</td>
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<td>The learner can:</td>
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<td>a. engine mechanical components</td>
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<td>b. ignition systems</td>
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<td>c. fuel systems</td>
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<td>d. engine management system</td>
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<tr>
<td>a. settings</td>
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<td>b. input and output values</td>
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<td>c. voltages</td>
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<td>d. current consumption</td>
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<td>e. resistance</td>
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<td>f. output patterns with oscilloscope</td>
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<td>g. pressures</td>
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<td>h. condition</td>
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<td>i. wear and performance</td>
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Unit 157 Knowledge of diagnosis and rectification of light vehicle engine faults

Supporting information

Unit range

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:

  e. air fuel ratio
     i. lambda ratio  
     ii. stoichiometric ratio.

  f. The by-products of combustion for different engine conditions and fuel mixtures:
     i. CO  
     ii. CO2  
     iii. O  
     iv. N  
     v. H2O  
     vi. NOx.

g. 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.
c. 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 matrices and temperature control systems
   iv. expansion tanks hoses, clips and pipes
   v. thermostats impellers and coolant
   vi. ventilation systems.
d. 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.
e. The layout and construction of internal heater systems.
f. The controls and connections within internal heater system.
g. 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.
h. 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.
k. 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:
e. pressure gauges
   i. multi-meter
   ii. breakout box
   iii. oscilloscope
   iv. diagnostic tester
   v. manufacturer's dedicated equipment
   vi. flow meter.
f. Evaluate and interpret test results from diagnostic testing.
g. Compare test result, values and fault codes with vehicle manufacturer's specifications and settings.
h. How to dismantle, components and systems using appropriate equipment and procedures.
i. 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.
j. Identification of probable faults and indications of faults, malfunctions, incorrect settings, wear, values, inputs and outputs, fault codes, pressures and leaks.
k. Rectification or replacement procedures.
l. Evaluation and operation of components and systems following diagnosis and repair to confirm system performance.