

Unit 14: Light Vehicle Suspension, Steering and Braking Systems

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

Advances in engine and transmission design mean that modern vehicles have an increased need for suspension, steering and braking technology that can cope with the forces associated with modern vehicle performance.

Some suspension systems have different modes for the driver to select according to personal demands or that of the terrain. The most sophisticated suspension systems can self level, have yaw control and adjust to the type of terrain being encountered.

Steering systems are now mostly power-assisted, in some cases to counter the effects of wider tyres and suspension that has been set to enhance the vehicle's road holding. Most tyres are now low profile in order to ensure that performance, control and stability are maximised.

Sports vehicles, family saloons, multi-purpose vehicles, off-road vehicles, passenger service vehicles and haulage vehicles all require different things from these systems in order to perform well in the environment for which they are intended. It is vital that these systems interrelate with, and complement each other to ensure maximum comfort and safety of the driver and passengers.

This unit will give learners a knowledge of the operating principles of light vehicle suspension, steering and braking systems enabling them to carry out inspection and fault-finding on these systems. Learners will develop an understanding of the main system components and their relationship to the efficient operation of the vehicle.

Learning outcomes

On completion of this unit a learner should:

- 1 Know about the function and operation of different types of suspension systems
- 2 Know about the function and operation of steering system components
- 3 Know about the function and operation of vehicle braking system components
- 4 Be able to carry out inspection and fault-finding procedures on steering, braking and suspension systems.

Unit content

1 Know about the function and operation of different types of suspension systems

Suspension systems: types of independent front suspension eg unequal length wishbones, transverse link and strut; types of independent rear suspension eg trailing arm, pure and semi, unequal transverse links, transverse link and strut, air suspension; dampers (construction, operation and typical faults); suspension requirements eg sprung weight, unsprung weight; impact of chassis design on suspension type eg ladder, monocoque, space frame, welded shell constructions

Adaptive suspension system main components: ECU; regulator; solenoid valve; sensors; dampers; system operation

2 Know about the function and operation of steering system components

Power-assisted steering main components: hydraulic pump; control valve; power cylinder; reservoir; filter; pressure relief valve; pipes; steering gear; types eg integral, semi-integral, rack and pinion, worm and follower, speed sensitive

Steering characteristics: understeer; oversteer; neutral steer; roll axis; roll centre; centre of gravity

Road wheels: wheel type eg alloy (cast or forged), steel, well based, specialist (such as wire spoke, flat-edge, double hump, divided, detachable flange); rim codes; wheel retention methods

Tyres: types of tyres eg belt and brace construction, ply construction; tyre profile and tyre markings eg width, aspect ratio, type of construction, load index, speed index, ply ratings, direction indicators; applications eg high performance, light/heavy vehicles, motorcycle, agriculture, industrial; valve types

3 Know about the function and operation of vehicle braking system components

Main components: types of system eg single piston disc brakes, multi-piston disc brakes; brake fluid characteristics; brake bleeding componentry; brake pad warning systems; types of brake circuits (construction and operation) eg tandem master cylinders, vacuum servo units, pressure apportioning valves

Anti-lock braking systems main components: wheel speed sensors; ECU; system modulator; reservoir; electronic control system

4 Be able to carry out inspection and fault-finding procedures on steering, braking and suspension systems

Fault-finding: identification of typical faults and corrective action to be taken for each of the above systems; adjustment and servicing of the main components for each of the systems; protection of units against the usual hazards during use or fault-finding; safe working practice

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describes the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<p>P1 describe the function and operation of two independent front and two independent rear vehicle suspension systems, including suspension requirements and the impact of chassis design</p> <p>P2 describe the function and operation of the main components of an adaptive suspension system</p> <p>P3 describe the function and operation of the main components of power assisted steering</p> <p>P4 distinguish between understeer, oversteer and neutral steering characteristics, vehicle roll axis, roll centre and centre of gravity</p>	<p>M1 compare the relative advantages and disadvantages of an adaptive suspension systems and one other type of suspension system</p> <p>M2 explain the effect of understeer, oversteer and neutral steering characteristics, vehicle roll axis, roll centre and centre of gravity on wheel/tyre function and operation.</p>	<p>D1 evaluate two different braking system applications for efficiency and safety when used in conjunction with an anti-lock braking system.</p>

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<p>P5 explain the functional differences between two different wheel and tyre combinations</p> <p>P6 describe the function and operation of the components found in a given type of braking systems and in an anti-lock braking system</p> <p>P7 carry out basic fault-finding on a suspension system to check for satisfactory operation and produce a list of the faults found and state the corrective action to be taken</p> <p>P8 carry out basic fault-finding on a steering system to check for satisfactory operation and produce a list of the faults found and state the corrective action to be taken</p> <p>P9 carry out basic fault-finding on a braking system to check for satisfactory operation and produce a list of the faults found and state the corrective action to be taken.</p>		

Essential guidance for tutors

Delivery

Delivery of this unit should ensure that learners have a thorough understanding of steering, suspension and braking system components and their interrelationship with each other.

Wherever possible, learners should carry out practical investigations of components, and a balance of theoretical and practical study is recommended. Systems and operating principles should be demonstrated using rigs, units and components. Safe working practices should be emphasised in any practical training programme. Learners should have access to appropriate information sources (eg manufacturer's manuals and data books, CD ROM-based technical data, online sources) and tools and equipment.

There is no defined order of delivery but it is recommended that learning outcomes 1, 2 and 3 are delivered before learning outcome 4, as learners need to apply knowledge gained within the first three.

While a detailed understanding of the main types of suspension systems is required for learning outcome 1, emphasis should be placed on the adaptive system and its main components.

Similarly for learning outcome 2, where a detailed understanding of road wheel and tyre characteristics is required, emphasis should be placed on power-assisted steering components and the characteristics of steering such as understeer and oversteer.

Note that the use of 'eg' in the content is to give an indication and illustration of the breadth and depth of the area or topic. As such, not all content that follows an 'eg' needs to be taught or assessed.

Assessment

This unit could be assessed through three written assignments and one practical assignment.

The first written assignment could give learners opportunities to meet the requirements of P1, P2 and M1. A task could be set asking learners to describe the function and operation of two main types of independent front and two types of independent rear vehicle suspension design (P1). Different types of rear suspension could be given to different learners from the range listed within the unit content. The task should ensure that learners cover dampers, the suspension requirements and the impact of chassis design.

For P2, a task should be given asking learners to describe the function and operation of the main components of an adaptive suspension system. The main components that need to be covered are listed within the unit content. A further written task could be set asking learners to carry out the comparison between an adaptive suspension system and one other suspension system (M1).

A second assignment could be given to meet the requirements of P3, P4, P5 and M2.

An initial task, covering P3, could require learners to describe the function of the components in a power-assisted steering system. Tutors can give different types of steering system to different learners.

A second task in this assignment could ask learners to show the differences between the range of steering characteristics in P4.

A third task, covering P5, would again give the opportunity for tutors to give different wheel and tyre combinations to different learners. Consideration should be given to wheel types, rim codes and retention methods, valve and tyre types including profile and markings and applications. A further task could be set asking learners to explain the effect of steering characteristics, vehicle roll axis, roll centre and centre of gravity on wheel/tyre function and operation (M2).

A third written assignment could be used to meet the requirements of P6 and D1. Initially learners could describe the function and operation of the components found in braking systems and anti-lock braking system components (P6). A further task could then be set asking them to evaluate two braking system applications when used in conjunction with an anti-lock braking system (D1). Although the components used in the anti-lock braking system are clearly listed within the unit content tutors can vary what is given to each learner. It is important that the type of system is fully explored and that brake bleeding componentry and brake pad warning systems are considered in the descriptions.

A final practical assignment could be set to meet the requirements of P7, P8 and P9. Learners would need to be given a particular vehicle to carry out a fault-finding exercise on its suspension, steering and braking systems. In doing so learners will need to establish which components are operating satisfactory and which are not. At least one fault in each system must be present to allow corrective action to be identified and at least one main component in each system should require adjustment during the exercise. A record of hazard protection and safe working needs to be made.

Depending on the resources available different learners could work on different vehicles. Evidence for this practical assignment is likely to be in the form of a witness statement/observation record, supplemented by annotated photographs and a list of the faults found and suggested corrective action for each.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The unit contributes towards the knowledge requirements for the following units in the Level 3 Automotive Skills National Occupational Standards for Vehicle Maintenance and Repair:

- Unit MR 04: Remove and Replace Vehicle Chassis Units and Components
- Unit MR 08: Diagnose and Rectify Vehicle Chassis System Faults.

The unit can be linked to *Unit 1: Operation of Vehicle Systems* and *Unit 3: Vehicle Fault Diagnosis and Rectification*.

Essential resources

A range of suspension, steering and braking components and equipment will be required for delivery of this unit. Learners will need access to vehicles in order to carry out fault-finding on the different systems.

Indicative reading for learners

Hillier V and Rogers D – *Fundamentals of Motor Vehicle Technology* (Nelson Thornes, 2007) ISBN 0748784357

Killingsworth J, Godfrey E and Haynes J – *Suspension, Steering and Driveline Manual* (Haynes, 1998) ISBN 1563922932

Nunney N J – *Light and Heavy Vehicle Technology* (Butterworth-Heinemann, 1998) ISBN 0750604778

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> describing the function and operation of two independent front and two independent rear vehicle suspension systems including suspension requirements and the impact of chassis design describing the function and operation of an adaptive suspension system's main components describing the function and operation of the main components of power assisted steering explaining the functional differences between two different wheel and tyre combinations describing the function and operation of the components found in a given type of braking system and in an anti-lock braking system. 	<p>C3.2 Read and synthesise information from at least two documents about the same subject.</p> <p>Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write two different types of documents each one giving different information about complex subjects.</p> <p>One document must be at least 1000 words long.</p>
Problem solving Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> carrying out basic fault-finding on suspension, steering and braking systems to check for satisfactory operation. 	<p>PS3.2 Plan and implement at least one way of solving the problem.</p>