Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle)

On Programme (9301)

Version 1.2 (February 2018)

On Programme Handbook

Apprenticeship at a glance

Subject area	Automotive
City & Guilds number	9301
Age group approved	16-19, 19+
Entry requirements	Individual employers will set the selection criteria for the applicant. It is recommended during the selection process that apprentices demonstrate the following qualities: • be interested in the way vehicles operate • demonstrate the potential to research, analyse and solve problems • be organised • show a methodical approach and pays attention to detail • be able to work in a team. It is also recommended that the apprentice can demonstrate a capacity for mechanical reasoning and good spatial awareness.
Assessment types	Knowledge Tests Practical Skills Tests Formal Review of the Apprentice's workplace behaviours
Approvals	Full approval
Support materials	E-Portfolio Training Manual SmartScreen Virtual learning Digital credentials
Registration and certification	Consult the Walled Garden/Online Catalogue for last dates

Title and level	City & Guilds number	Comments
Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle) – On Programme	9301-11	Centres must register apprentices on this programme; it covers the On Programme stage of the apprenticeship only.
Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle) – End Point Assessment (with venue)	9301-12	Centres must submit module 500 under 9301-12 to schedule the End Point Assessment if they need a venue to be provided by City & Guilds. 9301-12-500 must be submitted no later than three months before the End Point Assessment is required. In the case of a resit centres must follow the same rule outlined above but use 9301-12-550 instead.
Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle) – End Point Assessment (without venue)	9301-13	Centres must submit module 500 under 9301-12 to schedule the End Point Assessment at their venue. 9301-13-500 must be submitted no later than three months before the End Point Assessment is required. In the case of a resit centres must follow the same rule outlined above but use 9301-13-550 instead.

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1 Introduction

This document tells you what you need to do to deliver the Apprenticeship:

Area	Description
Who is the Apprenticeship for?	This Apprenticeship is aimed at individuals who would like to become Motor Vehicle Service and Maintenance Technicians (Light Vehicle). A Motor Vehicle Technician services and repairs light vehicles such as cars and vans and works either in dealerships that focus on a particular manufacturer, or for an independent garage that deals with many different makes of vehicles. They work on all the systems found within the vehicle. The nature of the work ranges from replacing simple parts through to solving complex faults with the use of diagnostic methods and equipment.
What does the Apprenticeship aim to do?	The Apprenticeship aims to: - Develop deep technical and diagnostic competence in response to the increasing complexity of vehicle technologies - Develop sophisticated customer service behaviours - Help the apprentice to have the motivation and ability to contribute to the commercial success of their company.
What opportunities for progression are there?	Apprentices can progress into further learning by taking up in-house CPD training or a Level 4 qualification in Advanced Vehicle Diagnostics training to become a Master Technician. They could also take up higher level qualifications through the Institute of Leadership and Management (ILM) to become a workshop controller/manager.
Who did we develop the Apprenticeship with?	This Apprenticeship has been developed in collaboration with the Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle) employer group which is led by organizations from the industry including: Jaguar Land Rover, Mercedes-Benz, BMW, Honda, VW Group (Volkswagen Passenger Cars, Audi, SEAT, Skoda and Volkswagen Commercial Vehicles), Stratstone Group, Arnold Clark Group, Cavalier garages, Quality Car Service Jim Steele Garages, Retail Motor Industry Federation (RMIF).

Structure

On Programme

As part of the on programme assessment, the employer and training provider can assess the progressive development via a formative assessment at the end of Gateways 1 and 2. The apprentice, employer and provider are also required jointly to maintain a logbook that captures progress over the programme. The on programme will also contain:

- a knowledge and understanding test that checks understanding at Gateways 1 and 2
- an on-going assessment of soft skills and behaviours
- a comprehensive skills test at Gateways 1 and 2.

The third check will be at Gateway 3. The employer and training provider are required to confirm that the apprentice is fully competent and ready to take the end point assessment.

End-point assessment

The end-point assessment is comprised of three methods:

- two online knowledge tests exploring knowledge/understanding of the apprentice
- a practical skills test
- a professional discussion in two parts (part 1 lasts approx. 20 minutes, part 2 lasts approx. 40 minutes).

ON PROGRAMME TRAINING TOWARDS GATEWAY 1

The apprentice completes the on programme tasks alongside an on-going review of their workplace soft skills and behaviours.

GATEWAY 1 (optional)

The apprentice successfully completes

- The training manual tasks up to Gateway 1
- A multiple-choice knowledge test graded Pass only
- A practical skills test graded Pass/Distinction
- A formal review of their workplace behaviours with a rating of either achieved or distinction.

ON PROGRAMME TRAINING TOWARDS GATEWAY 2

The apprentice completes the on programme tasks alongside an ongoing review of their workplace soft skills and behaviours.

GATEWAY 2 (optional)

The apprentice successfully completes

- The training manual tasks up to Gateway 2
- A multiple-choice knowledge test graded Pass or Distinction
- A practical skills test graded Pass/Distinction
- A formal review of their workplace behaviours with a rating of either achieved or distinction.

ON PROGRAMME TRAINING TOWARDS GATEWAY 3

The apprentice successfully completes the on programme tasks alongside an on-going review of their workplace soft skills and behaviours.

GATEWAY 3

The trainer/mentor and employer review the training manual, the results from the Gateway 1 and 2 assessments, if completed, the behavioural evidence and confirm that the apprentice is ready for the End-Point Assessment. Apprentices will also have achieved Level 2 Mathematics and Level 2 English qualifications (or relevant equivalent) either during or before their apprenticeship, as well as the required F-Gas qualification.

2 Centre requirements

Approval

To offer this Apprenticeship, new centres will need to gain both centre and qualification approval. Please refer to the Centre Manual - Supporting Customer Excellence available in our website for further information.

Resource requirements

Centre staff should familiarise themselves with the structure, content and assessment requirements of the Apprenticeship before designing a course programme.

The Training Manual includes information about the minimum equipment required to deliver the tasks to work towards the Gateways of the on programme stage of the Apprenticeship.

The Assessment Pack available on our website contains information about the minimum equipment required to carry out the practical tasks which are part of the summative assessment of the Gateways of the on programme stage of the Apprenticeship.

Centres must ensure that the staff delivering these qualifications are able to demonstrate they have the occupational expertise required to train the apprentices up to the standard set up by the industry and successfully achieve the End Point Assessment.

Apprentice entry requirements

Whilst any entry requirements will be a matter for individual employers, typically an apprentice might be expected to already have the following qualities:

- an interest in the way vehicles operate
- able to demonstrate general analytical and mechanical skills
- a capacity for mechanical reasoning and the potential to research
- analyse and solve problems
- well organised, methodical and good attention to detail
- good spatial awareness
- able to work in a team and to communicate well both orally and in writing
- cares about delivering excellent service – both internally and externally to colleagues and customers.

Age restrictions

City & Guilds cannot accept any registrations for individuals under 16 as this Apprenticeship is not suitable for anyone under the age of 16.

3 Assessment

Summary of optional assessment methods

Apprentices will:

- complete a logbook
- demonstrate appropriate workplace behaviours
- have achieved English and maths at GCSE Grade C (or Functional Skills Level 2)

Test Specifications

The way the knowledge is covered by the multiple-choice test is laid out in the tables below:

Test: 101	**Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle) - Gateway 1 Knowledge Test**	
Duration	1 hour	
Total number of questions	40	
This is a closed book test; no calculator is required		
Group	**Knowledge and Understanding**	**%**
01 Induction and Foundation Skills	01 Soft Skills and Behaviours	50
	02 Tools	
	03 Vehicle	
02 Routine Services and Inspections	01 Soft Skills and Behaviours	50
	02 Electrical systems	
	03 Servicing	
	04 Accessories	

Test: 201	Automotive Retail Motor Vehicle Service and Maintenance Technician (Light Vehicle) - Gateway 2 Knowledge Test	
Duration	1 hour 30 minutes	
Total number of questions	60	
This is a closed book test; no calculator is required		
Group	**Knowledge and Understanding**	**%**
01 Simple diagnosis and repair	01 Soft Skills and Behaviours	35
	02 Electrical systems	
	03 Lighting and auxiliary systems	
	04 Wheel and tyre construction	
	05 Disc brakes construction	
	06 Steering systems	
	07 Engine types and configurations	
	08 Exhaust systems	
	09 Engine cooling systems	
02 Intermediate diagnosis and repair	01 Soft skills and behaviours	65
	02 Diagnostic skills	
	03 Electrical systems	
	04 Drum brakes	
	05 Suspension layout and components	
	06 Steering	
	07 Power assisted steering	
	08 Vehicle starting and charging systems	
	09 Auxiliary electrics 1	
	10 Ignitions systems	
	11 Transmission drivelines	

Support materials

City & Guilds provides a one box solution for apprentices, trainers and workplace mentors to ensure a successful completion of the Apprenticeship which consists of:

Product	Description
E-Portfolio	A competence management system to track the progress of the apprentice during their Apprenticeship.
Training Manual	Include tasks to support the apprentice's progression during the on programme phase. Accessible via Walled Garden (ISBN: 9780851933757).
Virtual Learning	Allows the apprentice to learn at their own pace in their own time. Accessible via www.smartscreen.co.uk
SmartScreen	Schemes of work signposted to the virtual learning materials and workplace behaviours for trainers to facilitate the delivery of the Apprenticeship during the on programme phase. Accessible via www.smartscreen.co.uk

Assessment Types

Unit	Title	Assessment method
101	Knowledge test - Gateway 1	Online Multiple Choice Test – optional
201	Knowledge test - Gateway 2	Online Multiple Choice Test – optional

4 Training towards Gateway 1

Introduction

At **Gateway 1** the apprentice can take a practical skills test, a multiple-choice knowledge test (101) and have confirmation that they are sufficiently demonstrating workplace behaviours at the required standard before they are able to continue onto the next phase of the on-programme training.

Training towards **Gateway 1** will cover:

- Soft skills and behaviours
- Induction and foundation skills
- Routine services and inspection

This section outlines the required standard for each topic and will cover.

Soft skills and behaviours

Performance criteria

P1 Working together and building trust

Assessment criteria for P1

The apprentice can:

P1.1 routinely collaborate with others to achieve targets
P1.2 maintain positive working relationships even though the other person may be very different
P1.3 accept the tasks given, quickly recognise whether they have the ability to complete them and seek help appropriately
P1.4 demonstrate honesty when working as part of a team
P1.5 carry out tasks with consideration for others
P1.6 seek support and help from colleagues when appropriate
P1.7 flag up difficulties in sufficient time to take remedial action
P1.8 provide feedback to others at the appropriate moment and support it with relevant evidence
P1.9 actively contribute to team goals

Performance criteria

P2 Customer experience and communication

Assessment criteria for P2

The apprentice can:

P2.1 use a clear voice and polite tone
P2.2 speak confidently and use different types of questions appropriately
P2.3 complete internal documentation as required using legible, grammatically correct written communication for internal e-mails/repair order completion.
P2.4 exhibit appropriate body language and attitude when dealing with colleagues and customers
P2.5 be trusted and deal with customers with honesty and fairness
P2.6 ably converse with others regarding technical issues, explaining technical terminology when asked
P2.7 approach colleagues and customers with respect and follow the appropriate procedures when dealing with a problem
P2.8 quickly refer difficult issues to others
P2.9 wear appropriate clothing at all times and present a clean appearance especially when meeting customers

Performance criteria

P3 Making it happen and commercial awareness

Assessment criteria for P3

The apprentice can:

P3.1 contribute ideas
P3.2 take a systematic approach to problem solving
P3.3 know their limitations and when best to escalate issues
P3.4 know what they need to do and know the roles of people close to them
P3.5 confidently use systems and processes relevant to the role
P3.6 comply with legislation
P3.7 complete documentation with a clear understanding of its purpose
P3.8 understand the business side of managing a workshop and take steps to improve its overall efficiency
P3.9 be punctual and routinely meet deadlines
P3.10 think about the tasks ahead and how they should be prioritised
P3.11 react well to the unexpected
P3.12 confidently break down complex tasks and allocate time and resources appropriately
P3.13 understand the environmental impact of the materials they use and take steps to minimise waste
P3.14 understand the importance of PPE
P3.15 apply good housekeeping methods in the workshop
P3.16 routinely operate safely without the need for reminders

Performance criteria

P4 Learning to learn and striving for excellence

Assessment criteria for P4

The apprentice can:

P4.1 independently and regularly reflect on progress and set goals and priorities for future development
P4.2 share their knowledge and skills when requested
P4.3 demonstrate an interest in learning and actively use the opportunities to extend their knowledge and skills
P4.4 provide reports on their progress when asked

Soft skills and behaviours

Supporting Information and Unit guidance for performance criteria

For Performance criteria 1:

the apprentice should routinely collaborate with others to achieve targets ('others' could include customers, work colleagues, supervisors, managers)

For Performance criteria 2:

the different methods of communication could include:

- open questions
- closed questions
- probing questions.

For Performance criteria 3:

P3.1 contribute ideas

- think them through in detail
- consider their implications
- present them clearly

P3.14 understand the importance of the protection of:

- eyes
- ears
- head
- skin
- feet
- hands
- lungs

For Performance criteria 4:

the apprentice can demonstrate an interest in learning and actively use the opportunities to extend their knowledge and skills. This could be shown by using:

- network events
- job shadowing
- simulation
- training
- research

Values and Behaviours:

Consideration should be given to the following throughout **all** of the Performance criteria

For Performance criteria 1: Working together and building trust

The following should be considered:

P1.1 Working with others

- collaborate with others to achieve targets
- recognise when others have difficulties
- offer support where appropriate

P1.2 Positive working relationships

- maintain positive working relationships even though the other person may be very different from themselves
- encourage others to be involved

P1.3 Receiving and managing tasks

- accept the given tasks and quickly recognise whether they have the ability to complete them and seek help appropriately

P1.4 Developing trust

- demonstrate honesty when working as part of a team
- be aware of the impact on others

P1.5 Carry out tasks with consideration for others

- suggest remedial action
- recognise the strengths and weaknesses in themselves and others

P1.6 Seek support and help from colleagues when appropriate

- alert others to the problems they may encounter when completing a task
- offer solutions to ensure the team meets its agreed goals

P1.7 Flag up difficulties in sufficient time to take remedial action

P1.8 Feedback

- provide feedback to others at the appropriate time and support it with relevant evidence
- provide accurate and balanced feedback to others providing the appropriate support

P1.9 Contribution to team goals

- actively contribute to team goals
- contribute towards setting clear team goals and make a significant contribution to the effort required to complete them

For Performance criteria 2 Customer experience and communication:

The following should be considered:

P2.1 Oral communication

- use a clear voice and polite tone

P2.2 Speak confidently and use different types of questions appropriately

- use active listening skills and use the appropriate tone and questioning techniques particularly when talking to customers

P2.3 Written communication

- complete internal documentation as required using legible, grammatically correct written communication for internal e- mails/repair order completion
- confidently complete internal documentation using an appropriate method

P2.4 Body language and attitude

- exhibit appropriate body language and attitude when dealing with colleagues and customers
- aware of how tone and body language impacts on communications
- adjust body language and attitude to suit the situation, colleagues and customers

P2.5 Honesty and ethics

- be trusted and deal with customers with honestly and fairness

P2.6 Technical language

- able to converse with others regarding technical issues explaining technical terminology when asked
- able to talk about technical issues confidently using the language that is appropriate to the audience

P2.7 Colleague and customer relationships

- approach colleagues and customers with respect and
- follow the appropriate procedures when dealing with a problem

P2.8 Quickly refer difficult issues to others

- deal with difficult situations appropriately
- follow the requirements of the organisation
- capable of ensuring the customers enjoy a positive experience irrespective of the issue

P2.9 Personal presentation

- wear appropriate clothing at all times
- take pride in personal appearance
- present a clean appearance especially when meeting customers

For Performance criteria 3 Making it happen and commercial awareness:

The following should be considered:

P3.1 Contribute ideas

- think ideas through in detail and their implications and present them clearly

P3.2 Problem solving

- take a systematic approach to problem solving
- know own limitations and when best to escalate issues

P3.3 Roles and responsibilities

- know what to do

P3.4 Know the roles of people close to them

- colleagues
- mentors
- managers

P3.5 Confidently use systems and processes relevant to the role

- workplace procedures
- workplace policies

P3.6 Comply with legislation

- relevant automotive legislation

P3.7 Complete documentation with a clear understanding of its purpose to include:

- job cards
- inspection reports
- service records

P3.8 Commercial acumen

- understand the business side of managing a workshop
- take steps to improve its overall efficiency
- suggest how to reduce costs and generate revenue

P3.10 Think about the tasks ahead and how they should be prioritised

- planning and organisation
- meeting customer needs
- workshop loading

P3.11 React well to the unexpected

- always focus on the job in hand and makes confident judgements when choosing between quality and speed
- re-prioritise work appropriately and keep everyone informed

P3.12 Confidently break down complex tasks and allocate time and resources appropriately

- take account of the impact of own tasks on other business activities when carrying out own work
- keep everyone informed

P3.13 Environmental awareness

- consideration of the Environmental Protection Act (EPA)

For Performance criteria 4 Learning to learn and striving for excellence:

The following should be considered:

P4.2 Sharing learning with others

- share knowledge and skills when requested
- think how to best support others
- share own knowledge and skills at the appropriate time and in a way that works best for them

P4.3 Passion for automotive engineering

- demonstrate an interest in learning and actively use the opportunities to extend their knowledge and skills
- demonstrate a passion for the job and engage in a wide range of activities e.g. self-study, related hobbies
- demonstrate the need to be excellent

P4.4 Keeping others informed about progress

- provide reports on own progress when asked
- actively seek opportunities to share progress with mentors and tutors

Induction and foundation skills

Performance criteria

The apprentice can:

P1 contribute to the maintenance of a safe and efficient workshop and adheres to business processes

P2 carry out fundamental tasks associated with removal and replacement procedures on a vehicle

Range

(P1) Fundamental tasks to include

- use suitably maintained workshop equipment safely
- interpret correctly 'safe working load' on lifting and supporting equipment
- report any faulty or damaged tools and equipment to the relevant persons clearly and promptly
- store work tools and equipment in a safe manner which permits ease of access and identification for use
- ensure the work area is maintained to a suitable standard of cleanliness

(P2) Fundamental tasks to include

- using common tools, torque wrench and measuring instruments
- removing and replacing bolts, setscrews, studs, hoses, electrical connectors, trim, clips, drive belts, gaskets
- extracting seized and broken bolts
- handling fluids
- drilling, cutting, filing, tapping, riveting, joining metals and plastics
- carrying out basic procedures with the diagnostic machine
- jacking and lifting a vehicle

Learning outcome

K1 Soft skills and behaviours

Assessment criteria

The apprentice will have knowledge of:

K1.1 health and safety

K1.2 the structure of the organisation

K1.3 employment law

K1.4 the importance of vehicle protection

K1.5 how to ensure workplace security

K1.6 environmental procedures and the implications of not following them

K1.7 equal opportunities and diversity legislation and benefits of following equal opportunities and diversity legislation procedures

K1.8 how to communicate effectively

K1.9 core values and the impact of positive and negative traits

K1.10 standards of behaviour defined by own workplace

K1.11 the purpose of improving own performance, ways of improving own performance, identifying opportunities that are available

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Range

(K1.1) Health and Safety

- Legislation relevant to Health and Safety within the Apprentice's workplace:
  - policies
  - hazards
  - risks
  - signs
  - the location and use of safety equipment
  - prohibited areas and equipment
  - reporting procedures
  - implications of not following procedures

(K1.2) structure of the organisation

- the structure of different types of light vehicle repair businesses
- lines of communication within a business
- understand the structure of a typical vehicle repair business and how the areas relate to each other

(K1.3) employment law

- know own rights and responsibilities
- understand the responsibilities of the employer
- support available to an employee

(K1.4) vehicle protection

- wing protection
- seat protection
- carpet/floor protection
- steering wheel protection

(K1.8) communicate effectively

- principles of customer communication and care, to include:
  - first impressions
  - listening skills
  - eye contact and smiling
  - showing interest and concern
  - questioning techniques and customer understanding

- giving clear non-technical explanations
- written communication – purpose, content, presentation
- providing a high quality service

Learning outcome

K2 Tools

Assessment criteria

The apprentice will have knowledge of:

K2.1 the importance of having tool maintenance procedures and understand why they are carried out.

Range:

(K2.1) tools to include:

- hand tools
- measuring precision tools
- electrical measuring tools

Learning outcome

K3 Vehicle

Assessment criteria

The apprentice will have knowledge of:

K3.1 the location and function of the main components of a vehicle

Range:

(K3.1) vehicle components to include:

- engine
- steering / suspension
- braking
- transmission
- electrical

Induction and foundation skills

Supporting Information for performance criteria

Unit guidance

For **performance criteria 1 and 2** the apprentice will be able to:

- select, maintain and use suitable hand tools safely when fabricating and fitting in the automotive workplace
- select, maintain and use suitable measuring devices safely when fabricating and fitting in the automotive environment
- select, maintain and use suitable PPE for fabrication, repair and fitting in the automotive environment
- select, maintain and use suitable electrical measuring tools safely when repairing vehicles and components
- use suitably maintained workshop equipment safely
- interpret correctly 'safe working load' on lifting and supporting equipment
- report any faulty or damaged tools and equipment to the relevant persons clearly and promptly
- store work tools and equipment in a safe manner which permits ease of access and identification for use
- select and use appropriate materials whilst constructing, fitting, modifying or repairing vehicles and components
- Demonstrate correct procedures when:
    - filing
    - making threads
    - cutting
    - drilling
    - fitting
    - riveting
    - joining metals and plastics
- select and use:
    - gaskets
    - seals
    - sealants
    - fittings and fasteners
- select and use locking, fixing and fastening devices
- identify warning signs and notices
    - colours used for warning signs
    - shapes and meaning of warning signs

Supporting Information for knowledge requirements to include:

(K1.1) Legislation relevant to Health and Safety within the Apprentice's workplace:

- Health And Safety At Work Act
- Control of Substances Hazardous to Health Regulations

- Environmental Protection Agency
- Manual Handling Operations Regulations
- Personal Protective Equipment at Work

(K1.2) Structure of the organisation:

- body shop
- vehicle repair workshop
- paint shop
- valeting
- vehicle parts store
- main office
- vehicle sales
- reception

(K2.1) Tools:

- hand tools could include:
    - files
    - hacksaws and snips
    - hammers
    - screwdrivers
    - pliers
    - spanners
    - sockets
    - punches
    - types of drills and drill bits
    - taps and dies
    - stud removers
    - marking out tools
- measuring devices could include:
    - rule or tape
    - callipers
    - feeler gauge
    - volume measures
    - micrometer
    - dial gauges
    - torque wrenches
    - depth gauges
- electrical measuring tools could include:
    - Ammeter
    - Voltmeter
    - Ohmmeter
    - Multi-meter

Routine services and inspections

Performance criteria

P1 the apprentice can:

P1.1 use ICT to create emails and word-processed documents; copy and paste across documents; save and print documents

P1.2 use ICT to carry out web based searches

P1.3 obtain inspection schedules, data and recall information

P1.4 use equipment normally found in the workplace relating to servicing and inspections

P1.5 reset service indicator

P1.6 consistently complete a range of services and inspect and prepare a vehicle to the required quality standard for handover to the customer

P1.7 identify common faults found during routine service and inspections

P1.8 report faults using company procedures

P1.9 complete documentation following workplace procedures

P1.10 test the function of a wide range of fitted accessories

Learning outcome

K1 Soft skills and behaviours

Assessment criteria

The apprentice will have knowledge of:

K1.1 how the business works from an operational perspective
K1.2 the industry structure
K1.3 developing positive working relationships
K1.4 commercial awareness
K1.5 self-evaluation
K1.6 opportunities in the automotive Industry

Range

(K1.1) how the business works

- organisational structure
- interrelationship within the business

(K1.2) industry structure

- awareness of the automotive industry structure

(K1.3) developing positive working relationships

- importance of listening to the views of others
- honouring commitments

(K1.4) commercial awareness

- importance of promoting products and services to customers
- factors that influence customers

(K1.5) self-evaluation and opportunities in the Automotive Industry

- when, how and why to carry out
- career development

Learning outcome

K2 Electrical systems

Assessment criteria

The apprentice will have knowledge of:

K2.1 requirements for an electrical circuit
K2.2 connection between volts, amps and resistance; volt drop
K2.3 series and parallel circuits
K2.4 electrical calculations

Range

(K2.1) requirements for an electrical circuit to include

- voltage
- current
- resistance
- cables
- current consuming devices

(K2.2) connection between volts, amps and resistance; volt drop

- volt (electrical pressure)
- ampere (electrical current)
- ohm (electrical resistance)
- watt (power)
- volt drop

(K2.3) series and parallel circuits

- current flow
- voltage of components

(K2.4) electrical calculations

- OHMs law examples
- Watts law examples

Learning outcome

K3 Servicing

Assessment criteria

The apprentice will have knowledge of:

K3.1 where to obtain inspection schedules, data and recall information
K3.2 the need to use the correct lubricants for the vehicle
K3.3 why and how to carry out checks usually carried out at routine services and inspections
K3.4 the importance of following procedures when reporting faults
K3.5 the legal requirements for service procedures
K3.6 knowledge of which components should be checked during a road test

Range

(K3.1) where to obtain inspection schedules

- electronic sources
- service book
- manufacturers workshop data
- web sites/internet sources

(K3.2) use the correct lubricants

(K3.3) why and how to carry out checks

- manufacturers approved inspection methods

(K3.4) the importance of following procedures

- manufacturer requirements
- production of accurate work records
- workplace procedures

(K3.5) the legal requirements of

- tyres
- brakes
- steering
- suspension
- lighting

(K3.6) knowledge of components that should be checked during a road test

Learning outcome

K4 Accessories

Assessment criteria

The apprentice will have knowledge of:

K4.1 the implications and legal requirements of fitting accessories and carrying out modifications

- fines
- higher insurance costs
- construction and use

Range

(K4.1) legal requirements of fitting accessories

- wheels and tyres
- lighting
- emissions
- glazing/tinted glass
- towing equipment

Routine services and inspections

Supporting Information for performance criteria

Unit guidance

For performance criteria P1 the apprentice will be able to:

- use suitable personal protective equipment and vehicle coverings throughout all light vehicle routine maintenance activities
- work in a way which minimises the risk of damage or injury to the vehicle, people and the environment
- select suitable sources of technical information to support light vehicle routine maintenance activities including:
    - vehicle technical data
    - maintenance procedures
    - legal requirements
- use technical information to support light vehicle inspection activities
- select the appropriate tools and equipment necessary for carrying out routine maintenance
- ensure that equipment has been calibrated to meet manufacturers' and legal requirements
- use the correct tools and equipment in the way specified by manufacturers when carrying out routine maintenance
- carry out light vehicle maintenance using prescribed methods, adhering to the correct specifications and tolerances for the vehicle and following:
    - the manufacturer's approved inspection methods
    - recognised researched inspection methods
    - health and safety requirements
    - workplace procedures
- carry out adjustments, replacement of vehicle components and replenishment of consumable materials following the manufacturer's current specification
- ensure the examination methods identify accurately any vehicle system and or component problems falling outside the maintenance schedule are specified
- ensure any comparison of the vehicle against specification accurately identifies any:
    - differences from the vehicle specification
    - vehicle appearance and condition faults
    - variation from legal requirements
- use suitable testing methods to evaluate the performance of all replaced and adjusted components and systems accurately
- complete all system diagnostic activities within the agreed timescale
- produce work records that are accurate, complete and passed to the relevant person(s) promptly in the format required
- make suitable and justifiable recommendations for cost effective repairs
- identify and report any expected delays in completion to the relevant person(s) promptly in the format required
- record and report any additional faults noticed during the course of their work promptly in the format required
- carry out quality checks of the vehicle following routine maintenance

5 Training towards Gateway 2

Introduction

At **Gateway 2** the Apprentice can take a practical skills test, a multiple-choice knowledge test (201) and have confirmation that they are sufficiently demonstrating workplace behaviours at the required standard before they are able to continue onto the next phase of the on-programme training.

Training towards **Gateway 2** will cover:

- Simple diagnosis and repair
- Intermediate diagnosis and repair

This section outlines the required standard for each topic.

Simple diagnosis and repair

Performance criteria

The apprentice can:

P1 remove and replace a range of components that involve simple procedures (components that have easy access and no special tools or procedures are needed).

P2 measure components and carry out test procedures for common faults associated with simple removal and replacement procedures.

Learning outcome

K1 Soft skills and behaviours

Assessment criteria

The apprentice will have knowledge of:

K1.1 prioritising work

K1.2 taking on new challenges and adapting to change

Range

(K1.1) prioritising work

- not overpromising and under delivering

Learning outcome

K2 Electrical systems

Assessment criteria

The apprentice will have knowledge of:

K2.1 vehicle batteries including low maintenance and maintenance free

Range

(K2.1) vehicle batteries

- lead acid
- nickel cadmium

Learning outcome

K3 Lighting and Auxiliary systems

Assessment criteria

The apprentice will have knowledge of:

K3.1 simple circuit diagrams and lighting and auxiliary systems
K3.2 statutory requirements for lighting systems
K3.3 bulb types and advanced lighting technology.

Range

(K3.1) Lighting systems:

- front and tail lamps
- main and dip beam headlamps
- fog and spot lamps
- lighting and dip switch
- interior lights
- directional indicators
- circuit relays

(K3.2) Statutory requirements

- vehicle lighting
- headlamp adjustment /beam setting

(K3.3) bulb types and advanced lighting technology

- xenon lighting
- gas discharge lighting
- ballast system
- Light Emitting Diode (LED)
- intelligent front lighting
- blue lights
- complex reflectors
- fibre optics
- optical patterning

Learning outcome

4 Wheel and tyre construction

Assessment criteria

The apprentice will have knowledge of:

K4.1 tyre construction and tyre markings

K4.2 light vehicle wheels

Range

(K4.1) tyre construction and tyre markings

- tyre and wheel size markings
- speed rating
- direction of rotation
- profile
- load rating
- ply rating
- tread-wear indicators

(K4.2) light vehicle wheels

- light alloy
- pressed steel and wire wheels
- flat-edge and double hump rims

Learning outcome

5 Disc brakes construction

Assessment criteria

The apprentice will have knowledge of:

K5.1 construction and operation of disc brakes

Range

(K5.1) construction and operation of disc brakes

- disc pads
- caliper
- solid disc
- ventilated disc
- disc pad retraction
- wear indicators and warning lamps

Learning outcome

K6 Steering

Assessment criteria

The apprentice will have knowledge of:

K6.1 vehicle wheel alignment

Range

(K6.1) vehicle wheel alignment

- toe in
- toe out

Learning outcome

K7 Engine types and configurations

Assessment criteria

The apprentice will have knowledge of:

K7.1 two and four stroke cycles

K7.2 turbo charged and naturally aspirated

K7.3 engine configurations

Range

(K7.1) two and four stroke cycles

- petrol
- diesel

(K7.2) turbo charged and naturally aspirated

(K7.3) engine configurations

- inline
- flat
- vee
- W

Learning outcome

K8 Exhaust systems

Assessment criteria

The apprentice will have knowledge of:

K8.1 construction, purpose, layout and design

K8.2 safety with catalytic converters

Range

(K8.1) exhaust systems

- brackets
- silencers
- safety with catalytic convertors
- particulate filters

Learning outcome

K9 Engine cooling systems

Assessment criteria

The apprentice will have knowledge of:

K9.1 components, operating principles and functions of the cooling system

K9.2 ventilation systems layout and construction of internal heater systems

Range

(K9.1) components, operating principles and functions of the cooling system

- cooling fans and control devices
- header tanks
- radiators and pressure caps
- hoses
- clips
- pipes
- thermostats
- water pumps
- coolants
- cooling effect of oils

(K9.2) ventilation systems layout and construction of internal heater systems

- heater matrix
- temperature control systems

Simple diagnosis and repair

Supporting Information for performance criteria

Unit guidance

This unit is not an in-depth knowledge unit of vehicle systems. However sufficient knowledge of vehicle systems is needed for the knowledge and skills in order to complete Simple Diagnosis Repair Procedures.

For performance criteria 1 and 2 the apprentice will be able to:

- use suitable personal protective equipment and vehicle coverings when working on:
    - engine unit components
    - lighting and auxiliary electrical systems
    - chassis unit components
- work in a way which minimises the risk of damage or injury to the vehicle, people and the environment
- select suitable sources of technical information to support simple diagnostic activities
- use technical information to support simple diagnostic activities
- select the appropriate tools and equipment necessary for simple diagnostic activities and removal and replacement of:
    - engine systems to include:
        - exhaust systems
        - cooling systems
    - lighting systems
    - steering systems
    - wheels and tyres
    - batteries
- ensure that equipment has been calibrated to meet manufacturers' and legal requirements
- use the correct tools and equipment in the way specified by manufacturers to remove and replace components when carrying out simple diagnostic activities
- ensure that replacement units and components conform to the vehicle operating specification and any legal requirements
- use suitable testing methods to evaluate the performance of the reassembled system
- ensure that the reassembled systems performs to the vehicle operating specification and meets any legal requirements
- complete all system diagnostic activities within the agreed timescale
- produce work records that are accurate, complete and passed to the relevant person(s) promptly in the format required
- make suitable and justifiable recommendations when repairing vehicles
- identify and report any expected delays in completion to the relevant person(s) promptly in the format required
- record and report any additional faults noticed during the course of their service work promptly in the format required

Intermediate diagnosis and repair

Performance criteria

The apprentice can:

P1 complete repairs that involve two stage removal and replacement and involve removal of other components to access the repair

P2 identify causes of common faults associated with two stage removal and replacement and recommend suitable further actions

Learning outcome

K1 Soft skills and behaviours

Assessment criteria

The apprentice will have knowledge of:

K1.1 how to share ideas

Range

(K1.1) how to share ideas

- referral of problems
- communicate effectively
- suggest resolutions
- think innovatively

Learning outcome

K2 Diagnostic skills

Assessment criteria

The apprentice will have knowledge of:

K2.1 common fault types

K2.2 causes and effects of different types of faults

K2.3 how to ask questions

K2.4 how to avoid making wrong assumptions

Range

(K2.1) Common fault types:

- whine
- rumble

- vibration
- wander
- rattle
- knock
- misfire
- leaks

(K2.2) causes and effects of faults:

- abnormal noise(s)
- alignment
- condition
- malfunction
- run out
- wear
- vibration

(K2.3) how to ask questions

- listening skills
- questioning techniques

(K2.4) how to avoid making wrong assumptions

- give clear non-technical explanations
- confirm understanding (statement/question technique, reflective summary)
- obtain customer feedback and corrective actions when dissatisfaction expressed

---

Learning outcome

K3 Electrical systems

Assessment criteria

The apprentice will have knowledge of:

K3.1 magnetism
K3.2 construction and operation of Inductive and Hall Effect sensors
K3.3 the effect on circuit operation of open circuit component(s)
K3.4 the meaning of open circuit

Range

(K3.1) magnetism

- magnetism
- electromagnetism
- electromagnetic induction

(K3.2) inductive and Hall Effect sensors

- analogue sensors
- digital sensors
- output signals

(K3.3) circuit components to include:

- diodes
- transistors
- capacitors

Learning outcome

K4 Drum brakes

Assessment criteria

The apprentice will have knowledge of:

K4.1 construction and operation of drum brakes

Range

(K4.1) construction and operation of drum brakes

- brake drums
- linings and shoes
- leading and trailing shoes
- self-servo action
- automatic adjusters
- backing plates
- parking brake system

Learning outcome

K5 Suspension layouts and components

Assessment criteria

The apprentice will have knowledge of:

K5.1 advantages of light vehicle suspension systems

K5.2 light vehicle suspension terms

K5.3 types and components of light vehicle suspension

K5.4 operation of light vehicle suspension

Range

(K5.1) suspension systems

- rigid axle
- independent front suspension (IFS)
- independent rear suspension (IRS)
- hydraulic
- hydro-pneumatic

(K5.2) suspension terms

- rebound
- bump
- dive
- forces acting on suspension systems during
    - braking
    - driving
    - cornering
- to include:
    - pitch
    - roll
    - compliance

(K5.3) types and components of vehicle suspension

- Macpherson strut system
- hydro-pneumatic
- electronic systems
- beam axle
- leaf spring
- coil springs
- torsion bar
- anti-roll bars
- hydraulic dampers
- trailing arms
- wish bones
- ball joints
- track control arms
- bump stops
- stabiliser bars
- swinging arms
- parallel link
- swinging half- axles
- rubber springs
- hydraulic
- adaptive dampening
- transverse link and semi-swinging arms

(K5.4) operation of light vehicle suspension

- methods of locating the road wheels against braking, driving and cornering forces
- methods of controlling cornering forces by fitting anti-roll torsion members

Learning outcome

6 Steering

Assessment criteria

The apprentice will have knowledge of:

K6.1 geometry
K6.2 operation and layout of rear and four wheel steering

Range

(K6.1) geometry

- Ackerman principle
- castor angle
- camber angle
- kingpin or swivel pin inclination
- toe-out on turns
- negative offset
- thrust angle
- slip angles
- oversteer
- understeer
- self-aligning torque
- neutral steer

(K6.2) operation and layout of rear and four wheel steering

- passive
- active
- mechanical
- electrical

Learning outcome

K7 Power assisted steering

Assessment criteria

The apprentice will have knowledge of:

K7.1 components layout and operation
K7.2 principles and components of electrical and electronic steering systems
K7.3 advantages of power steering

Range

(K7.1) components layout and operation

- power cylinders

- drive belts
- pumps
- hydraulic valve (rotary, spool and flapper type)
- hydraulic fluid

(K7.2) components of electrical and electronic steering systems

- motors
- torque sensors
- ECU

(K7.3) advantages of power steering

- driver comfort
- variable assistance

Learning outcome

K8 Vehicle starting and charging system

Assessment criteria

The apprentice will have knowledge of:

K8.1 alternators

K8.2 starters

Range

(K8.1) alternators

- drive systems
- internal components
- output types
- types of windings
- SMART
- types of cooling
- rotor
- stator
- slip ring
- brush assembly
- diode rectification pack
- voltage regulation
- cooling fan
- phased winding connections
- three phase output

(K8.2) starters

- ignition/starter switch
- solenoid
- inertia

- pre-engaged
- ring gear
- pinion
- one-way clutch
- gear reduction

Learning outcome

K9 Auxiliary electrics

Assessment criteria

The apprentice will have knowledge of:

K9.1 relays
K9.2 engine cooling fans
K9.3 telematics and ICE systems and components
K9.4 radio frequencies

Range

(K9.1) relays

- normally open
- normally closed
- pin configuration
- relay protection
- purpose and operation

(K9.2) engine cooling fans

- operation (mechanical and electrical/electronic)
- layout and location

(K9.3) telematics and I.C.E. systems and components

- radios
- CD and multiplay units
- DVD players
- MP3 players
- speakers
- aerial systems
- amplifiers
- VDU screens
- SAT/NAV communication units

(K9.4) knowledge of radio frequencies

- analogue
- Digital Audio Broadcasting (DAB)
- factors affecting performance

Learning outcome

K10 Ignition systems

Assessment criteria

The apprentice will have knowledge of:

K10.1 layout of distributor ignition systems
K10.2 coils
K10.3 spark plugs

Range

(K10.1) layout of distributor ignition systems

- ignition terminology
- dwell angle/dwell variations
- ignition timing advance and retard systems
- dynamic and static ignition timing

(K10.2) coils

- voltages (low tension/high tension)
- principles of a coil
- safety
- oscilloscope patterns
- mapping
- advance and retard

(K10.3) spark plugs

- reach
- heat range
- electrode features
- electrode polarity

Learning outcome

K11 Transmission drivelines

Assessment criteria

The apprentice will have knowledge of:

K11.1 the layout and construction of drive shafts used in front wheel, rear wheel and four-wheel drive systems
K11.2 stresses applied to shafts
K11.3 wheel bearing arrangements (non-driven and driven)
K11.4 axles

Range

(K11.1) layout and construction of drive shafts

- constant velocity joints
- universal joints
    - flexible couplings
    - sliding joints

(K11.2) stresses applied to shafts

- torsional
- bending
- shear

(K11.3) wheel bearing arrangements

- roller
- taper roller
- needle
- ball
- plain

(K11.4) axles

- fully floating
- three quarter floating
- semi floating

Intermediate diagnosis and repair

Supporting Information for performance criteria

Unit guidance

This unit needs in-depth knowledge of vehicle systems in order to carry out two stage removal and replacement activities and Intermediate Diagnosis Repair Procedures.

For performance criteria 1 and 2 the apprentice will be able to:

- select suitable sources of technical information to support two stage removal activities for intermediate diagnosis and repair:
    - vehicle technical data
    - intermediate diagnostic test procedures
- use sufficient information in a systematic way to enable two stage removal activities for intermediate diagnosis and repair for:
    - faulty engine system units and components
    - faulty chassis system units and components
    - faulty driveline units and components
    - faulty auxiliary electrical system units and components
- select the appropriate tools and equipment necessary for intermediate diagnosis and repair
- use the equipment required, correctly and safely throughout all intermediate diagnosis and repair
- use repair and replacement methods that are relevant to the symptoms presented
- evaluate their assessment of dismantled sub-assemblies and identify their condition and suitability for repair or replacement accurately
- carry out all intermediate diagnosis and repair and replacement activities following:
    - manufacturers' instructions
    - recognised researched repair methods
    - workplace procedures
    - health and safety requirements
- ensure all repaired or replacement components and units conform to the vehicle operating specification and any legal requirements
- adjust components and units correctly to ensure that they operate to meet system requirements
- use testing methods that are suitable for assessing the performance of the system rectified
- ensure the rectified light vehicle engine system performs to the vehicle operating specification and any legal requirements
- complete all system diagnostic activities within the agreed timescale

Supporting information for knowledge requirements to include:

(K10.1) Distributor ignition systems

- operation of system components:
    - condenser
    - rotor arm
    - ignition leads
    - contact set / points

6 Training towards Gateway 3

Introduction

At **Gateway 3** the apprentice will need to have confirmation that they are sufficiently demonstrating workplace behaviours at the required standard before they are able to continue onto the end point assessment.

Training towards **Gateway 3** will cover:

- Complex diagnosis and repair
- Complete systems understanding and repair major components

This section outlines the required standard for each topic

Complex diagnosis and repair

Performance criteria

The apprentice can:

P1 complete a wide range of repairs that involve complex procedures, or in depth knowledge

P2 identify causes of common faults associated with two stage removal and replacement and recommend suitable further actions

P3 use current flow diagrams and electrical test equipment to carry out standard diagnostic and repair procedures

P4 use diagnostic, mechanical and electrical, measuring equipment

P5 follow a logical diagnostic sequence

Range

(P1.5) follow a logical diagnostic sequence

- carries out tests on components based only on the information available
- makes sound recommendations based on the information found

Learning outcome

K1 Soft skills and behaviours

Assessment criteria

The apprentice will have knowledge of:

K1.1 how to communicate effectively outside their own work environment

K1.2 resolve problems within the workplace

Range

(K1.1) communicate effectively outside their own work environment

- first impressions
- listening skills
- eye contact and smiling
- showing interest and concern
- questioning techniques and customer understanding
- giving clear non-technical explanations

(K1.2) resolve problems within the workplace

- types of problems that may occur
- identifying problems
- ways of dealing with problems
- how and when to refer problems

Learning outcome

K2 Diagnostic skills

Assessment criteria

The apprentice will have knowledge of:

K2.1 fault finding strategies

K2.2 how to work efficiently to minimise spares used in effecting a repair

Range

(K2.1) fault finding strategies

- how to adopt a methodical approach
- dealing with the unknown
- where to start
- initial assessment

Learning outcome

K3 Electrical systems

Assessment criteria

The apprentice will have knowledge of:

K3.1 electrical terms the meaning of:

a) short circuit
b) bad earth
c) high resistance
d) electrical capacity

K3.2 complex vehicle wiring diagrams

a) electrical and electronic symbols
b) earth and insulated return systems

K3.3 carrying out repairs to wires and connectors

K3.4 multiplex systems

a) principles
b) digital and fibre optic
c) databus types
d) error checking
e) oscilloscope patterns
f) ECU
g) electronic and electrical safety procedures

Range

(K3.3) carrying out repairs to wires and connectors

- terminal connectors
- soldering
- heat shrink

Learning outcome

K4 Auxiliary electrics 2

Assessment criteria

The apprentice will have knowledge of:

K4.1 construction and operation of:

a) displays
b) clock clusters
c) switch fitted to stalk and steering systems

K4.2 security

a) central door lock locking systems
b) door locking actuators
c) solenoids
d) dead locking actuators
e) luggage compartment release solenoids
f) anti-theft modules
g) audible warning units
h) sensing units
i) immobiliser units

K4.3 supplementary restraint and airbag systems

a) clock spring
b) airbag assemblies
c) seatbelt tensioner
d) control units
e) sensors
f) seat belt pre-tensioners
g) warning systems
h) circuit protection
i) safe handling procedures and regulations

K4.4 heater operation and construction

a) fan motors
b) rheostat interfaces
c) electro-valves

d) modules
e) switches
f) heated seats
g) electrically adjusted seats

K4.5 convenience systems
a) electric windows
b) window motor/regulators
c) heated screens
d) mirror operation mechanisms
e) sun roof operation

K4.6 construction and operation of wiper and washer systems
a) motor, (auto and intermittent wash wipe)
b) relays
c) washer motors
d) wiper linkage
e) multifunction relays
f) headlamp wash/wipe

Range

(K4.1) displays, clock clusters and switch fitted to stalk and steering systems
- digital
- analogue
- touch screen
- Head Up Display (HUD)

Learning outcome

K5 Engine inlet systems

Assessment criteria

The apprentice will have knowledge of:

K5.1 construction and purpose of air filtration systems

K5.2 torque and power
a) meaning of volumetric efficiency
b) the effect of volumetric efficiency on engine performance

K5.3 methods used to improve volumetric efficiency
a) turbo-chargers
b) superchargers
c) waste gates

K5.4 disadvantages of pressure charging induction systems

Range

(K5.1) construction and purpose of air filtration systems

- filter types
- air flow design
- intake noise reduction

(K5.3) methods used to improve volumetric efficiency

- turbo-chargers (including variable vane)centrifugal type
- positive displacement type

(K5.4) disadvantages of pressure charging induction systems

- turbo lag
- heat dissipation
- mechanical efficiency
- stress to engine components

Learning outcome

6 Engine sensors

Assessment criteria

The apprentice will have knowledge of:

K6.1 sensors; analogue and digital signal types

- MAP
- air and coolant temperature
- air flow
- throttle potentiometer
- oxygen
- flywheel/camshaft

K6.2 closed/open loop engine management systems

Range

(K6.1) sensors

- MAP (Manifold Absolute Pressure)
- air temperature/coolant temperature
    - PTC
    - NTC
- air flow
    - hot wire
    - film
- exhaust differential pressure
- oxygen
    - pre catalyst
    - post catalyst
- fuel pressure

Learning outcome

K7 Fuel systems

Assessment criteria

The apprentice will have knowledge of:

K7.1 the relative advantages and disadvantages of petrol and diesel engines
K7.2 fuel pressure regulators
K7.3 fuel pump relays
K7.4 mechanical control and electronic control throttle units
K7.5 function and layout of petrol injection systems
K7.6 principles and requirements of compression ignition engines
K7.7 rotary diesel systems

Range

(K7.1) the relative advantages and disadvantages of petrol and diesel engines

- weight
- efficiency
- heat
- torque
- power
- noise/knock

(K7.2) fuel pressure regulators

- electronic
- mechanical

(K7.3) fuel pump relays

- tachometric

- electro-mechanical

(K7.4) mechanical control and electronic control throttle units

- idle speed control
- mechanical governor
- stepper motor
- air control valve

(K7.5) function and layout of petrol injection systems

- single point systems
- multi-point systems
    - sequential
    - simultaneous
- unit injectors
- injection pump
- pump relay

(K7.6) principles and requirements of compression ignition engines

- combustion chambers (direct and indirect injection)
- function and basic operation of diesel fuel injection components
    - fuel pump
    - High Pressure pump
    - fuel filters
    - sedimenters
    - fuel lines – low and high pressures
- injector types (direct and indirect injection):
    - single and multi-hole
    - pintle
- glow plugs
- cold start devices
- fuel cut-off solenoid

(K7.7) rotary diesel systems

- governors
- fuel pipes
- procedures for injection pump timing
- bleeding the system

Learning outcome

K8 Emissions

Assessment criteria

The apprentice will have knowledge of:

K8.1 terms related to hydro-carbon fuels
K8.2 composition of hydro-carbon fuels and air percentages
K8.3 by-products of combustion for different engine conditions and fuel mixtures
K8.4 MOT requirements and current European legislation and regulations
K8.5 engine combustion

Range

(K8.1) terms related to hydro-carbon fuels

- volatility
- calorific value
- flash point
- octane rating
- cetane value

(K8.2) composition of hydro-carbon fuels and air percentages

- hydrogen
- carbon
- nitrogen
- oxygen
- combustion processes
- stoichiometric ratio
- lambda
- weak and rich air/fuel ratios

(K8.3) by-products of combustion for different engine conditions and fuel mixtures

- water vapour (H20)
- nitrogen (N)
- carbon monoxide (CO)
- carbon dioxide (CO2)
- carbon (C)
- hydrocarbon (HC)
- oxides of nitrogen (NOx, NO2,NO)
- particulates

(K8.4) MOT requirements and current European legislation and regulations

- MOT requirements
    - smoke testing
    - catalyst testing
    - BET (Basic Emissions Testing)
- current European legislation and regulations

- Euro 5 and 6
- introduction for reasons of legislation
    - Kyoto Protocol

(K8.5) engine combustion

- flame travel
- pre-ignition
- detonation
- flash point
- fire point
- methods used to reduce emissions to include:
    - Exhaust Gas Recirculation (EGR)
    - low emission fuels
        - low sulphur diesel
        - bio diesel
        - hydrogen
    - AdBlue
        - diesel exhaust additives
    - lean burn technology
    - catalytic converters

Learning outcome

K9 Clutch

Assessment criteria

The apprentice will have knowledge of:

K9.1 the construction and operation of clutches

Range

(K9.1) the construction and operation of clutch

- reasons for fitting
- coil spring clutches
- diaphragm spring clutches
- single plate clutches
- multi-plate clutches
    - wet clutch
    - dry clutch
- mechanical operating mechanisms
- hydraulic operating mechanisms
- master cylinder
- slave cylinders
    - external
    - concentric
- Electronic Gear Selection (EGS) clutch systems
    - twin clutch systems

Learning outcome

K10 Advanced suspension systems

Assessment criteria

The apprentice will have knowledge of:

K10.1 ECU sensors and actuators
K10.2 safety procedures
K10.3 self-levelling suspensions (reasons for fitting)
K10.4 operation of driver controlled and ride controlled systems

Range

(K10.1) ECU sensors and actuators

- electrical inputs
- voltages
- oscilloscope patterns

(K10.2) safety procedures

- jacking procedures

(K10.3) self-levelling suspensions reasons for fitting operation under different conditions

- ride height
- weight distribution
- towing

(K10.4) operation of driver controlled and ride controlled systems

- Driver (passive) controlled
- Hydraulic
- Pneumatic
- Vehicle (active) controlled
- Magnetic damping
- Ride height sensing
- Accelerometers

Learning outcome

K11 Brake hydraulics

Assessment criteria

The apprentice will have knowledge of:

K11.1 requirements of brake fluid
K11.2 terms associated with mechanical and hydraulic braking systems
K11.3 components and operation of master cylinder

K11.4 the principles and components of ABS and EBS systems

Range

(K11.1) requirements of brake fluid

- properties
- boiling point
- potential damage to paint surfaces
- hygroscopic action
- manufacturers' change periods
- fluid classification and rating

(K11.2) terms associated with mechanical and hydraulic braking systems

- braking efficiency
- brake fade
- brake balance

(K11.3) components and operation of master cylinder

- vacuum pumps
- servo
- proportioning valve
- load sensing pressure valve

(K11.4) the principles and components of ABS and EBS systems

- ECU
- speed sensors
- pump and valves
- warning lights

Learning outcome

K12 Stability

Assessment criteria

The apprentice will have knowledge of:

K12.1 operation of stability and traction control systems

Range

(K12.1) operation of stability and traction control systems

- speed sensors
- yaw control
- gyroscopic forces
- control systems

Learning outcome

K13 Climate control

Assessment criteria

The apprentice will have knowledge of:

K13.1 air conditioning mechanical components and operation

K13.2 electronic climate control

Range

(K13.1) air conditioning mechanical components and operation

- compressors
- condensers
- receiver-driers
    - accumulators
- connections
- valves
- hoses
- thermostats
- refrigerants
- comfort control systems
- internal heater systems

(K13.2) electronic climate control

- control panel
- sunlight sensors
- internal/external temperature sensors
- servomotors

Complex diagnosis and repair

Supporting Information for performance criteria

Unit guidance

This unit is about the complex diagnosis and repair of vehicle systems using test equipment in order to carry out repair activities. The focus is on a logical method of fault finding.

For **performance criteria 1 to 5** the apprentice will be able to:

- select suitable sources of technical information to support light vehicle complex diagnostic and repair activities including:
    - vehicle technical data
    - diagnostic test procedures
- use sufficient diagnostic information in a systematic way to enable an accurate complex diagnostic and repair of:
    - engine system faults
    - chassis system faults
    - clutch system faults
    - auxiliary electrical system faults
- select the appropriate tools and equipment necessary for complex diagnostic and repair activities
- ensure that equipment has been calibrated to meet manufacturers' and legal requirements
- use the equipment required, correctly and safely throughout all complex diagnostic and repair activities
- use diagnostic methods that are relevant to the symptoms presented
- evaluate your assessment of dismantled sub-assemblies and identify their condition and suitability for repair or replacement accurately
- carry out all complex diagnostic and repair activities following:
    - manufacturers' instructions
    - recognised researched repair methods
    - workplace procedures
    - health and safety requirements
- dismantle, components and systems using appropriate equipment and procedures
- assess, examine and evaluate the operation, settings, values, condition and performance of components and systems
- identify probable faults, malfunctions and incorrect settings
- follow rectification or replacement procedures
- check the operation of systems following complex diagnosis and repair to confirm operation and performance.
- use appropriate complex diagnostic and repair tools and equipment including:
    - multi-meters
    - oscilloscope
    - pressure gauges
    - scanners/code readers
    - computer interface

Supporting Information for knowledge requirements:

(K5.1) filter types and air intake construction

- paper element
- polyester filter
- pleated filter
- High Efficiency Particulate Arrestance (HEPA) filters
- washable filters
- resonator boxes

(K7.5) petrol injection systems

- Gasoline Direct Injection (GDI)
- indirect injection

Complete systems understanding and repair major components

Performance criteria

The apprentice will have the competence to:

P1.1 apply advanced diagnostic principles and logical problem-solving techniques, supported by diagnostic tools and testing regimes, to establish electrical, mechanical and electronic faults

P1.2 use appropriate recommended diagnostic techniques across all systems

P1.3 interpret a wide range of diagnostic information and confirm system serviceability using suitable test instruments

Skills criteria

S1 Differential and gearbox

Assessment criteria

The apprentice will have the skills to:

S1.1 carry out procedures used for inspecting testing and rebuilding differentials and gearboxes including:

a) leaks
b) gear selection
c) synchromesh operation
d) abnormal noise
e) electrical and hydraulic systems

Skills criteria:

S2 Engine mechanical

Assessment criteria

The apprentice will have the skills to:

S2.1 carry out restoration and repair

S2.2 assess the condition of engine mechanical components

S2.3 measuring for wear and serviceability including

a) cylinder bores
b) crankshaft journals

Learning outcome

K1 Differential

Assessment criteria

The apprentice will have knowledge of:

K1.1 calculating final drive gear ratios and calculate the overall gear ratio from given data
K1.2 the construction and operation of final drive units and reasons for fitting

---

Range

(K1.1) calculate the final drive gear ratios and the overall gear ratio from given data

- final drive gear ratio =driven gear/drive gear
- overall gear ration = tyre circumference/final drive gear drive ratio

(K1.2) the construction and operation of final drive units and reasons for fitting:

- crown wheel and pinion
  - bevel gears
  - hypoid gears
  - helical gears
- differential gears
  - sun and planet gears
- lubricants required
- bearings and seals
- limited slip differential
- third differential
- differential locks
- traction control systems
- launch control systems

Learning outcome

K2 Manual gearboxes

Assessment criteria

The apprentice will have knowledge of:

K2.1 reasons for fitting gearboxes
K2.2 calculating gear ratios and driving torque for typical gearbox specifications
K2.3 transverse and inline layouts
K2.4 layout and construction of gears and shafts for 4, 5 and 6 speed gearbox designs
K2.5 procedures used for inspecting, testing and rebuilding gearboxes

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Range

(K2.1) reasons for fitting gearboxes

- torque multiplication
- engine efficiencies
- direction of vehicle travel

(K2.2) calculating gear ratios and driving torque for typical gearbox specifications

- gear ratio = driven/driver
- overall gearbox ratio = driven/driver x driven/driver x driven/driver for the total number of gear trains

(K2.3) transverse and inline layouts

- front engine Front / rear wheel drive
- rear engine rear wheel drive
- mid engine rear wheel drive
- four wheel drive

(K2.4) layout and construction of gears and shafts for 4, 5 and 6 speed gearbox designs

- sliding mesh
- constant mesh
- synchromesh
- reverse gear
- gear selection linkages
- selector forks and rods
- detents and interlock mechanisms
- arrangements for gearbox bearings
- bushes
- oil seals
- gaskets
- gearbox lubrication
- speedometer drive
- electrical and electronic components including reverse lamp switch

(K2.5) procedures used for inspecting, testing and rebuilding gearboxes

- leaks
- gear selection
- synchromesh operation
- abnormal noise

Learning outcome

K3 Engine mechanical

Assessment criteria

The apprentice will have knowledge of:

K3.1 how to calculate compression ratios from given data
K3.2 engine components and layouts
K3.3 rotary engines
K3.4 how to restore and repair

Range

(K3.1) how to calculate compression ratios from given data

- compression ratio=volume at BDC/volume at TDC

(K3.2) engine components and layouts

- single (OHC) and multi camshaft (DOHC) arrangements
- single and multi-cylinder (2,4,6, 8 cylinder) types
- cylinder head layout and design
  - cross flow porting
  - Siamese porting
- combustion chamber
  - bath tub
  - hemispherical
  - wedge
  - pent roof
- piston design
  - concave
  - convex
  - flat
  - skirt types
  - fully and semi floating
- layout and operation of multi-valve engines
  - 2, 3, 4,5 valves per cylinder
  - hydraulic actuation
  - mechanical actuation
  - electronic actuation
- variable valve timing and the effect on performance
  - camshaft operation
  - actuation to include electro-hydraulic/mechanical/electronic
  - characteristics to include torque/economy/power

(K3.3) rotary engines

- advantages

- disadvantages
- rotor
- eccentric shaft
- housing
- seal

(K3.4) how to restore and repair

- assess engine mechanical components
- measure for wear and serviceability including:
  - cylinder bores – wet and dry liners
  - cylinder heads
  - crankshaft journals
  - valve faces/guides/seats
  - camshaft

Learning outcome

K4 Engine lubrication

Assessment criteria

The apprentice will have knowledge of:

K4.1 terms associated with lubrication and engine oil

K4.2 requirements and features of engine oil

Range

(K4.1) terms associated with lubrication and engine oil

- hydrodynamic
- boundary
- multi-grade
- organic, mineral and synthetic oil
- lubrication grades
- viscosity index
- additives to cover
  - detergents
  - dispersants
  - anti-oxidants
  - inhibitors
  - anti-foaming agents
  - anti-wear

(K4.2) requirements and features of engine oil

- operating temperatures
- pressures
- splash and pressurised systems
- pumps
- pressure relief valve
- filters
  - full flow
  - by-pass
- oil ways
- oil coolers
- wet and dry sump systems

Learning outcome

K5 Automatic transmissions

Assessment criteria

The apprentice will have knowledge of:

K5.1 automatic transmission components
K5.2 methods for achieving different gear ratios
K5.3 Continuously Variable Transmissions (CVT)
K5.4 Sequential Manual Gearbox (SMG)

Range

(K5.1) automatic transmission components

- fluid flywheel
- torque converter
- benefits of torque converter over fluid flywheel
- epicyclic gearing
  - sun
  - planet
  - annulus/carrier

(K5.2) methods for achieving different gear ratios

- hydraulic control systems
- electronic control systems
- epicyclic gearing

(K5.3) continuously variable transmissions (CVT)

- variable pulleys
- infinite number of ratios
- steel belt
- smoother / efficient
- more energy loss due to friction
- allows engine to keep to optimum rev range

(K5.4) sequential manual gearbox (SMG)

- ECU
- sensors and actuators
- electrical inputs and outputs
- voltages
- oscilloscope patterns
- interaction between the electrical/electronic system with hydraulic system and mechanical components
- electronic and electrical safety procedures
- allows for faster gear changes
- power is maintained throughout acceleration

Learning outcome

K6 Alternative fuels and hybrid and electric systems

Assessment criteria

The apprentice will have knowledge of:

K6.1 alternative fuels, hybrid and electric systems

K6.2 health and safety when working with hybrid and electric vehicles,

K6.3 advantages and disadvantages of the different alternative fuels and hybrid and electric systems

K6.4 system layouts

Range

(K6.1) alternative fuels

- hydrogen
- Liquid Petroleum Gas (LPG)
- vegetable based fuels (Bio Diesel)

(K6.2) health and safety

- industry standards and regulations
- the importance of isolating high voltage systems

(K6.3) advantages

- emissions
- environmental
- legislation/road tax/government grants
- running costs

(K6.3) disadvantages

- range
- availability of charging points
- initial cost
- battery life
- parallel/ mild parallel
- series
- power split
- dual- Hybrid4

(K6.4) system layouts

- charging systems
    - internal and external charging
    - Fast / slow charging
- regeneration brakes
- battery types
    - Nickel metal hydride
    - Lithium Ion
    - Lead acid (AGM)

Complete systems understanding and repair major components

Supporting Information for performance criteria

Unit guidance

For **performance criteria 1 and 2** the apprentice will be able to:

- use diagnostic methods that are relevant to the symptoms presented
- evaluate their assessment of dismantled sub-assemblies and identify their condition and suitability for repair or replacement accurately
- carry out all diagnostic and rectification activities following:
    - manufacturers' instructions
    - recognised researched repair methods
    - workplace procedures
    - health and safety requirements
- ensure all repaired or replacement components and units conform to the vehicle operating specification and any legal requirements
- adjust components and units correctly to ensure that they operate to meet system requirements
- use testing methods that are suitable for assessing the performance of the system rectified
- ensure the rectified engine system performs to the vehicle operating specification and any legal requirements
- complete all system diagnostic activities within the agreed timescale
- produce work records that are accurate, complete and passed to the relevant person(s) promptly in the format required
- make suitable and justifiable recommendations for cost effective repairs
- identify and report any expected delays in completion to the relevant person(s) promptly in the format required
- record and report any additional faults noticed during the course of their work promptly in the format required.

For **performance criteria 2.1:**

- procedures used when inspecting engines
- procedures to assess:
    - serviceability
    - wear
    - condition
    - clearances
    - settings

For **performance criteria 4.2**:

- advantages and disadvantages of wet and dry sump systems

Supporting Information for knowledge requirements

(K2.2) example calculation of calculating an over gear ration from given data:

- Example calculation for a single pair of gears : 40/120 X 20/80 = 80/9600 or 1/12 which equals 1:12 or 0.833:1

(K3.1) calculate compression ratios from given data:

- to accurately calculate compression ratio the following must be noted:
    - bore of the cylinder
    - stroke of the piston
    - volume of the combustion chamber

Appendix 1 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the **Centres and Training Providers homepage** on **www.cityandguilds.com**.

City & Guilds Centre Manual

This document provides guidance for organisations wishing to become City & Guilds approved centres, as well as information for approved centres delivering City & Guilds qualifications. It covers the centre and qualification approval process as well as providing guidance on delivery, assessment and quality assurance for approved centres.

It also details the City & Guilds requirements for ongoing centre and qualification approval, and provides examples of best practice for centres. Specifically, the document includes sections on:

- the centre and qualification approval process
- assessment, internal quality assurance and examination roles at the centre
- registration and certification of candidates
- non-compliance and malpractice
- complaints and appeals
- equal opportunities
- data protection
- management systems
- maintaining records
- internal quality assurance
- external quality assurance

Our Quality Assurance Requirements

This document explains the requirements for the delivery, assessment and awarding of our qualifications. All centres working with City & Guilds must adopt and implement these requirements across all of their qualification provision. Specifically, this document:

- specifies the quality assurance and control requirements that apply to all centres
- sets out the basis for securing high standards, for all our qualifications and/or assessments
- details the impact on centres of non-compliance

The **centre homepage** section of the City & Guilds website also contains useful information on

Walled Garden: how to register and certificate candidates on line
Events: dates and information on the latest Centre events
Online assessment: how to register for e-assessments

Useful contacts

UK learners General qualification information	**E: learnersupport@cityandguilds.com**
International learners General qualification information	**E: intcg@cityandguilds.com**
Centres Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	**E: centresupport@cityandguilds.com**
Single subject qualifications Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	**E: singlesubjects@cityandguilds.com**
International awards Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	**E: intops@cityandguilds.com**
Walled Garden Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	**E: walledgarden@cityandguilds.com**
Employer Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 **E: business@cityandguilds.com**

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About City & Guilds

As the UK's leading vocational education organisation, City & Guilds is leading the talent revolution by inspiring people to unlock their potential and develop their skills. We offer over 500 qualifications across 28 industries through 8500 centres worldwide and award around two million certificates every year. City & Guilds is recognised and respected by employers across the world as a sign of quality and exceptional training.

City & Guilds Group

The City & Guilds Group is a leader in global skills development. Our purpose is to help people and organisations to develop their skills for personal and economic growth. Made up of City & Guilds, City & Guilds Kineo, The Oxford Group and ILM, we work with education providers, businesses and governments in over 100 countries.

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