

Pearson BTEC Level 2 Extended Certificate and Diploma in Vehicle Technology

Specification

First teaching July 2012
Issue 4

Edexcel, BTEC and LCCI qualifications

Edexcel, BTEC and LCCI qualifications are awarded by Pearson, the UK's largest awarding body offering academic and vocational qualifications that are globally recognised and benchmarked. For further information, please visit our qualifications website at qualifications.pearson.com. Alternatively, you can get in touch with us using the details on our contact us page at qualifications.pearson.com/contactus

About Pearson

Pearson is the world's leading learning company, with 35,000 employees in more than 70 countries working to help people of all ages to make measurable progress in their lives through learning. We put the learner at the centre of everything we do, because wherever learning flourishes, so do people. Find out more about how we can help you and your learners at qualifications.pearson.com

This specification is Issue 4. Key changes are listed in the summary table on the next page. We will inform centres of any changes to this issue. The latest issue can be found on the Pearson website: qualifications.pearson.com

These qualifications were previously known as:

Pearson BTEC Level 2 Extended Certificate in Vehicle Technology (QCF)

Pearson BTEC Level 2 Diploma in Vehicle Technology (QCF)

The QNs remain the same.

References to third party material made in this specification are made in good faith. Pearson does not endorse, approve or accept responsibility for the content of materials, which may be subject to change, or any opinions expressed therein. (Material may include textbooks, journals, magazines and other publications and websites.)

All information in this specification is correct at time of publication.

ISBN 9781446956960

All the material in this publication is copyright
© Pearson Education Limited 2017

Summary of Pearson BTEC Level 2 Extended Certificate and Diploma in Vehicle Technology specification Issue 4 changes

Summary of changes made between previous Issue 3 and this current Issue 4	Page number
All references to 600/4854/2 - Edexcel BTEC Level 2 Certificate in Vehicle Technology (QCF) have been removed from the specification, as this qualification has expired	Throughout
All references to QCF have been removed throughout the specification	Throughout
Definition of TQT added	2
Definition of sizes of qualifications aligned to TQT	3
TQT value added	7, 8
QCF references removed from unit titles and unit levels in all units	26-260
Guided learning definition updated	20

Earlier issue(s) show(s) previous changes.

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Contents

BTEC Level 2 qualification titles covered by this specification	1
What are BTEC Level 2 qualifications?	2
Sizes of BTEC qualifications	2
Pearson BTEC Level 2 Extended Certificate — 30 credits	4
Pearson BTEC Level 2 Diploma — 60 credits	4
Key features of the Pearson BTEC Level 2 Extended Certificate and Diploma in Vehicle Technology	4
National Occupational Standards	5
Rules of combination for Pearson BTEC Level 2 qualifications	6
Pearson BTEC Level 2 BTEC Extended Certificate in Vehicle Technology	7
Pearson BTEC Level 2 Diploma in Vehicle Technology	8
Pearson BTEC Level 2 Diploma in Vehicle Technology (Motorsports)	9
Assessment and grading	10
Grading domains	10
Guidance	10
Calculation of the qualification grade	12
Quality assurance of centres	13
Programme design and delivery	15
Mode of delivery	15
Resources	16
Delivery approach	16
Meeting local needs	16
Functional Skills	17
Personal, learning and thinking skills	17
Access and recruitment	18
Restrictions on learner entry	18
Access arrangements and special considerations	19
Recognition of Prior Learning	19
Unit format	20

Unit title	20
Unit code	20
Level	20
Credit value	20
Guided learning hours	20
Aim and purpose	20
Unit introduction	21
Learning outcomes	21
Unit content	21
Assessment and grading grid	22
Essential guidance for tutors	22

Units **24**

Unit 1: Essential Working Practices for Vehicle Technology	26
Unit 2: Vehicle Electrical and Electronic Principles	42
Unit 3: Engineering Skills for Vehicle Technology	54
Unit 4: Vehicle Component Removal and Refitting Techniques	66
Unit 5: Vehicle Engine Principles and Operation	78
Unit 6: Vehicle Design and Operation of Vehicle Systems	88
Unit 7: Vehicle System Fault Diagnosis	98
Unit 8: Function and Operation of Vehicle Electrical Systems and Components	112
Unit 9: Routine Vehicle Maintenance Techniques	124
Unit 10: Vehicle Science and Mathematics	136
Unit 11: Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	152
Unit 12: Operation and Repair of Vehicle Braking Systems	166
Unit 13: Inspection and Replacement of Vehicle Exhaust Systems	178
Unit 14: Non-Structural Vehicle Body Repair Processes	190
Unit 15: Preparation and Application of Vehicle Body Foundation Materials	206
Unit 16: Welding and Assembly Techniques for Vehicle Maintenance and Repair	222
Unit 17: Motorsport Vehicle Preparation and Inspection Techniques	234
Unit 18: Stripping and Rebuilding Motorsport Engines	246

Further information and useful publications	261
Professional development and training	262
Annexe A	264
The Pearson BTEC qualification framework for the automotive sector	264
Annexe B	269
Grading domains: BTEC Level 2 generic grading domains	269
Annexe C	271
Personal, learning and thinking skills	271
Annexe D	277
Generic examples of calculating qualification grade above pass grade	277
Points available for credits achieved at different levels and unit grades	277

BTEC Level 2 qualification titles covered by this specification

Pearson BTEC Level 2 Extended Certificate in Vehicle Technology

Pearson BTEC Level 2 Diploma in Vehicle Technology

These qualifications are eligible for public funding as determined by the Department for Education (DfE) under Section 96 of the Learning and Skills Act 2000.

Qualifications eligible and funded for post-16-year-olds can be found on the funding Hub. The Skills Funding Agency also publishes a funding catalogue that lists the qualifications available for 19+ funding.

The Qualification Number (QN) should be used by centres when they wish to seek public funding for their learners. As well as a QN, each unit within the specification also has a unit reference number (URN).

The qualification and unit codes will appear on learners' final certification documentation.

The QNs for the qualifications in this publication are:

Pearson BTEC Level 2 Extended Certificate in Vehicle Technology	600/4342/8
Pearson BTEC Level 2 Diploma in Vehicle Technology	600/4341/6

These qualification titles will appear on learners' certificates. Learners need to be made aware of this when they are recruited by the centre and registered with Pearson.

What are BTEC Level 2 qualifications?

BTEC Level 2 qualifications are undertaken in further education and sixth-form colleges, schools and other training providers, and have been since they were introduced in 1983. Their purpose, approaches to teaching, learning and assessment are established and understood by teaching professionals, employers and learners alike.

BTEC Level 2 qualifications are designed to provide specialist work-related qualifications in a range of sectors. They give learners the knowledge, understanding and skills that they need to prepare for employment. The qualifications also provide career development opportunities for those already in work. Consequently, they provide a course of study for full-time or part-time learners in schools, colleges and training centres.

The qualifications provide much of the underpinning knowledge and understanding for the National Occupational Standards for the sector, where these are appropriate. They are supported by the relevant Standards Setting Body (SSB) or Sector Skills Council (SSC). A number of BTEC Level 2 qualifications are recognised as Technical Certificates and form part of the SASE Apprenticeship Framework. They attract achievement and attainment points that equate to similar-sized general qualifications.

On successful completion of a BTEC Level 2 qualification, learners can progress to or within employment and/or continue their study in the same or related vocational area.

Sizes of BTEC qualifications

For all regulated qualifications, Pearson specify a total number of hours that it is estimated learners will require to complete and show achievement for the qualification – this is the Total Qualification Time (TQT). The TQT value indicates the size of a qualification.

Within the TQT, Pearson identifies the number of Guided Learning Hours (GLH) that we estimate a centre delivering the qualification might provide. Guided learning means activities, such as lessons, tutorials, online instruction, supervised study and giving feedback on performance, that directly involve tutors and assessors in teaching, supervising and invigilating learners. Guided learning includes the time required for learners to complete external assessment under examination or supervised conditions.

In addition to guided learning, other required learning directed by tutors or assessors will include private study, preparation for assessment and undertaking assessment when not under supervision, such as preparatory reading, revision and independent research.

As well as TQT and GLH, qualifications can also have a credit value – equal to one tenth of TQT, rounded to the nearest whole number.

TQT and credit values are assigned after consultation with users of the qualifications.

BTEC qualifications are generally available in the following sizes:

- Award – a qualification with a TQT value of 120 or less (equivalent to a range of 1–12 credits)
- Certificate – a qualification with a TQT value in the range of 121–369 (equivalent to a range of 13–36 credits)
- Diploma – a qualification with a TQT value of 370 or more (equivalent to 37 credits and above).

Pearson BTEC Level 2 Extended Certificate — 30 credits

The 30-credit BTEC Level 2 Extended Certificate covers the key knowledge and practical skills required in the appropriate vocational sector. It offers flexibility and a choice of emphasis through the optional units. It is broadly equivalent to two GCSEs.

The BTEC Level 2 Extended Certificate offers an engaging programme for those who are clear about the area of employment that they wish to enter. These learners may wish to extend their programme through the study of a related GCSE, a complementary NVQ or another qualification. These learning programmes can be developed to allow learners to study complementary qualifications without duplication of content.

For adult learners the BTEC Level 2 Extended Certificate can extend their experience of work in a particular sector. It is a suitable qualification for those wishing to change career or move into a particular area of employment following a career break.

Pearson BTEC Level 2 Diploma — 60 credits

The 60-credit BTEC Level 2 Diploma extends the specialist work-related focus of the BTEC Level 2 Extended Certificate. There is potential for the qualification to prepare learners for employment in the appropriate vocational sector and it is suitable for those who have decided that they wish to enter a particular area of work. It is broadly equivalent to four GCSEs.

Some learners may wish to gain the qualification in order to enter a specialist area of employment or to progress to a Level 3 programme. Other learners may want to extend the specialism they studied on the BTEC Level 2 Extended Certificate programme.

Key features of the Pearson BTEC Level 2 Extended Certificate and Diploma in Vehicle Technology

The BTEC Level 2 qualifications in Vehicle Technology have been developed in the engineering sector to:

- provide education and training for vehicle engineering employees
- provide employees working in the vehicle technology sector with opportunities to achieve a nationally recognised Level 2 vocationally specific qualification
- provide full-time learners with the opportunity to enter employment in the Vehicle Technology sector or to progress to vocational qualifications such as the Pearson BTEC Level 3 Nationals in Engineering
- provide learners with the opportunity to develop a range of skills and techniques, personal skills and attributes essential for successful performance in working life.

National Occupational Standards

BTEC Level 2 qualifications are designed to provide much of the underpinning knowledge and understanding for the National Occupational Standards (NOS), as well as developing practical skills in preparation for work and possible achievement of NVQs in due course. NOS form the basis of National Vocational Qualifications (NVQs). BTEC Level 2 qualifications do not purport to deliver occupational competence in the sector, which should be demonstrated in a work context.

Each unit in the specification identifies links to elements of the NOS.

Rules of combination for Pearson BTEC Level 2 qualifications

The rules of combination specify the:

- total credit value of the qualification
- the minimum credit to be achieved at the level or above the level of the qualification
- the mandatory unit credit
- the optional unit credit
- the maximum credit that can come from other BTEC units at level 2 or above
- When combining units for a BTEC Level 2 qualification, it is the centre's responsibility to ensure that the following rules of combination are adhered to.

Pearson BTEC Level 2 Extended Certificate in Vehicle Technology

- 1 Qualification credit value: a minimum of 30 credits.
- 2 Minimum credit to be achieved at, or above, the level of the qualification: 30 credits.
- 3 Mandatory unit credit: 10 credits
- 4 Optional unit credit: 20 credits

No credits can be used to meet local needs.

Pearson BTEC Level 2 Diploma in Vehicle Technology

- 1 Qualification credit value: a minimum of 60 credits.
- 2 Minimum credit to be achieved at, or above, the level of the qualification: 60 credits.
- 3 Mandatory unit credit:
 - unendorsed pathway: 20 credits
 - motorsports endorsed pathway: 25 credits

Optional unit credits:

- unendorsed pathway: 40 credits
- motorsports endorsed pathway: 35 credits

A maximum of **10 optional** credits can come from other BTEC units at level 2 or above to meet local needs.

Centres should be aware that some BTEC Level 2 units are 'pass only' and therefore may affect the learner's overall grade.

Pearson BTEC Level 2 BTEC Extended Certificate in Vehicle Technology

The Pearson BTEC Level 2 Extended Certificate in Vehicle Technology is a 30-credit and 180-guided learning hour qualification. Learners must achieve 10 credits from the two mandatory units and a minimum of 20 credits from the optional units.

The Total Qualification Time (TQT) for this qualification is 300.

Pearson BTEC Level 2 Extended Certificate in Vehicle Technology			
Unit	Mandatory units	Credit	Level
5	Vehicle Engine Principles and Operation	5	2
6	Vehicle Design and Operation of Vehicle Systems	5	2
Optional units			
2	Vehicle Electrical and Electronic Principles	5	2
3	Engineering Skills for Vehicle Technology	5	2
4	Vehicle Component Removal and Refitting Vehicle Techniques	5	2
8	Function and Operation of Vehicle Electrical Systems and Components	5	2
9	Routine Vehicle Maintenance Techniques	10	2
10	Vehicle Science and Mathematics	10	2
11	Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	10	2
12	Operation and Repair of Vehicle Braking Systems	5	2
13	Inspection and Replacement of Vehicle Exhaust Systems	5	2

Pearson BTEC Level 2 Diploma in Vehicle Technology

The Pearson BTEC Level 2 Diploma in Vehicle Technology is a 60-credit and 360-guided learning hour qualification. To achieve the unendorsed pathway, learners must achieve 20 credits from the three mandatory units **and** a minimum 40 credits from the optional units.

The Total Qualification Time (TQT) for this qualification is 600.

Pearson BTEC Level 2 Diploma in Vehicle Technology			
Unendorsed pathway			
Unit	Mandatory units	Credit	Level
1	Essential Working Practices for Vehicle Technology	10	2
2	Vehicle Electrical and Electronic Principles	5	2
3	Engineering Skills for Vehicle Technology	5	2
Optional units			
4	Vehicle Component Removal and Refitting Techniques	5	2
5	Vehicle Engine Principles and Operation	5	2
6	Vehicle Design and Operation of Vehicle Systems	5	2
7	Vehicle System Fault Diagnosis	10	2
8	Function and Operation of Vehicle Electrical Systems and Components	5	2
9	Routine Vehicle Maintenance Techniques	10	2
10	Vehicle Science and Mathematics	10	2
11	Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	10	2
12	Operation and Repair of Vehicle Braking Systems	5	2
13	Inspection and Replacement of Vehicle Exhaust Systems	5	2
14	Non-Structural Vehicle Body Repair Processes	10	2
15	Preparation and Application of Vehicle Body Foundation Materials	10	2
16	Welding and Assembly Techniques for Vehicle Maintenance and Repair	5	2

Pearson BTEC Level 2 Diploma in Vehicle Technology (Motorsports)

The Pearson BTEC Level 2 Diploma in Vehicle Technology (Motorsports) is a 60-credit and 360-guided learning hour qualification.

To achieve the endorsed motorsports pathway, learners must achieve 25 credits from the five mandatory units **and** 35 credits from the motorsports endorsed pathway optional units.

The Total Qualification Time (TQT) for this qualification is 600.

Pearson BTEC Level 2 Diploma in Vehicle Technology (Motorsports)			
Endorsed motorsports pathway			
Unit	Mandatory units	Credit	Level
1	Essential Working Practices for Vehicle Technology	10	2
2	Vehicle Electrical and Electronic Principles	5	2
3	Engineering Skills for Vehicle Technology	5	2
17	Motorsport Vehicle Preparation and Inspection Techniques	5	2
Optional units			
4	Vehicle Component Removal and Refitting Techniques	5	2
5	Vehicle Engine Principles and Operation	5	2
6	Vehicle Design and Operation of Vehicle Systems	5	2
7	Vehicle System Fault Diagnosis	10	2
8	Function and Operation of Vehicle Electrical Systems and Components	5	2
10	Vehicle Science and Mathematics	10	2
18	Stripping and Rebuilding Motorsport Engines	10	2

Assessment and grading

All assessment for BTEC Level 2 qualifications is criterion referenced, based on the achievement of all the specified learning outcomes.

Each unit within the qualification has specified assessment and grading criteria which are to be used for grading purposes. A summative unit grade can be awarded at pass, merit or distinction:

- to achieve a 'pass' a learner must have satisfied **all** the pass assessment criteria
- to achieve a 'merit' a learner must additionally have satisfied **all** the merit grading criteria
- to achieve a 'distinction' a learner must additionally have satisfied **all** the grading distinction criteria.

Grading domains

The assessment and grading criteria are developed in relation to grading domains which are exemplified by a number of indicative characteristics at the level of the qualification.

There are four BTEC Level 2 grading domains:

- application of knowledge and understanding
- development of practical and technical skills
- personal development for occupational roles
- application of generic skills.

Guidance

The purpose of assessment is to ensure that effective learning has taken place to give learners the opportunity to:

- meet the assessment and grading criteria and
- achieve the learning outcomes within the units.

All the assignments created by centres should be reliable and fit for purpose, and should be built on the unit assessment and grading criteria. Assessment tasks and activities should enable learners to produce valid, sufficient and reliable evidence that relates directly to the specified criteria. Centres should enable learners to produce evidence in a variety of different forms including written reports, graphs, posters, along with projects, performance observation and time-constrained assessments.

Centres are encouraged to emphasise the practical application of the assessment and grading criteria, providing a realistic scenario for learners to adopt, and making maximum use of practical activities and work experience. The creation of assignments that are fit for purpose is vital to achievement and their importance cannot be over-emphasised.

The assessment and grading criteria must be clearly indicated on the fit for purpose assignments. This gives learners focus and helps with internal verification and standardisation processes. It will also help to ensure that learner feedback is specific to the assessment and grading criteria.

When looking at the unit assessment and grading criteria grids and designing assignments, centres are encouraged to identify common topics and themes.

The units include guidance on appropriate assessment methodology. A central feature of vocational assessment is that it allows for assessment to be:

- current, i.e. to reflect the most recent developments and issues
- local, i.e. to reflect the employment context of the delivering centre
- flexible to reflect learner needs, i.e. at a time and in a way that matches the learner's requirements so that they can demonstrate achievement.

Calculation of the qualification grade

Pass qualification grade

Learners who achieve the minimum eligible credit value specified by the rule of combination will achieve the qualification at pass grade (see *Rules of combination for Pearson BTEC Level 2 qualifications*).

Qualification grades above pass grade

Learners will be awarded a merit or distinction or distinction* qualification grade by the aggregation of points gained through the successful achievement of individual units. The number of points available is dependent on the unit level and grade achieved, and the credit size of the unit (as shown in the 'points available for credits achieved at different levels and unit grades' below).

Points available for credits achieved at different levels and unit grades

The table below shows the **number of points scored per credit** at the unit level and grade.

Unit level	Points per credit		
	Pass	Merit	Distinction
Level 1	3	4	5
Level 2	5	6	7
Level 3	7	8	9

Learners who achieve the correct number of points within the ranges shown in the 'qualification grade' table will achieve the qualification merit or distinction or distinction* grade.

Qualification grade

Qualification	Points range above pass grade		
	Merit	Distinction	Distinction*
BTEC Level 2 Certificate	85-94	95-99	100 and above
BTEC Level 2 Extended Certificate	170-189	190-199	200 and above
BTEC Level 2 Diploma	340-379	380-399	400 and above

Please refer to *Annexe D* for examples of calculation of qualification grade above pass grade.

Quality assurance of centres

Pearson's qualification specifications set out the standard to be achieved by each learner in order to be awarded the qualification. This is covered in the statement of learning outcomes, and assessment and grading criteria in each unit. Further guidance on delivery and assessment is given in the *Essential guidance for tutors* section in each unit. This section is designed to provide additional guidance and amplification related to the unit to support tutors, deliverers and assessors and to provide for a coherence of understanding and a consistency of delivery and assessment.

Approval

Centres that have not previously offered BTEC qualifications will first need to apply for, and be granted, centre approval before they can apply for approval to offer the programme.

When a centre applies for approval to offer a BTEC qualification they are required to enter into an approvals agreement.

The approvals agreement is a formal commitment by the head or principal of a centre to meet all the requirements of the specification and any linked codes or regulations. Sanctions and tariffs may be applied if centres do not comply with the agreement. Ultimately, this could result in the suspension of certification or withdrawal of approval.

Centres will be allowed 'accelerated approval' for a new programme where the centre already has approval for a programme that is being replaced by the new programme.

The key principles of quality assurance are that:

- a centre delivering BTEC programmes must be an approved centre and must have approval for programmes or groups of programmes that it is operating
- the centre agrees as part of gaining approval to abide by specific terms and conditions around the effective delivery and quality assurance of assessment; it must abide by these conditions throughout the period of delivery
- Pearson makes available to approved centres a range of materials and opportunities intended to exemplify the processes required for effective assessment and examples of effective standards. Approved centres must use the materials and services to ensure that all staff delivering BTEC qualifications keep up to date with the guidance on assessment
- an approved centre must follow agreed protocols for standardisation of assessors and verifiers; planning, monitoring and recording of assessment processes; and for dealing with special circumstances, appeals and malpractice.

The approach of quality assured assessment is made through a partnership between an approved centre and Pearson. Pearson is committed to ensuring that it follows best practice and employs appropriate technology to support quality assurance processes where practicable. Therefore, the specific arrangements for working with centres will vary. Pearson seeks to ensure that the quality assurance processes that it uses do not place undue bureaucratic processes on centres and works to support centres in providing robust quality assurance processes.

Pearson monitors and supports centres in the effective operation of assessment and quality assurance. The methods which it uses to do this for BTEC Level 2 and Level 3 programmes include:

- ensuring that all centres have completed appropriate declarations at the time of approval, undertaking approval visits to centres where necessary
- requiring all centres to appoint a Lead Internal Verifier for designated groups of programmes and to ensure that this person is trained and supported in carrying out that role
- requiring that the Lead Internal Verifier completes compulsory online standardisation related to assessment and verification decisions for the designated programme
- assessment sampling and verification, through requested samples of assessments, completed assessed learner work and associated documentation
- overarching review and assessment of a centre's strategy for assessing and quality assuring its BTEC programmes.

Pearson Quality Assurance Handbook

Centres should refer to the *UK BTEC Quality Assurance Handbook*, issued annually, for detailed guidance.

An approved centre must make certification claims only when authorised by Pearson and strictly in accordance with requirements for reporting.

Centres that do not fully address and maintain rigorous approaches to quality assurance will be prevented from seeking certification for individual programmes or for all BTEC Level 2 and Level 3 programmes. Centres that do not comply with remedial action plans may have their approval to deliver qualifications removed.

Programme design and delivery

BTEC Level 2 qualifications consist of mandatory units and optional units. Optional units are designed to provide a focus to the qualification and give more specialist opportunities in the sector.

In BTEC Level 2 qualifications each unit has a number of guided learning hours.

Guided learning hours are defined as all the times when a tutor, trainer or facilitator is present to give specific guidance towards the learning aim being studied on a programme. This definition includes lectures, tutorials and supervised study in, for example, open learning centres and learning workshops. It also includes time spent by staff assessing learners' achievements. It does not include time spent by staff in day-to-day marking of assignments where the learner is not present.

Centres are advised to consider this definition when planning the programme of study associated with this specification.

Mode of delivery

Pearson does not define the mode of study for BTEC Level 2 qualifications. Centres are free to offer the qualifications using any mode of delivery (such as full time, part time, evening only, distance learning) that meets their learners' needs. Whichever mode of delivery is used, centres must ensure that learners have appropriate access to the resources identified in the specification and to the subject specialists delivering the units. This is particularly important for learners studying for the qualification through open or distance learning.

Learners studying for the qualification on a part-time basis bring with them a wealth of experience that should be utilised to maximum effect by tutors and assessors. The use of assessment evidence drawn from learners' work environments should be encouraged. Those planning the programme should aim to enhance the vocational nature of the qualification by:

- liaising with employers to ensure a course relevant to learners' specific needs
- accessing and using non-confidential data and documents from learners' workplaces
- including sponsoring employers in the delivery of the programme and, where appropriate, in the assessment
- linking with company-based/workplace training programmes
- making full use of the variety of experience of work and life that learners bring to the programme.

Resources

BTEC Level 2 qualifications are designed to prepare learners for employment in specific occupational sectors. Physical resources need to support the delivery of the programme and the proper assessment of the learning outcomes and should, therefore, normally be of industry standard. Staff delivering programmes and conducting the assessments should be familiar with current practice and standards in the sector concerned. Centres will need to meet any specific resource requirements to gain approval from Pearson.

Where specific resources are required these have been indicated in individual units in the *Essential resources* sections.

Delivery approach

It is important that centres develop an approach to teaching and learning that supports the specialist vocational nature of BTEC Level 2 qualifications and the mode of delivery. Specifications give a balance of practical skill development and knowledge requirements, some of which can be theoretical in nature. Tutors and assessors need to ensure that appropriate links are made between theory and practical application and that the knowledge base is applied to the sector. This requires the development of relevant and up-to-date teaching materials that allow learners to apply their learning to actual events and activity within the sector. Maximum use should be made of the learner's experience.

An outline learning plan is included in every unit as guidance which demonstrates one way in planning the delivery and assessment of the unit. The outline learning plan can be used in conjunction with the programme of suggested assignments.

Where the qualification has been designated and approved as a Technical Certificate and forms part of an Apprenticeship scheme, particular care needs to be taken to build strong links between the learning and assessment for the BTEC Level 2 qualification and the related NVQs and Functional Skills that also contribute to the scheme.

Meeting local needs

These qualifications have been developed in consultation with centres and employers and the Sector Skills Councils or the Standards Setting Bodies for the relevant sector. Centres should make maximum use of the choice available to them within the optional units to meet the needs of their learners, and local skills and training needs.

In certain circumstances, units in the Diploma specification might not allow centres to meet a local need. In this situation, Pearson will ensure that the rule of combination allows centres to make use of units at level 2 or above from other standard BTEC specifications. Centres are required to ensure that the coherence and purpose of the qualification is retained and to ensure that the vocational focus is maintained.

These units cannot be used at the expense of the mandatory units.

See Pearson BTEC Level 2 Diploma rule of combination for information about meeting local needs.

Functional Skills

BTEC Level 2 qualifications give learners opportunities to develop and apply Functional Skills.

Functional Skills are offered as stand-alone qualifications at Level 2. See individual units for opportunities to cover ICT, Mathematics and English Functional Skills.

Personal, learning and thinking skills

Opportunities are available to develop personal, learning and thinking skills (PLTS) within a sector-related context. PLTS are identified in brackets after the unit pass criteria to which they are associated. Further opportunities for learners to demonstrate these skills may also be apparent as learners progress throughout their learning.

Access and recruitment

Pearson's policy regarding access to its qualifications is that:

- they should be available to everyone who is capable of reaching the required standards
- they should be free from any barriers that restrict access and progression
- there should be equal opportunities for all wishing to access the qualifications.

Centres are required to recruit learners to BTEC qualifications with integrity. This will include ensuring that applicants have appropriate information and advice about the qualifications and that the qualification will meet their needs. Centres should take appropriate steps to assess each applicant's potential and make a professional judgement about their ability to successfully complete the programme of study and achieve the qualification. This assessment will need to take account of the support available to the learner within the centre during their programme of study and any specific support that might be necessary to allow the learner to access the assessment for the qualification. Centres should consult Pearson's policy on learners with particular requirements.

Centres will need to review the entry profile of qualifications and/or experience held by applicants, considering whether this profile shows an ability to progress to a Level 2 qualification. For learners who have recently been in education, the profile is likely to include one of the following:

- a BTEC Level 1 qualification or a related vocational area
- a standard of literacy and numeracy supported by a general education equivalent to four GCSEs at grade D-G
- other related Level 1 qualifications
- related work experience.

More mature learners may present a more varied profile of achievement that is likely to include experience of paid and/or unpaid employment.

Restrictions on learner entry

Most BTEC Level 2 qualifications are accredited for learners aged 14 years and over.

In particular sectors the restrictions on learner entry might also relate to any physical or legal barriers, for example people working in health, care or education are likely to be subject to police checks.

Access arrangements and special considerations

Equality and fairness are central to our work. Pearson's Equality Policy requires that all learners should have equal opportunity to access our qualifications and assessments and that our qualifications are awarded in a way that is fair to every learner.

We are committed to making sure that:

- learners with a protected characteristic (as defined by the Equality Act 2010) are not, when they are undertaking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve from undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Learners taking a qualification may be assessed in British sign language or Irish sign language where it is permitted for the purpose of reasonable adjustments.

Details on how to make adjustments for learners with protected characteristics are in the policy document Reasonable Adjustment and Special Considerations for BTEC and Edexcel NVQ Qualifications, which are on our website, qualifications.pearson.com

Recognition of Prior Learning

Recognition of Prior Learning (RPL) is a method of assessment (leading to the award of credit) that considers whether a learner can demonstrate that they can meet the assessment requirements for a unit through knowledge, understanding or skills they already possess and so do not need to develop through a course of learning.

Pearson encourages centres to recognise learners' previous achievements and experiences whether at work, home and at leisure, as well as in the classroom. RPL provides a route for the recognition of the achievements resulting from continuous learning.

RPL enables recognition of achievement from a range of activities using any valid assessment methodology. Provided that the assessment requirements of a given unit or qualification have been met, the use of RPL is acceptable for accrediting a unit, units or a whole qualification. Evidence of learning must be sufficient, reliable and valid.

Unit format

All units in Pearson BTEC Level 2 qualifications have a standard format. The unit format is designed to give guidance on the requirements of the qualification for learners, tutors, assessors and those responsible for monitoring national standards.

Each unit has the following sections.

Unit title

This is the formal title of the unit that will appear on the learner's certificate.

Unit code

Each unit is assigned a unit code that appears with the unit title on the Register of Regulated Qualifications.

Level

All units and qualifications have a level assigned to them. The level assigned is informed by the level descriptors defined by Ofqual, the qualifications regulator.

Credit value

In BTEC Level 2 qualifications each unit consists of a credit value; learners will be awarded credits for the successful completion of whole units.

A credit value specifies the number of credits that will be awarded to a learner who has achieved all the learning outcomes of the unit.

Guided learning hours

Guided Learning Hours (GLH) is the number of hours that a centre delivering the qualification needs to provide. Guided learning means activities that directly or immediately involve tutors and assessors in teaching, supervising, and invigilating learners, for example lectures, tutorials, online instruction and supervised study.

Aim and purpose

The aim provides a clear summary of the purpose of the unit and is a succinct statement that summarises the learning outcomes of the unit.

Unit introduction

The unit introduction gives the reader an appreciation of the unit in the vocational setting of the qualification, as well as highlighting the focus of the unit. It gives the reader a snapshot of the unit and the key knowledge, skills and understanding gained while studying the unit. The unit introduction also highlights any links to the appropriate vocational sector by describing how the unit relates to that sector.

Learning outcomes

Learning outcomes state exactly what a learner should 'know, understand or be able to do' as a result of completing the unit.

Unit content

The unit content identifies the breadth of knowledge, skills and understanding needed to design and deliver a programme of learning to achieve each of the learning outcomes. This is informed by the underpinning knowledge and understanding requirements of the related NOS. The content provides the range of subject material for the programme of learning and specifies the skills, knowledge and understanding required for achievement of the pass, merit and distinction grading criteria.

Each learning outcome is stated in full and then the key phrases or concepts related to that learning outcome are listed in *italics* followed by the subsequent range of related topics.

Relationship between content and assessment criteria

The learner must have the opportunity within the delivery of the unit to cover all of the unit content.

It is not a requirement of the unit specification that all of the content is assessed. However, the indicative content will need to be covered in a programme of learning in order for learners to be able to meet the standard determined in the assessment and grading criteria. The merit and distinction grading criteria enable the learner to achieve higher levels of performance in their acquisition of knowledge, understanding and skills.

Content structure and terminology

The information below shows how the unit content is structured and gives the terminology used to explain the different components within the content.

- Learning outcome: this is shown in bold at the beginning of each section of content.
- Italicised sub-heading: it contains a key phrase or concept. This is content which must be covered in the delivery of the unit. Colons mark the end of an italicised sub heading.
- Elements of content: the elements are in plain text and amplify the sub-heading. The elements must be covered in the delivery of the unit. Semi-colons mark the end of an element.
- Brackets contain amplification of elements of content which must be covered in the delivery of the unit.

- 'e.g.' is a list of examples, used for indicative amplification of an element, (that is, the content specified in this amplification could be covered or could be replaced by other, similar material).

Assessment and grading grid

Each grading grid gives the assessment and grading criteria used to determine the evidence that each learner must produce in order to receive a pass, merit or distinction grade. It is important to note that the merit and distinction grading criteria require a qualitative improvement in a learner's evidence and not simply the production of more evidence at the same level.

Essential guidance for tutors

This section gives tutors additional guidance and amplification to aid understanding and a consistent level of delivery and assessment. It is divided into the following sections.

- *Delivery* – explains the content's relationship with the learning outcomes and offers guidance about possible approaches to delivery. This section is based on the more usual delivery modes but is not intended to rule out alternative approaches.
- *Outline learning plan* – the outline learning plan has been included in every unit as guidance and demonstrates one way in planning the delivery and assessment of a unit. The outline learning plan can be used in conjunction with the programme of suggested assignments.
- *Assessment* – gives amplification about the nature and type of evidence that learners need to produce in order to pass the unit or achieve the higher grades. This section should be read in conjunction with the grading criteria.
- *Programme of suggested assignments* – the table shows how the suggested assignments match and cover the assessment grading criteria.
- *Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications* – sets out links with other units within the qualification. These links can be used to ensure that learners make connections between units, resulting in a coherent programme of learning. The links show opportunities for integration of learning, delivery and assessment.
- *Essential resources* – identifies any specialist resources needed to allow learners to generate the evidence required for each unit. The centre will be asked to ensure that any requirements are in place when it seeks approval from Pearson to offer the qualification.
- *Employer engagement and vocational contexts* – gives a short list of agencies, networks and other useful contacts for employer engagement and for sources of vocational contexts.
- *Indicative reading for learners* – gives a list of learner resource material that benchmarks the level of study.
- *Delivery of PLTS* – gives summary references where applicable of the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.
- *Functional Skills* – gives an indication of opportunities for developing functional skills at level two.

Units

Unit 1:	Essential Working Practices for Vehicle Technology	26
Unit 2:	Vehicle Electrical and Electronic Principles	42
Unit 3:	Engineering Skills for Vehicle Technology	54
Unit 4:	Vehicle Component Removal and Refitting Techniques	66
Unit 5:	Vehicle Engine Principles and Operation	78
Unit 6:	Vehicle Design and Operation of Vehicle Systems	88
Unit 7:	Vehicle System Fault Diagnosis	98
Unit 8:	Function and Operation of Vehicle Electrical Systems and Components	112
Unit 9:	Routine Vehicle Maintenance Techniques	124
Unit 10:	Vehicle Science and Mathematics	136
Unit 11:	Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	152
Unit 12:	Operation and Repair of Vehicle Braking Systems	166
Unit 13:	Inspection and Replacement of Vehicle Exhaust Systems	178
Unit 14:	Non-Structural Vehicle Body Repair Processes	190
Unit 15:	Preparation and Application of Vehicle Body Foundation Materials	206
Unit 16:	Welding and Assembly Techniques for Vehicle Maintenance and Repair	222
Unit 17:	Motorsport Vehicle Preparation and Inspection Techniques	234
Unit 18:	Stripping and Rebuilding Motorsport Engines	246

Unit 1:

Essential Working Practices for Vehicle Technology

Unit code: H/502/6741

Level: 2

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to develop the knowledge, skills and understanding needed to work safely in a vehicle workshop, build good working relationships with colleagues and customers and access and use relevant information.

Unit introduction

Motor vehicle repair work is by its nature high risk. The work is often complex and the potential for injury occurs frequently. Exposure to occupational hazards such as noise, dust and potentially dangerous chemicals (for example isocyanate) can also be significant. Most risks can be minimised or eliminated if the relevant people understand and adhere to the requirements of health and safety legislation, good housekeeping procedures and the need to work safely when carrying out everyday working activities. This unit enables learners to understand the essential working practices that cover these areas and will bring relevance to the study of health and safety by approaching it from a hands-on perspective.

The unit also focuses on the requirement of any customer service organisation to ensure that individuals have good working relationships with peers, supervisors, managers and customers. Learners will develop an understanding of the principles of maintaining good working relationships with colleagues, customers and the general public in the working environment by focusing on effective communication and supporting skills. Learners will recognise the reasons for this in terms of customer loyalty and, hence, repeat business.

Finally, the processes involved in ensuring that the customer receives the most efficient service are examined. Accessing information in order to ensure a 'first time fix', recording mechanisms for invoicing or warranty purposes, and the storage of information are just some of the critical aspects studied.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the good housekeeping and health and safety procedures that need to be followed in a motor vehicle workshop
- 2 Be able to work in accordance with the practical and legal considerations affecting the safe maintenance and repair of motor vehicles
- 3 Understand the importance of maintaining positive communication and working relationships with colleagues and customers
- 4 Be able to access and use information, data and documentation for vehicle maintenance and repair.

Unit content

1 **Know the good housekeeping and health and safety procedures that need to be followed in a motor vehicle workshop**

Reducing risks: scope (employees, customers and their property, vehicles); personal and protective equipment e.g. overalls, protective footwear, eye protection; equipment to prevent chemical contamination; safety of customers, their property and vehicle e.g. customer waiting rooms, customer/visitor access to workshop areas, securing valuables left in vehicles, keeping vehicles locked, safe parking of vehicles to avoid damage, use of seat and wing covers, steering wheel protection

Emergency and accident procedures: evacuation procedures; accident and incident reporting; securing accident site

Fire extinguishers: types of fire extinguisher e.g. water, foam, dry powder, CO₂ (carbon dioxide); applications (combustible material, flammable liquids, electrical fires); consequence of incorrect selection

Health and safety issues: legislation applicable to a vehicle workshop environment; employer and employee responsibilities; requirements relating to chemicals and materials handling e.g. Control of Substances Hazardous to Health (COSHH) Regulations, safe disposal of waste materials and components (fluids, filters, batteries, tyres); manual handling; safe use of electrical and pressurised equipment; legal consideration with regard to health and safety regulations when repairing motor vehicles; Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR)

2 **Be able to work in accordance with the practical and legal considerations affecting safe maintenance and repair of motor vehicles**

Safe working practices: use of manufacturers' inspection, maintenance and servicing techniques; preparation of the vehicle e.g. selection and use of jacks, axle stands, vehicle lift, body jigs and alignment equipment, protective covers; isolation of electrical and electronic systems e.g. battery, electronic control unit (ECU), supplementary restraint system (air bag, seatbelt pre-tensioner); safe handling of vehicle components and units e.g. to prevent damage from static discharge, moisture, oil or chemical contamination

Safe use of tools and equipment: basic engineering tools e.g. hammers, spanners, chisels, panel beating tools; electrical leads e.g. care and use of extension leads, precautions for trip hazard and fluid spills; vehicle supports e.g. stands, jacks; specialised vehicle repair equipment e.g. pullers, hydraulic press, tyre removal/replacement equipment, mobile crane, vehicle lift; safety checks for wear, damage and conditions likely to prejudice safety of self, others and vehicles

Legal, legislative and codes of practice: relevance of current motor vehicle legislation for repairing, maintaining and enhancing road vehicles; approved codes of practice with regard to vehicle repairs; legal implications of fitting enhancement or performance equipment to customer vehicles e.g. contravention of construction and use regulations, impact on owner's insurance; concept of contract law (verbal and written contracts)

3 Understand the importance of maintaining positive communication and working relationships with colleagues and customers

Positive communication: company structure; methods of dealing with communication within a company; vehicle parts and service supply chains

Working relationships: good and bad practices e.g. dress, language, timekeeping, personal appearances, behaviour, fulfilling obligations; company image; dealing with a customer complaint; actions in the event of a dispute with a customer or colleague; options available to resolve disputes; importance of teamwork

4 Be able to access and use information, data and documentation for vehicle maintenance and repair

Information: e.g. workshop manuals, technical bulletins, servicing schedules, approved body repair techniques

Data: sources e.g. manuals, online data, CD ROM, microfiche; types e.g. technical data manuals, repair times, tyre pressures

Documentation: documentation for both company and customer purposes e.g. service history sheet, reporting faults, customer's service/repair report; importance of accuracy and record keeping e.g. filing, use of databases; post-repair documentation and warranty procedures

Assessment and grading criteria

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

Assessment and 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:
P1 identify how risks to safety can be reduced	M1 explain methods of assessing and minimising risks to health and safety in the vehicle repair environment	D1 evaluate the health, safety and risk issues involved in a specific workshop situation
P2 describe emergency and accident action procedures used in the workplace	M2 explain the legal implications of a vehicle repair or maintenance procedure	D2 analyse a specific working relationship and identify its strengths and potential improvements.
P3 identify appropriate types of fire extinguisher for four different given applications	M3 compare methods of maintaining effective working relationships with colleagues to those with customers	
P4 identify health and safety issues relevant to a vehicle repair or maintenance environment	M4 compare different methods of accessing information, data and documentation for a vehicle repair or maintenance procedure.	
P5 prepare a vehicle for repair or maintenance using safe working practice [SM4]		
P6 use vehicle workshop tools and equipment safely [SM4]		

Table continues on next page

Assessment and grading criteria		
P7 identify legal and legislative considerations and codes of practice to be taken into account when working on road vehicles		
P8 explain the factors that create positive communication and working relationships with colleagues and customers [EP4]		
P9 access and use the information, data and documentation necessary for vehicle maintenance or repair procedure [IE4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Delivery of this unit should focus on developing a sound understanding of health and safety requirements in the workplace. This should be from a practical perspective but include an awareness of the legal implications of the learner's actions. Delivery should also facilitate learner understanding of the methods of accessing, assessing and using information, data and documentation. The importance of good relationships with colleagues and customers is also an underpinning aspect to the unit. It is recommended that centres maintain a balance of theoretical and practical study. Where possible, the principles and concepts considered should be reinforced through practical investigation and demonstration. It is strongly recommended that some of the delivery takes place in a workshop environment to ensure that learners can relate their studies to an industrial context. Whatever approach is taken it is expected that the learner's experience should be sufficiently varied to give them the underpinning knowledge and skills to enable them to perform safely in an industrial setting.

The learning outcomes are ordered logically and it would be reasonable to develop them sequentially. In this way, the learner will begin to understand health and safety requirements and the consequences of not adhering to them before implementing what they have learned in a practical environment. It should be noted that the work undertaken for learning outcome 2 is intended to give learners an awareness of specific applications of law and legislative processes in a vehicle context and not an in-depth understanding of law in general. This could be achieved by references to suitable extracts or case studies set within a vehicle context.

Finally, the maintenance of positive working relationships and the information, data and documentary processes used in the effective and efficient execution of vehicle repair work will need to be considered. A hands-on approach to these areas would also be recommended (for example use of role play, work-based experiences, observation of practice).

Formative assessment will play an important part in the general development of learners throughout delivery of the unit particularly in aiding achievement at merit and distinction level. Formative assessment and feedback can be used to good effect to encourage learners to develop the comparative, evaluative and analytical skills required.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to unit content, overview of activities and assessment methodology
- describe the methods of reducing risks to employees, customers and vehicles in a motor vehicle workshop
- explain the evacuation procedures to be followed in a vehicle workshop, the correct methods for accident/incident reporting and securing an accident site
- describe the different types of fire that can occur, the corresponding fire extinguishers that can be used on them safely and the consequences of selecting the wrong extinguisher
- describe health and safety issues and requirements that apply in a motor vehicle workshop
- tour of a vehicle workshop to identify potential risks

Individual learner activities:

- investigation of health and safety issues relevant to a vehicle maintenance workshop

Prepare for and carry out Assignment 1: Good Housekeeping and Health and Safety Procedures (P1, P2, P3, M1)

Whole-class teaching:

- describe manufacturer's inspection and maintenance techniques
- explain and demonstrate correct methods for preparing a vehicle for maintenance, isolating electrical systems and safe handling of vehicle components
- explain and demonstrate safe use of maintenance and repair tools and equipment

Practical workshop activities:

- use of safe working practices to prepare vehicles for repair and maintenance
- practise methods for safe use of tools and equipment

Prepare for and carry out Assignment 2: Safe Working in a Motor Vehicle Workshop (P4, P5, P6, D1)

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- ☐ explain the legislation and codes of practice that apply to vehicle maintenance, repair and enhancement
- ☐ explain the potential implications of fitting enhancement equipment to vehicles
- ☐ describe the implications of entering into a verbal or written contract

Individual learner activities:

- ☐ investigation and research of legal considerations to be taken in to account when carrying out vehicle maintenance and repair

Prepare for and carry out Assignment 3: Legal and Legislative Considerations (P7, M2)**Whole-class teaching:**

- ☐ explain typical company structures, good and bad methods of communication within a company and the wider parts and service supply chain
- ☐ explain the factors that can contribute to both good and bad working relationships
- ☐ describe the importance of company image and teamwork
- ☐ explain the best methods of dealing with customer complaints and the actions to take and ways to resolve disputes in the workplace

Small- group work:

- ☐ role play to simulate dealing with customers and colleagues under different circumstances

Individual learner activities:

- ☐ use of case studies of good and bad practice and factors that create positive communication and working relationships

Prepare for and carry out Assignment 4: Positive Communication in the Vehicle Workshop (P8, M3, D2)**Whole-class teaching:**

- ☐ explain the sources, types and uses of information and data required for vehicle maintenance and repair
- ☐ explain and demonstrate use of documentation and accurate record keeping

Practical workshop activities:

- ☐ accessing and using information, data and documentation for vehicle repair and technology

Prepare for and carry out Assignment 5: Vehicle Maintenance and Repair Information and Documentation (P9, M4)

Feedback to learners, unit evaluation and close

Assessment

This unit will benefit from a variety of evidence being gathered to support assessment. For example, the centre may wish to devise tests or set investigative assignments where learners are asked to describe, explain, compare and justify. However, although some of the pass criteria require descriptive evidence, it is not expected that centres will only use tests to achieve this. The unit lends itself to a varied approach and this should be reflected in the assessment strategy wherever possible.

To achieve a pass, learners should demonstrate knowledge, within the scope of employees, customers and their property and vehicles, of how risks to safety can be reduced (P1). This will include personal and protective equipment, the safety of the customer (for example customer waiting rooms, customer/visitor access to workshop areas), their property (for example securing valuables left in vehicles) and their vehicle (for example safe parking of vehicle to avoid damage). Learners must also be able to describe accident and emergency procedures used in the workplace (P2), including evacuation, reporting and securing an accident site and identify appropriate types of fire extinguisher for four different given applications (P3). Examples of fire appliances are given in the unit content but it is not intended to be exhaustive. For example, the simple methods of using a fire blanket or sand are not included but could be used. The three types of fire (combustible material, flammable liquids, electrical fires) need to be covered and this means that the learner will need to choose two different appliances for one type of fire (for example water or fire blanket for types of combustible material fires). This could be achieved through a short test item that lists types of fire in vehicle settings and asks the learner to identify at least four different fire extinguishers that would be suitable.

The three criteria P4, P5 and P6 could be linked together using a suitable vehicle repair task(s). The task(s) would need to allow learners to identify health and safety issues relevant to the vehicle repair or maintenance environment (P4), prepare the vehicle for repair or maintenance using safe working practice (P5) and use vehicle workshop tools and equipment safely (P6). If only one task is used, centres will need to take care that all the required content can be covered.

The legal and legislative aspects (P7) should be appropriate to the work of a motor vehicle technician at this level. It should be related to the areas of their work that legislation and codes of practice will impact on. For example, entering into a verbal contract with a customer requires a basic understanding of contract law. However, it is not expected that learners would be able to write a contract but rather have an awareness of the implications of entering into a contract, both written and verbal.

The final two pass criteria (P8 and P9) require the learner to consider and explain factors that create positive communication and working relationships with colleagues and customers (P8), aligned with how to work with information, data and documentation necessary for a vehicle repair or maintenance procedure (P9). Both criteria lend themselves to practical hands-on applications but, where real work-based evidence is not available, centres may wish to consider role-play and/or case studies to retain relevance to the vehicle industry. Positive communication begins with learners understanding a company structure and the methods of dealing with communication within that company. In this way, learners can begin to interact effectively and begin to

know when to communicate with others. The other aspect to this is a wider appreciation of communication through the vehicle parts and service supply chains. This is essential for the smooth operation of a vehicle repair and maintenance organisation. Communication relies on the ability of the learner to establish working relationships and appreciate both good and bad practices (for example dress, language, timekeeping, personal appearances, behaviour, fulfilling obligations). For many organisations, company image, the ability to deal with customers and teamwork are key to survival in a very competitive arena. The emphasis of assessment should once again be on application and use. An example might be the use of role-play for a customer complaint or for dealing with a dispute with a customer or colleague. The possible options available to resolve the dispute could then be assessed through oral questioning during the debrief with the learner.

When working with information the sources can be varied for criterion P9 and they can contain data. For example, a workshop manual would provide the learner with information on disassembly and reassembly methods but could also provide the data on settings, for example clearances, angles, timings. The important aspects to capture during assessment will be the actual use of documentation for both company and customer purposes (for example for the company it may be the service history sheet or the method of reporting faults to line manager/supervisor in writing; for the customer it may be the service/repair report provided with their invoice that details the work carried out). The most important dimension to this will be the accuracy (and legibility) of records and the ability to access information through good record for example filing, use of databases. The learner should be able to demonstrate a general awareness of post-repair documentation and that associated with warranty procedures within the context of how it impacts on repair and maintenance work.

To achieve a merit, learners should be able to explain methods of assessing and minimising risks to health and safety in the vehicle repair environment (M1). The key aspect of this criterion is the step change from pass to merit. The learner should now be considering the wider working environment and reflecting on the assessment and minimisation of risks. This could be achieved through an extension activity from P1 and P2 or as a stand-alone activity. The learner should also be able to explain the legal implications of a vehicle repair or maintenance procedure (M2). Again, this is a natural extension to the task(s) undertaken for the pass criteria P7. The last two merit criteria are comparative. For criterion M3, the learner is required to compare the methods adopted to maintain effective working relationships with colleagues to those approaches necessary with customers. This is an important step for learners to take as it requires a degree of self-awareness. Second, the learner is required to compare different methods of accessing information, data and documentation for a vehicle repair or maintenance procedure (M4). This is another important step towards independence in terms of the learner's development.

To achieve a distinction, learners should be able to evaluate the health, safety and risk issues involved in a workshop situation and analyse a specific working relationship for its strengths and potential improvements. Both criteria require a high level of independence. The first (D1) could be linked to the task set for P4 – P6 or an alternative opportunity used. The second criterion (D2) will require a detailed study of a working relationship and this could be based on a colleague, a tutor, or a work-based supervisor. The criterion focuses on strengths and potential improvements; therefore there should not be confidentiality issues with respect to negative comments.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1	Good Housekeeping and Health and Safety Procedures	A technician needs to provide a safety briefing for a new member of staff	A written description or information leaflet/poster
P4, P5, P6, D1	Safe Working in a Motor Vehicle Workshop	A technician needs to prepare a vehicle for maintenance and use tools and equipment safely	A practical task supported by learners' written records and records of tutor observation and oral questioning
P7, M2	Legal and Legislative Considerations	A technician needs to ensure that relevant legal and legislative considerations are being followed during a maintenance procedure	A written assignment
P8, M3, D2	Positive Communication in the Vehicle Workshop	A technician has been asked to investigate a customer complaint	A written assignment and/or records of oral questioning
P9, M4	Vehicle Maintenance and Repair Information and Documentation	A technician needs to use a variety of different sources of information and documentation when carrying out a maintenance procedure	A practical task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle Component Removal and Refitting Techniques	
	Vehicle System Fault Diagnosis	

The unit also covers some of the knowledge and understanding associated with the following generic IMI National Occupational Standards units:

- Unit G1: Contribute to Housekeeping in Motor Vehicle Environments
- Unit G2: Reduce Risks to Health and Safety in the Motor Vehicle Environment
- Unit G3: Maintain Working Relationships in the Motor Vehicle Environment
- Unit G4: Use of hand tools and equipment in Motor Vehicle Engineering.

Essential resources

Centres will need to have, or at least have access to, a vehicle workshop equipped with appropriate vehicles and a range of tools and equipment (e.g. jacks, axle stands, lifting platforms). The centre will also need to have the necessary documentation systems (e.g. risk assessments, COSHH assessments) together with the necessary control measures (e.g. COSHH storage facilities, manufacturer's safety data sheets (MSDS)) with which to demonstrate good practice.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk/
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Health and Safety Executive – *A Step by Step Guide to COSHH Assessments* (HSE Books, 2004) ISBN 9780717627851

Health and Safety Executive – *Health and Safety in Motor Vehicle Repair* (HSE Books, 2009) ISBN 9780717663088

Hillier, V and Coombes, P – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition Book Edition (Nelson Thornes, 2010) ISBN9781408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	accessing and using information, data and documentation, judging its relevance and value
Self-managers	anticipating and managing risks when preparing a vehicle for repair and using tools and equipment safely
Effective participators	identifying improvements that can be made to improve communication and working relationships

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	accessing and using a variety of different information and data sources for vehicle maintenance and repair
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	developing positive communication and working relationships with colleagues and customers
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	accessing and using a variety of different information and data sources for vehicle maintenance and repair
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing how risks can be reduced, the accident and emergency procedures and relevant health and safety issues in a vehicle maintenance environment

Unit 2: Vehicle Electrical and Electronic Principles

Unit code:	R/502/6217
Level:	2
Credit value:	5
Guided learning hours:	30

Aim and purpose

The aim of this unit is to develop learner understanding of the electrical and electronic principles involved in modern motor vehicle systems, circuits and components.

Unit introduction

There has been significant development and increase in the use of electronic systems during recent years benefiting almost all areas of life, including the motor vehicle. The functioning and control of almost every system now involves the use of electronic/electrical components making the vehicle safer and more efficient. To be able to understand how these systems work, the principles must be understood.

In this unit learners will explore the basic electrical/electronic principles that can be applied to modern vehicle systems for example light or heavy vehicles, motorsport, motorcycles, etc. The unit explores the nature of electrical current, the factors which influence the flow of electricity and the effects of electrical current flow, and how these can be used to good effect in a motor vehicle. Learners will develop the ability to use formulae to calculate values of electrical voltage, resistance, current and power in electrical/electronic circuits and components. In working through the unit they will identify different types of circuit and the construction of wiring diagrams. There will be an opportunity to use electrical measuring instruments to measure various electrical values and make use of the results to decide if a system is serviceable. The basic characteristics and principles of solid-state electrical components, their use as sensors and actuators is explained and the electronic control of a basic vehicle system using sensor (input) and actuator (output) will be explored.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to apply the laws of electricity and magnetism to vehicle electrical and electronic systems
- 2 Understand the principles of solid-state devices used in electrical and electronic circuits and components found in motor vehicle systems.

Unit content

1 Be able to apply the laws of electricity and magnetism to vehicle electrical and electronic systems

Principle of current flow: electron theory e.g. flow, electrical charge, conventional current flow; electro motive force (emf); potential difference (pd); voltage drop (vd); conductors and insulators e.g. semi conductors, conductivity, resistance; use of electrical units e.g. volts, amps, ohms, watts; effect of an electrical current in vehicle components e.g. heating, magnetic, chemical

Electrical values: series and parallel circuit calculations e.g. voltage, current, resistance, power, use of Ohm's Law and power equations such as $V = IR$, $P = IV$, $P = I^2R$; application to values in vehicle circuits and components

Electrical/electronic circuits: types of circuit e.g. series, parallel, series/parallel; earth return; insulated return; multiplex; cable capacity and selection; circuit protection e.g. fuses, circuit breakers, thermal cut outs

Wiring diagrams: interpretation; construction (hand/computer generated) of simple vehicle wiring diagrams e.g. starter, lighting, indicators; correct use of circuit symbols e.g. British Standards Institution (BSI)/International Electrotechnical Commission (IEC) standards symbols

Measuring instruments: circuit measurements e.g. safe use of digital multimeter, voltmeter, ammeter, oscilloscope; checking and setting meters before use e.g. correctly specified equipment, free from defects that might affect safety, setting correct scales/ranges; interpreting results

Electromagnetic induction: nature of magnetism e.g. effects, permanent and electromagnetism; generation of an emf in a conductor e.g. relative movement of magnetic field and conductor, varying the magnetic field; effect of a magnetic field on an adjacent current carrying conductor

2 Understand the principles of solid-state devices used in electrical and electronic circuits and components found in motor vehicle systems

Properties and characteristics: motor vehicle applications; recognition e.g. resistor colour coding, component markings and sizes such as 10 k Ω (kilo-Ohm), 1 μ F (micro-Farad), types of construction

Solid-state devices: resistors e.g. fixed, variable, ballast, rheostat, potentiometer, NTC and PTC resistors; capacitors e.g. capacitance, dielectric materials; diodes e.g. intrinsic and extrinsic semi-conductors, N-type and P-type materials, hole/electron flow, P-N junction characteristics, forward and reverse bias; transistors e.g. operation of NPN and PNP transistors; sensors; actuators; effect of input on output

Electronic control unit (ECU): role of sensors and actuator in providing/receiving signals; processing role of the ECU e.g. input-outputs and processing function in an engine management system

Assessment and grading criteria

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

Assessment and 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:
P1 explain the principles of current flow	M1 compare the properties of conductors, semi-conductors and insulators	D1 explain the benefits and limitations of using multiplex, earth return and insulated return wiring systems
P2 calculate electrical values in series and parallel electrical/ electronic circuits	M2 compare circuits/ component test results with calculated and stated values	D2 analyse test results of an electrical/ electronic component to judge its serviceability.
P3 produce a wiring diagram that includes circuit protection	M3 explain the function of two applications of ECUs within a motor vehicle.	
P4 select the correct cable size and fuse to be used in a vehicle circuit from given values [IE4]		
P5 use measuring instruments to determine values in vehicle electrical/ electronic circuits [SM3]		
P6 explain the principles of electromagnetic induction		

Table continues on next page

Assessment and grading criteria		
P7 explain the properties, characteristics and function of solid state devices in a vehicle system		
P8 explain the function of an ECU in a vehicle system.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

If possible, the unit should be taught in the context of the learner's occupational discipline (for example light or heavy vehicles, motorsport etc). Principles should relate to vehicle system applications, whenever possible, to generate interest and lay the foundation for future study in this area.

The learning outcomes are ordered logically and while they may be delivered separately, in practice integration of delivery may be advantageous. Once the learner has the necessary basic knowledge and skills then, wherever possible, a practical approach using real or simulated systems should be adopted. It is important that the full breadth of the unit is delivered along with the underpinning concepts and principles defined by the unit content. The teaching and learning strategies used to deliver the unit must take account of the intention to assess this unit through written and practical assignments.

Achievement of merit and distinction will be demonstrated through the learner's ability to compare, consider benefits and limitations and carry out analysis. Therefore, during the delivery/learning phase the development of these skills needs to be encouraged. Formative assessment will play an important part in the general development of learners but especially their achievement of the higher-level grades.

Please note the use of e.g. 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 e.g. needs to be taught or assessed.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments. The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ define terms used and explain electron theory and electron flow
- ☐ demonstrate and explain battery, emf, pd and volt drop in vehicle systems
- ☐ demonstrate conductors and insulators and explain use of electrical units
- ☐ demonstrate effects of electrical current in vehicle components and explain the effect of a magnetic field on a current carrying conductor

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- explain Ohm's law and its application in vehicle circuits and components

Individual learner activities:

- calculations involving Ohm's law
- calculation of resistance in series/parallel circuits

Whole-class teaching:

- explain circuit types and safety devices
- explain series and parallel circuits insulated and earth return

Individual learner activity:

- investigate cable sizes and fuse values for given circuits
- practical investigation of given or identified circuits

Whole-class teaching:

- demonstrate circuit diagram construction and correct use of circuit symbols

Individual learner activity:

- construction of vehicle wiring diagrams

Whole-class teaching:

- demonstrate safe use of measuring devices and instruments
- explain and demonstrate how test equipment is used to determine serviceability of electrical circuits and components
- explain the application of magnetic principles and the relationship to vehicle electrical components
- explain production of electro-motive force and relationship with vehicle alternator function and operation

Practical experiment:

- investigate electro-motive force generation
- building and testing of circuits

Prepare for and carry out Assignment 1: Electrical and Magnetic Principles (P1, P2, P3, P4, P6, M1, D1)

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- describe vehicle applications of resistors/capacitors, their function, colour codes and values
- explain the principles of resistors, variable resistors, light dependent resistors, related tolerances and colour codes
- explain the principles of semiconductors, diodes and LEDs and identify and operate transistors (NPN and PNP)
- explain ECU operation in engine management

Practical workshop activities:

- testing components for satisfactory operation
- testing ECU input-output values

Prepare for and carry out Assignment 2: Solid-state Devices (P5, P7, P8, M2, D2)

Feedback to learners, unit evaluation and close

Assessment

Evidence for this unit will be generated through written and practical assessments. For the latter, learners should describe the work undertaken, results generated and any conclusions drawn. The assessor should provide an observation record to authenticate the work, giving details of what has been seen and of any oral questioning that has taken place. If learners work in pairs (or more) then there must be a clear strategy to ensure that each learner produces relevant and individual evidence to satisfy the criteria.

To achieve a pass grade, learners should demonstrate that they can explain the principles of current flow (P1). They will need to consider electron theory, voltage (emf, pd, vd), conductors and insulators. Learners are also expected to state the correct electrical units for voltage, current, resistance and power. In addition, as part of the electron theory, learners will identify the possible effect of an electrical current in vehicle components. For example, learners should identify the heating effect (for example rear screen demister, bulb, heating coil application), chemical effect (for example battery) and magnetic effect (for example coil, alternator, starter).

At this level, learners should be able to calculate electrical values in series and parallel electrical/electronic circuits (P2). This will include the use of Ohm's law and power equations. Learners will also need to apply their understanding of the electrical units developed through P1. Typically, it would be expected that learners would calculate the total resistance of series; parallel and combined series parallel circuits and calculate one unknown when given either the current, voltage, or power of the other components in the circuit. These calculations should be set within the context of typical vehicle circuits and components. The first two assessment criteria support and interlink with P3, produce wiring diagrams, and includes circuit protection. The individual circuits (for example starter, lighting, indicators) should include a circuit protection device where appropriate (but not a relay) and should use correct IEC/BSI recommended symbols. Circuit diagrams can be hand or computer generated.

The scenario for the task to select and calculate a correct cable size and fuse (P4) should include a vehicle circuit in which the selection of the incorrect cable size or fuse would have implications (for example starter motor, heavy vehicle trailer lights). Learners will need to provide sufficient information (for example the current or power carried, system voltage, cable length).

At this level, the correct and safe use of electrical meters could be challenging for learners. Diligent support, following the initial demonstration, should be considered so learners develop the required skills before generating evidence for P5. Typically, this will consist of obtaining the correct values from simple electrical/electronic circuits and components entailing the use of measuring instruments to measure voltage, current, resistance (for example in electronic board circuits, components, vehicle circuits). This would include the use of a voltmeter (for example battery, lighting circuits), ammeter (for example starter, lighting circuit) and oscilloscope (for example wave forms and their characteristic values). Learners need to provide evidence that they have checked and set the instruments before use.

The explanation of the principles of electromagnetic induction (P6) (for example magnetic field produced when a current is passed through a conductor), emf being induced into a conductor by relative movement of the conductor or magnetic field, and change in magnetic field intensity and force of magnetism (for example reaction between two magnetic fields when brought near each other) could be generated by learners carrying out suitable investigations. Care is needed to ensure that the evidence can be attributed to the individual and that the work and conclusions drawn fully satisfy the criteria.

For P7 learners should be able to explain the properties and characteristics of resistors, capacitors, diodes and transistors and their function in typical motor vehicle systems (for example throttle valve, radio interference, rectification, switching). Similarly, learners will need to do this for sensors (for example providing information on variation in speed, temperature), actuators (for example responding the ECU signal to increase fuel, vary ignition point) and the ECU (for example interpreting signals from sensors analysing, sending signals to actuators). Typically, the properties, characteristics and function of sensors, actuators and an ECU (P8) could be dealt with by a 'black box' treatment of a typical engine managements system.

The tasks set to generate evidence for the merit criteria should allow learners to draw on the application and understanding developed for pass and apply it in various situations. They will need to do this to compare properties (M1) through applying the electron theory to differentiate between conductors, semi-conductors and insulators. M2 also requires a similar need but this time by comparing test results that the learner has taken from components/circuits with values obtained from standards or manufacturer's data and calculations. Some of the circuits/components should produce fault readings (for example V_d in a lighting circuit; faulty diode readings; alternator - low/high voltage or low current flow; high/low resistance in a plug lead). Learners should have the opportunity to undertake fault diagnosis using at least three different meters. For M3, learners need to use vehicle systems which incorporate the use of ECUs (for example ABS, fuel, ignition etc) and explain the function of two in terms of the information fed in and the action the ECU takes (for example in a fuel injection systems the ECU will determine amount of fuel delivery at an injector dependant on temperature, speed etc). The make and model of the vehicles using each system should be included.

To achieve a distinction, learners for D1, will need to explain the benefits and limitations of using a (a) multiplex wiring system, (b) earth return system and (c) insulated return system and be able to give typical examples of where each may be used (e.g. (a) executive cars, (b) production saloon cars, (c) racing cars). The evidence of analysing test results (D2) and reaching/justifying a conclusion could realistically be generated from an extension of the task for M2, providing that sufficient faults are included. Typically, this will be 4 to 6 sets of test results from electrical and electronic circuits/components where at least four are deemed to be unserviceable. From these results the learner will need to analyse the data in terms of the information given and what it infers, decide if the components are serviceable and give reasons for the decision.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, P4, P6, M1, D1	Electrical and Magnetic Principles	A technician needs to use knowledge of a range of electrical and magnetic principles to solve vehicle-related problems	An assignment consisting of a series of written tasks
P5, P7, P8, M2, M3, D2	Solid-state Devices	A technician needs to test circuits/components	A practical task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle Electrical Systems and Components	Vehicle Electrical and Electronic Principles
	Vehicle Science and Mathematics	

This unit has links with many standards but particularly the Level 2 and Level 3 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit LV03: Remove and Replace Motor Electrical Systems and Components
- Unit AE06: Diagnose and Rectify Motor Electrical Unit and Component Faults.

Essential resources

Centres will need to provide learners with access to a range of vehicle electrical and electronic components, vehicles/running rigs, data/manufacturers' information and ideally a vehicle with a multiple wiring system.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Automotive Electronics*, Second Edition (Nelson Thornes, 1996) ISBN 0748726950

James D. Halderman – (Prentice Hall 2010) – *Automotive Electricity and Electronics 2010* ISBN 0135124069

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	analysing and evaluating information when determining the correct cable size and fuse for a vehicle circuit
Self-managers	organising time and resources, prioritising actions when using measuring instruments to determine values in electrical/electronic circuits

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
Mathematics	
Select and apply a range of skills to find solutions	calculating electrical values in series and parallel circuits
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	using measuring instruments to obtain correct values from electrical/electronic circuits and components
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	<p>explaining the principles of current flow and electromagnetic induction</p> <p>explaining the correct electrical units for voltage, current, resistance and power</p> <p>describing the properties, characteristics and function of solid state devices</p>
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	<p>explaining the principles of current flow and electromagnetic induction</p> <p>explaining the correct electrical units for voltage, current, resistance and power</p> <p>describing the properties, characteristics and function of solid state devices</p>

Unit 3: Engineering Skills for Vehicle Technology

Unit code:	R/503/1448
Level:	2
Credit value:	5
Guided learning hours:	30

Aim and purpose

The aim of this unit is to develop the skills needed to measure, mark out and cut materials for vehicle repair and in the use of tools and equipment to cut threads and remove broken studs.

Unit introduction

Invariably carrying out of maintenance and rectification of faults in vehicle systems requires the removal and replacement of components. Unfortunately, vehicle repair work is not always straightforward as breakages occur and learners will require additional skills to cope in a range of situations. An example of this would be finding a broken stud during the removal and replacement of an exhaust system. To rectify this, drilling and stud removal techniques would be needed. In other circumstances, threads may be damaged and need repairing or the modification/manufacture of a bracket or template may be required which could involve marking out and cutting metal or plastic.

In this unit learners will develop the necessary skills and knowledge to carry out the type of work outlined above. It is recognised that these skills will need to be used and practised to gain full proficiency and opportunities for this will also occur in some of the other vehicle technology units.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to use tools and equipment to measure, mark out and cut materials
- 2 Be able to use tools and equipment to cut threads and remove broken studs.

Unit content

1 **Be able to use tools and equipment to measure, mark out and cut materials**

Fit for purpose: appropriate to the marking out and cutting task e.g. following the guidance of drawings, job instructions; health and safety considerations e.g. safe working methods, relevant regulations and guidelines, Control of Substances Hazardous to Health (COSHH) Regulations, risk assessment, personal protective equipment and clothing; safe and serviceable condition

Measuring and marking out: measuring tools e.g. rule; marking out tools e.g. scribe, centre punch, square, dividers, surface plate, blueing or paint; features (datum and centre-lines); shapes (square, rectangular, circular shapes); cutting detail; hole centring; material types (metal, plastics and composites); form of supply (sheet materials, bar stock)

Cutting operations: care, selection and use of hand tools e.g. hacksaw, tin snips, hand files, drills; hand power tools e.g. hand drill, offhand grinder; machine tools e.g. pillar drill; work holding device e.g. drill vice, vice jaw protectors, clamps; metal removal e.g. straight cuts, circular profile, use of files (deburr, rough, final finish), chisels; material types (metal, non-metallic materials e.g. plastics and composites)

2 **Be able to use tools and equipment to cut threads and remove broken studs**

Cutting internal and external threads: selection of drill size for tapping hole; drilling e.g. centring, pilot, open and blind hole; selection of internal and external thread cutting tools e.g. types of threads, taps (first, second, final cut), dies, die nuts; thread repair e.g. die nut, thread file; thread insert

Removal and replacement of broken stud: use of stud extractor and relevant hand tools; care of surrounding material/surfaces when removing stud

Quality and accuracy: specification adherence e.g. standard of work, finish, mating of parts, quality of screw threads (function of thread, thread profile, clean threads, thread insert accepts bolt); quality of studs (replaced stud alignment, no damage to the stud/threads)

Assessment and grading criteria

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

Assessment and 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:
P1 check that given tools and equipment to be used are fit for purpose	M1 describe the necessary safety precautions to be followed when using tools for metal removal	D1 justify the selection of tools and procedures used for cutting different types and thickness of material
P2 use measuring and marking out tools to mark vehicle components	M2 identify damaged and unserviceable cutting tools and take remedial action	D2 justify the selection of two types of threads used for vehicle applications.
P3 use tools to perform cutting operations [SM3, SM4]	M3 identify a vehicle application of two different screw thread types.	
P4 use tools to cut internal and external screw threads [SM3, SM4]		
P5 use tools to remove and replace a broken stud [SM3, SM4]		
P6 check the compliance of a damaged vehicle screw thread repair for quality and accuracy		
P7 check the compliance of a broken stud repair for quality and accuracy.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

The unit should be delivered predominantly using tutor-led demonstrations followed by practical tasks during which learners will be able to gain experience of working in a vehicle repair setting with the appropriate tools and equipment. Learners should achieve the required level of knowledge and skill in a given area before moving to the next formative stage. For example, when learners have sufficient understanding of tools, their purpose and care, they will then move on to measuring and marking out and then develop competence in performing the cutting operations in a formative setting. This type of approach will not only provide learners with the opportunity to apply their knowledge at an early stage but will also enable them to progress relatively quickly to the completion of a summative task(s), that integrates these skills.

Underpinning knowledge would be delivered through a combination of practical demonstrations supported by classroom-based sessions focusing on specific theoretical aspects of the processes and techniques. Learners will perform a range of tasks designed to improve their knowledge and understanding of the tools, materials and systems used in an industrial environment. Formative assessments should be short and progressive to ensure that learners are both competent and confident in their ability to proceed to the next task. Learners should be encouraged to evaluate their own performance by completing self/peer assessment. In this period of skill development, it will be important to monitor and make learners aware of the need for both speed and accuracy in their work to meet industrial expectations.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to unit content, overview of activities and assessment methodology
- describe the aspects of health and safety that need to be considered when carrying out cutting operations
- explain the care and selection of appropriate tools for measuring, marking out and cutting operations
- explain and demonstrate the use of measuring and marking out tools

Practical workshop activities:

- following job instructions to measure and mark out components from different materials

Whole-class teaching:

- demonstrate use of tools and holding devices for cutting components from metallic and non-metallic materials

Practical workshop activities:

- ensuring tools are fit for purpose and using them to cut components from different materials
- practise measuring, marking and cutting out of materials

Prepare for and complete Assignment 1: Measuring, Marking Out and Cutting Operations (P1, P2, P3, M1, M2, D1)

Whole-class teaching:

- explain and demonstrate the selection and use of drills, taps and dies for cutting and repairing threads

Practical workshop activities:

- use of tools for drilling aligned to cutting internal and external threads

Prepare for and complete Assignment 2: Cutting Screw Threads (P4, M3, D2)

Topic and suggested assignments/activities and/assessment
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ explain and demonstrate the use of stud extractors and relevant hand tools for removing and replacing broken studs □ explain the importance of protecting surrounding materials when removing studs and ensuring correct stud alignment <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ application of drilling skills □ removing and replacing studs
<p>Prepare for and complete Assignment 3: Removing and Replacing Broken Studs (P5)</p>
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ explain and demonstrate procedures for checking repairs to threads and studs meet quality and specification requirements <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ checking for quality and accuracy □ checking repaired components or threads
<p>Prepare for and complete Assignment 4: Checking Compliance of Repairs (P6, P7)</p>
<p>Feedback to learners, unit evaluation and close</p>

Assessment

P1, P2 and P3 could be assessed through one coherent summative assessment activity. This would enable learners to apply all the techniques from the three criteria (ie check tools and equipment are fit for purpose(P1), use measuring and marking out tools to mark components(P2), use tools to perform cutting operations(P3)) in one related activity. This would involve learners using tools to mark out and cut a given workpiece. To satisfy P2 and P3 learners need to work with two different material types (metal and non-metallic). It is also expected that they will have the skills to work with materials of differing thickness. This evidence should reflect the types of material/components found whilst working on vehicles and would typically involve bar steel, sheet metal/plastic, mounting brackets, vehicle bodywork modifications, manufacturing a component or special tool.

The tasks for P4 will require learners to produce a mating internal and external thread through the use of selected drills, taps and dies. They will also need to carry out the repair of a screw thread (for example making use of a die nut or thread file). Learners will need the opportunity to demonstrate their competence in the use of thread inserts.

To meet P5, learners will need to remove and replace a broken stud (for example exhaust manifold, cylinder head). The task selected must necessitate the use of stud extractors and relevant hand tools. Reasonable emphasis should be placed on the need to protect the parent metal in cases where this is softer than the stud (for example brass, aluminium) and the alignment of the replaced stud.

Finally, P6 and P7 require learners to check compliance of the screw thread and stud repairs for quality and accuracy. This should be a natural part of the repair process but is clearly critical from a commercial aspect.

To achieve M1 learners will need to describe safety precautions when using tools for metal removal and of the dangers of adopting bad practices.

For M2, learners will need to recognise damaged and unserviceable tools and equipment and undertake remedial action (for example sharpen drills and chisels, identify broken/faulty taps and dies). Centres may need to arrange such situations for the purpose of this criterion by providing learners with some defective or inappropriate tools in the toolkit used for the task(s) set. If this did happen naturally then, of course, this evidence can be captured for the individual learner's summative assessment records but this should not be left to chance.

To achieve M3 learners will need to have greater understanding of the screw threads cut for P4. They need to be able to identify a vehicle application of two different screw thread types. For example, this could be the application of fine BA threads in electrical applications against the application of large thread profiles used for wheel nuts. The important aspect to capture in the learner's evidence is their recognition that a choice of thread type has been made and it is not a random process. This is developed further by D2.

For D1, learners need to justify the selection of tools, methods and techniques used for cutting metal and plastic materials of different thickness. This should naturally include explanations of the consequences of using the incorrect techniques but this dimension may need a prompt in the brief for the task that covers this criterion.

Finally, D2 requires learners to justify the selection of two types of threads (for example imperial, metric, BA fine, coarse, left/right hand threads) used in vehicle applications. This should be a natural extension to P4 and M3. To achieve D2 learners will need to research the various types of threads used on vehicles, relate these to a particular vehicle situation and justify the selection of thread and size.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, M2, D1	Measuring, Marking Out and Cutting Operations	A technician needs to replace vehicle components	A practical task supported by learners' written records and records of tutor observation and oral questioning
P4, M3, D2	Cutting Screw Threads	A technician needs to produce an internal and external thread while carrying out repairs on a vehicle	A practical task supported by learners' written records and records of tutor observation and oral questioning
P5	Removing and Replacing Broken Studs	A technician needs to remove and replace a broken stud while carrying out repairs on a vehicle	A practical task supported by learners' written records and records of tutor observation and oral questioning
P6, P7	Checking Compliance of Repairs	A technician needs to ensure that repairs carried out meet specification and quality requirements	A practical task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle Component Removal and Refitting	
	Non-structural Body Repair Processes	

This unit has links with many standards but particularly with the Level 2 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit G4: Use of Handtools and Equipment in Motor Vehicle Engineering
- Unit LV01: Carry out Routine Motor Vehicle Maintenance
- Unit LV02: Remove and Replace Motor Engine Units and Components
- Unit LV04: Remove and Replace Motor Vehicle Chassis Units and Components.

Essential resources

Centres will need to provide learners with access to all the tools and equipment specified in the unit content. Learners will also require access to suitable reference materials for information and data on screw thread types and applications.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk/
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Livsey A and Robinson A – *The Repair of Vehicle Bodies* (Butterworth-Heinemann, 2006) ISBN 9780750667531

Timings R – *Fabrication and Welding Engineering* (Newnes, 2008) ISBN 9780750666916

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	organising time and resources and anticipating and managing risks when using tools and equipment to cut materials and repair broken studs

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	analysing and evaluating information when following job instructions and checking repairs against specification
Reflective learners	setting goals with success criteria for their development and work
Team workers	collaborating with others when working as part of a group to measure, mark out and cut materials, cut threads and replace broken studs

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing the safety precautions to be followed when using tools for metal removal justifying the selection of tools and procedures
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the safety precautions to be followed when using tools for metal removal justifying the selection of tools and procedures

Unit 4: **Vehicle Component Removal and Refitting Techniques**

Unit code: **H/502/6173**

Level: **2**

Credit value: **5**

Guided learning hours: **30**

Aim and purpose

The aim of this unit is to enable learners to use tools and equipment safely to carry out the removal and refitting of a range of vehicle components and systems.

Unit introduction

In this unit learners will use a range of tools and equipment and check that they are in a safe and usable condition. When removing and replacing components learners will be required to work to given procedures and check that they have the appropriate information and tools to carry out the task set. Having followed the replacement instructions, learners will be expected to ensure that the components are orientated, positioned and aligned correctly, that moving parts have the correct working clearances, that all fasteners are tightened, that wiring or piping is correctly laid and that the component or system functions as per specification.

Learners will need to understand the components and systems being worked on, their functions and expected operating parameters.

Safe working practices and good housekeeping will be a recurrent theme throughout the unit. Learners will be expected to demonstrate an understanding of their responsibility for their own safety and that of others in the workplace.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to use dismantling and assembly tools, equipment and measuring instruments safely
- 2 Be able to remove and refit vehicle components.

Unit content

1 Be able to use dismantling and assembly tools, equipment and measuring instruments safely

Tools, equipment and measuring instruments: hand tools e.g. spanners, wrenches, sockets, screwdrivers, crimping tools, torque wrench; power tools e.g. drills, air tools, soldering irons; equipment e.g. for lifting and moving, fixtures, pullers, expanders, tensioners; measuring instruments e.g. rule, tape measures, micrometers, dial indicators, gauges, multimeter

Fit for service: appropriate to the dismantling/assembly task e.g. following the guidance of drawings, job instructions, assembly procedures; health and safety considerations e.g. safe and serviceable condition, competent to operate, safe environment for operation; permitted operating range of tools e.g. torque, safe working load, voltage/current range

Safely: e.g. safe working methods, relevant regulations and guidelines, use of Control of Substances Hazardous to Health (COSHH) Regulations, risk assessment, personal protective equipment and clothing, safe and serviceable conditions

2 Be able to remove and refit vehicle components

Locking devices: e.g. spring washers, locking tab, split pin, lock nut, locking wire, nyloc nuts

Sealed joints: typical sealed joints e.g. cylinder head, water pump flange, rear axle, rotating shafts, exhausts; gaskets, seals and jointing material e.g. exhaust, cylinder head gaskets, oil seals, jointing compound and paper

Assembly methods and techniques: methods appropriate to remove, replace, strip and rebuild tasks e.g. following the guidance, drawings, job instructions, manufacturers' data/instructions/bulletins, assembly procedures; manual handling; waste disposal; avoidance of damage to other vehicle systems; selection of correct lubricants e.g. engine oil, grease; working to time frames e.g. estimating time to complete task, working to set times, reporting of need for additional time

Remove and refit components: engine system e.g. engine unit, engine components (cylinder head, sump, oil pump, timing chain/belt), cooling (water pump, thermostat), ignition (distributor, sensors, ECU), fuel (pumps, injectors, tanks); vehicle system e.g. transmission (clutch assembly, clutch plate, gearbox, selector mechanism, shafts, prop/drive shaft, drive joint, final drive, wheel bearing), suspension (road spring, dampers), steering (track rod end, steering arm), brakes (pads, shoes, disks, wheel cylinders); electrical system e.g. engine management, data control boxes, lighting, instruments, auxiliaries, electric window, starter motor, alternator

Quality checks: completeness; alignment/positional accuracy; component security; damage or foreign objects; operating checks e.g. component/system functions to design specification and operational parameters; electrical/electronic tests e.g. correct inputs/outputs, electrical continuity; fluid systems e.g. system function, leak and pressure testing, pipe-work free from ripple and creases; sub-assemblies e.g. function, freedom of movement, orientation, operating/working clearances, bearing end float

Assessment and grading criteria

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

Assessment and 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:
P1 check that given tools, equipment and measuring instruments to be used are fit for service	M1 explain the action to be taken with defective or inappropriate tools, equipment and measuring instruments	D1 evaluate the methods and techniques used to dismantle and assemble a vehicle component and make a proposal for improvement.
P2 use five different types of locking device used in vehicle systems	M2 identify and correct any assembly problems that occur and that are within their control	
P3 use four different methods to provide sealed joints in vehicle systems [SM3, SM4]		
P4 use relevant assembly methods and techniques to safely remove and refit vehicle components [SM3, SM4]		
P5 use tools, equipment and measuring instruments to carry out quality checks on a re-built vehicle system [SM3, SM4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Delivery of this unit could concentrate on a specialist area (for example on engine, transmission, brake components and assemblies) with less detailed coverage of the other aspects. However, a generic approach that covers the range of components and assemblies equally (for example mechanical, electrical/electronic, fluid systems) is more likely and recommended. Centres will determine their delivery approach through an analysis of learner needs and consideration of the range of repair outlets that centres are working with or preparing learners for. Whichever approach is taken it is expected that learner experience should be sufficiently varied to give them the underpinning knowledge and skills to work with tools, equipment, measuring instruments, removal and refitting methods and techniques on most vehicle systems.

The two learning outcomes are probably best delivered in order. In this way, learners will begin to recognise a range of specific tools, their function and limits in relation to specific tasks, components and assemblies. This approach will be more practical rather than learners spending too much time in theory lessons. For example, a short introduction to a component (or range of components), its function within the larger assembly, the tools necessary to carry out the removal and refitting task (including their limits/special features), together with any safety consideration, followed by a practical session. Once the learner has the necessary knowledge and skills to work with a sufficient range of tools the other aspects can then be introduced, such as working to instructions, quality checking own/other's work, checking compliance with given standards, specifications or job instructions.

Achievement at merit and distinction will be demonstrated through learners working autonomously when carrying out tasks, plus their ability to know when to seek advice. Therefore, it is important that during the delivery/learning phase development of these skills is encouraged. Formative assessment will play an important part in the general development of learners but especially their achievement of the higher-level grades. Evaluative skills are required at distinction level and again formative work in the delivery phase will enable centres to encourage learners to consider how the removing and refitting processes and techniques being applied could be improved.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ explain health and safety, safe working methods and the legal implications of working safely
- ☐ explain the correct use of PPE
- ☐ explain safe material disposal methods and environmental considerations
- ☐ explain and demonstrate the checks to be made to ensure tools, equipment and measuring instruments are fit for service
- ☐ demonstrate selection of appropriate tools and equipment for typical dismantling and assembly procedures

Practical workshop activities:

- ☐ investigation of a range of tools and equipment to identify their function and use for different removal/refitting/assembly tasks
- ☐ practical application on set activities

Whole-class teaching:

- ☐ describe and demonstrate different methods for creating sealed joints
- ☐ describe the use of a range of different locking devices and their vehicle system applications
- ☐ explain and demonstrate the use of relevant assembly methods for the removal and refitting of a range of components from engine systems
- ☐ explain and demonstrate quality checks to be made on a rebuilt engine system

Practical workshop activities:

- ☐ use of assembly methods and tools, equipment and measuring instruments to remove and refit components from engine systems
- ☐ carry out quality checks to ensure quality of refitted system components

Prepare for and complete Assignment 1: Removing and Refitting Engine System Components (P1 part, P2 part, P3 part, P4 part, P5 part, M1, M2)

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- explain and demonstrate the use of relevant assembly methods for the removal and refitting of a range of components from vehicle systems
- explain and demonstrate quality checks to be made on a rebuilt vehicle system

Practical workshop activities:

- use of assembly methods and tools, equipment and measuring instruments to remove and refit components from vehicle systems
- carry out quality checks to ensure quality of refitted system components

Prepare for and complete Assignment 2: Removing and Refitting Vehicle System Components (P1 part, P2 part, P3 part, P4 part, P5 part)**Whole-class teaching:**

- explain and demonstrate the use of relevant assembly methods for the removal and refitting of a range of components from electrical systems
- explain and demonstrate quality checks to be made on a rebuilt electrical system

Practical workshop activities:

- use of assembly methods and tools, equipment and measuring instruments to remove and refit components from electrical systems
- carry out quality checks to ensure quality of refitted system components

Prepare for and complete Assignment 3: Removing and Refitting Electrical System Components (P1 part, P2 part, P4 part, P5 part)**Prepare for and complete Assignment 4: Evaluating Dismantling and Assembly Techniques (D1)**

Feedback to learners, unit evaluation and close

Assessment

A large proportion of the assessment for this unit will naturally be through tutor observation and oral questioning. To support the high level of process evidence, centres will also need to consider what additional product evidence (that often surrounds a process) could be used. For example, the use of a logbook record, maintained by the learner, of the assembly task(s) carried out. The log could contain, for example, a description of the task undertaken, the instructions provided (annotated to record progress or difficulties), a list of tools provided and their condition, written tool/equipment defect reports, relevant photographs that have been annotated to explain procedures/difficulties, etc. Such supporting product evidence would then validate the tutor or witness observation/oral questioning records and vice-versa.

For summative assessment, group work would be inappropriate unless very large assemblies were available.

Due to the diverse range of applications across motor vehicle systems (engine, vehicle, electrical) it is recommended that the assessment of several criteria such as P1, P2, P3, P4 and P5 is carried out over two or three assignments.

It can be seen from the assessment grid that the main task(s) to meet criteria P4, 'remove and refit vehicle components' is supported by the two other 'checking' criteria, P1 and P5. It may mean that these two criteria (P1 and P5) are covered more than once depending on the approach taken. It is thought unlikely that learners will be able to provide sufficient evidence within just one task to adequately reflect the unit content. Therefore, the range of tasks set for P4 (engine, vehicle, electrical systems) could have P1 and P5 built into them, checking the tools before starting the task and carrying out quality checks on finished work. It is for the tutor to determine the range of assessment opportunities. Having done so, they need decide when they (the assessor) are confident that the learner would be able to demonstrate the criteria in any future context and indicate to the learner what has been achieved or what needs further evidence.

It is important that the criteria that require the use of 'tools, equipment and measuring instruments' (P1, P5, M1) are not fragmented. It is expected that the task(s) chosen for summative assessment will offer sufficient scope for the learner to use all three (ie hand and power tools, equipment and measuring instruments) as defined by the unit content.

It is not practical, within the time allocated for this unit, to cover all the components and systems indicated in the unit content. However, learner evidence should demonstrate generic skills of removing and replacing vehicle components (for example use of job instruction, information data, jointing processes, locking devices, use of tools and equipment, confirming system integrity, etc). To achieve this, learners will need to provide evidence of removing and replacing a minimum of one component from each of the systems identified in the content (i.e. engine, vehicle and electrical systems). Tasks will also need to be carefully chosen so that they provide sufficient evidence opportunities for P3 and P4 to be achieved. P5 should include operating checks, electrical/electronic tests, fluid system checks and checks on sub assemblies.

To achieve a merit grade, learners will need to explain the action to be taken with defective or inappropriate tools, equipment and measuring instruments (M1). Centres may need to arrange situations for the purpose of this criterion by giving the learner some defective or inappropriate tools in the toolkit provided for the task(s). If this does occur naturally then this evidence can be captured for the learner's summative assessment records, but this should not be left to chance. Equally, to enable the learner to achieve M2 these situations may need to be arranged. For example, the learner could be given incorrect parts, such as bolts that are too short for the task, but are able to simply requisition the correct replacements from the workshop stores under their own authority.

To achieve a distinction, the learner must evaluate the methods and techniques used to dismantle and assemble a vehicle component and make a proposal for improvement.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1 (in part), P2 (in part), P3 (in part), P4 (in part), P5 (in part), M1, M2	Removing and Refitting Engine System Components	A vehicle technician needs to remove and refit a cylinder head	A practical task supported by learners' written records and records of tutor observation and oral questioning. Annotated photographs.
P1 (in part), P2 (in part), P3 (in part), P4 (in part), P5 (in part)	Removing and Refitting Vehicle System Components	A vehicle technician needs to remove and refit a clutch assembly	A practical task supported by learners' written records and records of tutor observation and oral questioning. Annotated photographs.
P1 (in part), P2 (in part), P4 (in part), P5 (in part)	Removing and Refitting Electrical System Components	A vehicle technician needs to remove and refit vehicle's starter motor	A practical task supported by learners' written records and records of tutor observation and oral questioning. Annotated photographs.
D1	Evaluating Dismantling and Assembly Techniques	A vehicle technician needs to see where improvements can be made to the dismantling and assembly techniques used in a workshop	A written report

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Engineering Skills for Vehicle Repair	
	Stripping and Rebuilding Motorsports Engines	

This unit has links with many standards but particularly the Level 2 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit G4: Use of Hand Tools and Equipment in Motor Vehicle Engineering
- Unit LV01: Carry out Routine Motor Vehicle Maintenance
- Unit LV02: Remove and Replace Motor Engine Units and Components
- Unit LV03: Remove and Replace Motor Electrical Units and Components
- Unit LV04: Remove and Replace Motor Vehicle Chassis Units and Components.
- Essential resources

To deliver this unit it is essential that the centre has, or has access to, most if not all the range of vehicle systems and components specified in the unit content. Centres will need to ensure that they have sufficient hand tools and equipment to enable the proposed number of learners to carry out tasks individually.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition (Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	organising time and resources and anticipating and managing risk when removing and refitting components

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for the development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing safety precautions and procedures that relate to component removal and refitting

Unit 5:

Vehicle Engine Principles and Operation

Unit code:	K/502/6174
Level:	2
Credit value:	5
Guided learning hours:	30

Aim and purpose

The aim of this unit is to develop learner knowledge of the fundamental principles of vehicle engines and related fuel, exhaust, ignition, cooling and lubrication systems.

Unit introduction

The internal combustion engine produces the power and torque which propels the vehicle and has to comply with various functional and legal requirements. It also provides the power to operate the various ancillaries such as the alternator, water pump, vacuum assisted brakes, air conditioning and power steering. When the accelerator pedal is released, and the road wheels are made to turn the engine, it provides a useful amount of vehicle retardation without the application of the brakes. The output characteristics produced depend on many design factors and principles. Together with advances in materials, fuel, lubrication and design technology, and with the control and monitoring systems integrated into today's vehicle, the modern engine (for a given size) outperforms its predecessors in every way. These enhancements bring a greater need to understand the complexities of these power units.

In this unit learners will gain a fundamental understanding of the constructional detail and principles of operations associated with the internal combustion engine and its sub-systems. Learner will also develop the generic skills that are transferable between different engines and sub-systems regardless of the manufacturer. The underpinning knowledge will be subject to, but not limited by, reinforcement in a practical context through investigations, laboratory work and workshop activities.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the fundamental principles of internal combustion engines
- 2 Know the function and operation of vehicle engine systems.

Unit content

1 Know the fundamental principles of internal combustion engines

Operating cycles: two and four stroke cycles of operation for spark ignition (SI), compression ignition (CI) and Rotary engines e.g. aspiration/compression/ignition/swept and clearance volume/compression ratio/valve timing/port timing/pressure charging

Engine configurations and layout: engine orientation and position e.g. longitudinally mounted, transverse, front, mid and rear engines; cylinder arrangements e.g. single cylinder, twin cylinder, four cylinder, six cylinder, eight cylinder; cylinder configuration e.g. in-line, vee, horizontally opposed arrangements

Engine components/assemblies: function and constructional details of the cylinder block, cylinder head, sump, piston, connecting rod, crankshaft and bearings, flywheel, camshaft, inlet and exhaust valves; valve operating mechanisms e.g. overhead valve (ohv), single overhead cam (ohc), double ohc arrangements; inlet and exhaust manifolds

2 Know the function and operation of vehicle engine systems

Fuel and exhaust system: petrol and diesel engine fuel systems e.g. carburettor, single-point petrol fuel injection, multi-point petrol fuel injection, single element diesel pump and injector, common rail diesel injection; exhaust systems e.g. silencer, catalytic converter, particulate filter; fuel and exhaust control systems e.g. cold start enrichment, emission control, fuel quantity indication, exhaust gas recirculation

Ignition systems: spark and compression ignitions e.g. coil, distributor, spark plug, ignition timing, low (LT) and high tension (HT) circuits, firing order, electronic ignition, distributor less ignition; ignition control systems e.g. dwell control, ignition timing, knock sensing

Cooling system: air cooled e.g. cylinder construction, fan, shutters, thermostat; water cooled e.g. radiator, radiator cap, expansion tank, water pump, viscous/electric/mechanical fans, thermostat, hoses, use of anti-freeze; engine cooling control systems e.g. engine temperature sensing, coolant level indication

Engine lubrication system: wet and dry sumps; oil pumps; pressure relief valve; oil filter; types and properties of engine oil e.g. viscosity, Society of Automotive Engineers (SAE) rating, multi-grade oil; lubrication control systems e.g. level indication, low pressure indication

Assessment and grading criteria

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

Assessment and 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:
P1 describe the operating cycles of naturally aspirated and pressure charged internal combustion engines [IE2]	M1 compare the advantages and disadvantages of three different engine configurations and layouts	D1 select and justify an engine operating cycle, configuration and layout for a given vehicle.
P2 describe the engine configuration and layout of a given vehicle	M2 compare the advantages and disadvantages of air and water cooled engines.	
P3 describe the function and construction of the principal engine components and assemblies		
P4 describe the function and operating principles of an engine fuel and exhaust system		
P5 describe the function and operating principles of an engine ignition system		

Table continues on next page

Assessment and grading criteria		
P6 describe the function and operating principles of an engine cooling system		
P7 describe the function and operating principles of engine lubrication systems.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Delivery of this unit should focus on developing underpinning knowledge of the principles involved in modern engine systems. A balance of theoretical and practical study is recommended and, where possible, systems and operating principles should be demonstrated through practical investigation using rigs, units and components. It is strongly recommended that some of the delivery of this unit takes place in a workshop environment to ensure that learners can relate their studies to an industrial context and develop a practical understanding of the unit content. Whichever approach is taken learner experience should be sufficiently varied to give them the underpinning knowledge and transferable skills that will enable them to perform routine operations on vehicle engine systems in an industrial setting.

A reasonable delivery approach would be to develop the learning outcomes in order. In this way learners will begin to understand the constructional details of engines and the essential principles of combustion before targeting the complexities of the input and output processes. Finally, the interdependency of engine performance and reliability with the fuelling, ignition, exhaust, lubrication and cooling requirements should be addressed.

The ability to compare and justify will be required for the merit and distinction grades and formative assessment and feedback should encourage learners to carry out comparisons and consider the relative advantages and disadvantages of each engine configuration, layout and system.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to the unit content, scheme of work and assessment strategy
- ☐ introduction to relevant engine terminology
- ☐ explain the types and operating cycles of internal combustion engines
- ☐ carry out compression ratio calculations
- ☐ explain valve timing diagrams
- ☐ explain advantages and disadvantages of various engine configurations and layouts
- ☐ explain function and construction of cylinder head and engine components
- ☐ explain function of mechanical engine components

Topic and suggested assignments/activities and/assessment
<p>Individual learner activities:</p> <ul style="list-style-type: none"> □ produce valve timing diagrams from given data <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ investigation of a range of vehicles with different engine layout and configuration □ strip and investigate engine components and comment on serviceability
Prepare for and carry out Assignment 1: Engine Operating Principles and Components (P1, P3)
Prepare for and carry out Assignment 2: Engine Configuration and Layout (P2, M1, D1)
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ outline the interdependence of the different engine systems □ describe the function and operation of petrol and diesel fuel systems and exhaust system components □ describe the operation of fuel and exhaust control systems □ describe the function and operation of spark and compression ignition systems and ignition control systems □ describe the function and operation of air and water cooling systems and control systems □ describe the function and operation of engine lubrication and control systems and the types and properties of oil <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ tutor-led investigation of engines and engine systems
Prepare for and carry out Assignment 3: Engine Systems (P4, P5, P6, P7, M2)
Feedback to learners, unit evaluation and close

Assessment

Although the pass criteria require descriptive evidence, it is not expected that centres will only use tests to enable learners to generate this evidence. The unit lends itself to an investigative approach and this should also be reflected in the assessment strategy wherever possible.

To achieve a pass grade, learners will need to demonstrate a knowledge of the operational principles of naturally aspirated and pressure charged engines from SI, CI and Rotary/Rotary engines operating cycles (P1). The components and assemblies to be described in P3 also relate to the three types of combustion engine and this would suggest that P1 and P3 could be assessed together in view of their interrelationship. The criterion P2 would be best assessed through investigation and practical examination of live vehicle layouts and

configurations. The remaining criteria would need to be assessed more discretely as their interrelationship is less obvious but again assessment should focus on practical aspects of construction, operation and a fundamental understanding of the underpinning principles. The assessment method for this could be investigative experimentation.

To achieve M1, learners should demonstrate that they can compare, through logical reasoning, the advantages and disadvantages of three different engine configurations and layouts (for example a longitudinally mounted vee-four engine with a transverse front mounted four cylinder engine against a rear engined horizontally opposed four cylinder). In doing this, the learner should relate a particular use to the specific requirements and application of the vehicle and other considerations such as space utilisation. They should also demonstrate an awareness of the adverse effects caused by certain configurations and layouts (for example steering characteristics, traction under certain conditions). For M2, the learner will compare the advantages and disadvantages of air and water cooled engines.

For D1, learners should select and justify an engine operating cycle, configuration and layout for a given vehicle.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P3	Engine Operating Principles and Components	An investigation of the operating principles and components of SI, CI and Rotary engines	A written report based on practical investigation
P2, M1, D1	Engine Configuration and Layout	An investigation of the engine configuration of different vehicles	A written report based on practical investigation
P4, P5, P6, P7, M2	Engine Systems	An investigation of engine systems	A written report based on practical investigations

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle Design and Operation of Vehicle Systems	

This unit has links with many standards but particularly the Level 2 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit LV01: Carry out Routine Motor Vehicle Maintenance
- Unit LV02: Remove and Replace Motor Engine Units and Components.

Essential resources

Centres will need access to a vehicle workshop equipped with appropriate vehicles, a range of two stroke and four stroke SI and CI power units of varying configurations, in addition to engine components (e.g. pistons, connecting rods, valves, crankshafts, camshafts) and assemblies (e.g. cylinder blocks, cylinder heads and rigs).

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk/
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Gilles, T – *Automotive Engines – Diagnosis, Repair, Rebuilding* (Delmar Cengage, 2010) ISBN 9781435488267

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition (Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	planning and carrying out research when investigating engine operating principles

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	<p>researching and investigating engine operating principles</p> <p>researching and investigating the operation of different engine systems</p>
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	<p>describing the operating cycles of internal combustion engines</p> <p>describing the function and operation of engine systems</p>

Unit 6: Vehicle Design and Operation of Vehicle Systems

Unit code:	T/502/6212
Level:	2
Credit value:	5
Guided learning hours:	30

Aim and purpose

The aim of this unit is to develop learner knowledge of the types of vehicle design and the operation of a range of vehicle systems including the transmission, steering, brakes and suspension systems.

Unit introduction

Vehicle body design and construction is a complicated set of individual panel pressings, welded or fastened together to form the body shell, onto which additional non-structural panels can be hung. The purpose of a vehicle's transmission system is to provide the forces necessary for movement. These forces are produced by converting the chemical energy of fuel into kinetic energy, the energy of motion. Therefore, some form of transmission involving a clutch and varying gear ratios is necessary to ensure that the engine is able to operate within its optimum power and torque characteristics at all times. Of the remaining systems, steering systems are now mostly power assisted, aligned to the use of appropriate braking systems, and suspension systems also now have a high degree of sophistication.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the types of vehicle design
- 2 Know the operation of vehicle systems.

Unit content

1 Know the types of vehicle design

Types of vehicle: e.g. heavy goods vehicle (HGV) (rigid, articulated vehicle, tractor unit, semi-trailer, combinations, drawbar trailer), light goods vehicle (LGV) (van, pick up), passenger service vehicles (PSV) (bus, coach, minibuses), light vehicles (saloon, coupe, estate, hatch), multi-purpose vehicle (MPV), motorsports vehicle (single seater, kart, rallying, historic, motorcycle)

Body design: monocoque and non-monocoque constructions and body panels (manufacture, safety, reparability, durability, rigidity, stability, flexibility, economy); impact absorption e.g. front end collision, rear end collision, side collision; structural and non-structural components e.g. floor pans, side members, door skins; materials e.g. aluminium, low carbon (mild) steel, zinc coated steel, high strength steel, plastics; material properties e.g. malleability, elasticity, strength, work hardening, annealing, thermosetting, thermoplastic, sound deadening

Engine position: front, mid, rear, transverse, inline

Power train arrangement: rear wheel drive, front wheel drive, four-wheel drive, heavy vehicle drive arrangements e.g. 4x2, 6x2, 6x4, 8x4

2 Know the operation of vehicle systems

Power train: function e.g. transmission of drive and torque distribution; types of application e.g. on road, off road; components e.g. clutch (diaphragm and coil spring mechanisms), manual transmission, final drive and differential, universal joint, Hooke type joint, rubber trunnion mountings, constant velocity joint, e.g. Tracta joint, Rzeppa joint, Weiss joint, drive shafts; operating principles e.g. friction, torque multiplication, torque equalisation, rotational speed differential between driven wheels

Brakes: function e.g. stopping the vehicle, reducing vehicle speed, holding the vehicle stationary; components e.g. disc brakes (vented and non-vented) and calipers (single and multi-piston, sliding and fixed), drum brakes (leading and trailing, twin leading shoe arrangements), hydraulic circuits and master cylinders, handbrake linkage layouts, pressure regulating valves, vacuum assistance; anti-lock braking systems; braking efficiency; operating principles e.g. energy conversion, inertia, pressure

Steering: function e.g. two wheel and four wheel steering, directional stability, driver 'feel' for the road, minimisation of tyre wear, reduction in the effect of uneven road surface; components e.g. ball joints, steering linkage arrangements, swivel joints, steering boxes (rack and pinion, recirculating ball); operating principles e.g. Ackermann, true rolling motion, castor, camber, centre point steering, wheel alignment

Suspension: function e.g. wheel and axle assembly location, lateral movement and swivel action of wheels, absorption of lateral and vertical forces, weight distribution, maintenance of contact between road and wheels, isolation of road noise, driver and passenger comfort; components e.g. leaf spring, coil spring, torsion bar, rubber spring, air spring, beam axle suspension, suspension dampers; operating principles e.g. dependent and independent systems, mechanical, hydro-pneumatic, pneumatic, self-leveling

Assessment and grading criteria

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

Assessment and 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:
P1 describe two types of vehicle by their body design, their engine position and power train arrangement	M1 compare vehicle body design, engine position and power arrangements for two different vehicles	D1 select and justify the vehicle body design, engine position and power arrangements for two different vehicle applications.
P2 describe the operation of a power train system	M2 compare the advantages and disadvantages of the braking, steering and suspension systems of two different vehicles.	
P3 describe the operation of a braking system		
P4 describe the operation of a steering system		
P5 describe the operation of a suspension system.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

The delivery of this unit should focus primarily on developing a fundamental understanding of the operating principles of modern vehicle systems. A balance of theoretical and practical study is recommended and, where possible, systems and principles should be demonstrated through practical investigation using rigs, units, components and equipment. It is strongly recommended that some of the delivery of this unit takes place in a workshop environment to ensure that learners can relate their studies to an industrial context and to develop a practical understanding of the unit content.

A reasonable delivery approach would be to develop the learning outcomes in order. In this way learners will start to understand the design principles of vehicles before targeting the complexities of the discrete systems.

Formative assessment will play an important part in the general development of learners throughout the delivery of the unit, but in particular it will benefit their achievement at merit and distinction level. The ability to analyse and compare will be required at the higher levels. Formative assessment and feedback should encourage learners to carry out comparisons and consider the relative advantages and disadvantages of the vehicle configurations, layouts and systems they examine.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ describe the difference between monocoque and non-monocoque constructions and body panels
- ☐ describe the different types of impact absorption that are available and the structural and non-structural components used
- ☐ describe the different materials used in vehicle construction including material properties
- ☐ describe the different engine positions and power train arrangements used in vehicle design
- ☐ explain the function and operating principles of a vehicle power train and describe its main components

Individual learner activities:

- ☐ research of vehicle designs and power train arrangements

Practical workshop activities:

- ☐ practical investigation of a range of vehicles with different design features
- ☐ use components and test rigs to investigate function and operation of power train systems

Prepare for and complete Assignment 1: Vehicle Designs (P1, P2, M1, D1)

Whole-class teaching:

- ☐ explain the function and operating principles of a vehicle braking system and describe its main components
- ☐ explain the function and operating principles of a vehicle steering system and describe its main components
- ☐ explain the function and operating principles of a vehicle suspension system and describe its main components

Practical workshop session:

- ☐ use components and test rigs to investigate function and operation of braking, steering and suspension systems

Prepare for and complete Assignment 2: Function and Operation of Vehicle Systems (P3, P4, P5, M2)

Feedback to learners, unit evaluation and close

Assessment

This unit will benefit from a variety of evidence being gathered to support assessment. For example, the centre may wish to devise tests or investigative assignments where learners are asked to describe, explain, compare and justify. Although all the pass criteria require descriptive evidence, it is not expected that centres will only use written tests to enable learners to generate evidence. The unit lends itself to an investigative approach and this should also be reflected in the assessment strategy wherever possible.

The unit content would be best delivered discretely, then reinforced and underpinned by practical investigations, examinations, experiments, etc.

To achieve a pass, learners will need to demonstrate their knowledge of the fundamental aspects of vehicle body types by describing the design features, function and purpose of vehicles. A task could be developed to allow the learner to describe two different types of vehicle layout (P1), as outlined in the unit content, and consider an appropriate body design, engine position and power train arrangement for each. It would be advisable to give learners access to a range of suitable vehicles so that they can develop a practical knowledge of different vehicle types. P1 and P2 are closely linked and could be assessed together if learners describe the power train of one of the vehicles described for P1. In order for learners to satisfy the remaining pass criteria further tasks need to be developed to allow them to describe the operation of braking (P3), steering (P4) and suspension (P5) systems for a given vehicle.

To achieve a merit, learners should demonstrate that they can compare vehicle body design, engine position and power arrangements for two different vehicles. They also need to compare the advantages and disadvantages of braking, steering and suspension systems of two different vehicles. The ability to fully satisfy these criteria will depend on the depth of understanding gained from the pass criteria and assessment will likely involve a high degree of directed investigation into a variety of vehicles, units and components from which to draw conclusions. Whilst the criteria target discrete systems, M1 and M2 could be covered simultaneously through learners conducting a review of a number of suitably different vehicles to draw comparisons and identify relative merits and drawbacks.

To achieve a distinction, learners should be able to bring together all they have learned in a largely independent manner and learner responses should be analytical. In doing so, a task should be developed to enable learners to select and justify the constructional features for two given vehicle applications. These applications, whilst different, should not be unrelated for example HGV Rigid and PSV Coach, or LGV and MPV.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1, D1	Vehicle Designs	A technician needs to investigate the design and layout of two different vehicles	A written report
P3, P4, P5, M2	Function and Operation of Vehicle Systems	A technician needs to describe to a new apprentice the operation of vehicle braking, steering and suspension systems	A written report

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

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Operation and Repair of Vehicle Braking Systems	
	Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	

This unit has links with many standards but particularly the Level 2 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- LV04: Remove and Replace Motor Vehicle Chassis Units and Components
- LV12: Remove and Replace Motor Vehicle Driveline Units and Components
- LV13: Diagnose and Rectify Motor Vehicle Transmission and Driveline System Faults.

Essential resources

Learners will need access to a vehicle workshop equipped with appropriate resources that represent the range of brakes, steering, suspension, body and power train systems and as identified in the unit content.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology, 6th Edition* (Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	planning and carrying out research of vehicle design and justification
Reflective learners	setting targets to meet development to meet schedules
Self-managers	organising time to develop learning and attainment to meet objectives

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	using ICT to plan and present information as set out in tasks
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	using ICT present information as set out in tasks
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: <ul style="list-style-type: none"> <input type="checkbox"/> text and tables <input type="checkbox"/> images <input type="checkbox"/> numbers <input type="checkbox"/> records 	Presenting information and developing on the constructive feedback given on their evidence to achieve unit criteria

Unit 7: Vehicle System Fault Diagnosis

Unit code:	F/502/6214
Level:	2
Credit value:	10
Guided learning hours:	60

Aim and purpose

The aim of this unit is to provide learners with the skills, knowledge and understanding needed to use a range of equipment to diagnose faults in modern vehicle systems.

Unit introduction

Vehicle technology has advanced, and is continuing to advance, at an exceptional rate. Materials technology has led to the production of components and systems with a significantly improved service life. This has led to increased reliability but invariably, for a variety of reasons, components and systems still malfunction. However, when modern systems do develop a defect it is more important than ever, from a speed, operational, safety and often a legal standpoint, to effect a first time repair if a vehicle is to remain respected for its reliability.

In this unit learners will diagnose a range of routine faults in a vehicle's mechanical, electrical and electronic systems regardless of the manufacturer or vehicle type (for example light or heavy vehicle, passenger service vehicle, motorsport vehicle). For the purpose of this unit, a routine fault may be considered to be a component failure or system malfunction that requires the use of a linear thought process for its correct diagnosis. This type of malfunction would normally exist in one system only and not adversely affect the correct operation of other systems.

Learners will use a range of diagnostic tools and equipment and check that they are in a safe and useable condition prior to use. When diagnosing faults learners will be required to work in a logical manner, working to instructions obtained from appropriate sources. Safe working practices and good housekeeping will be recurrent themes throughout the unit.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to carry out fault diagnostic checks
- 2 Know the techniques used to identify vehicle system faults
- 3 Be able to use diagnostic equipment to diagnose faults
- 4 Be able to record test data and report results to enable rectification to be carried out.

Unit content

1 Be able to carry out fault diagnostic checks

Preparation: health and safety regulations applicable to task e.g. Control of Substances Hazardous to Health (COSHH) Regulations, Provision and Use of Work Equipment Regulations (PUWER), Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), motorsport specific; positioning e.g. use of ramps, jacks, stands; vehicle protection e.g. covers, sheeting; component/system access e.g. removal of bodywork, fairings and covers, removal of excessive oil, dust, grease and dirt, competition/road debris

Checks: obvious sign of damage e.g. impact damage, broken parts; wear and play e.g. in mechanical linkages, bearings, spherical joints, drive shafts; leaks e.g. seals, gaskets, bushes, controls and pipe fittings; internal component damage e.g. metallic particles in lubricants; condition e.g. secure, fit for purpose, electrical equipment

2 Know the techniques used to identify vehicle system faults

Sources of information: documentary e.g. maintenance/history records, vehicle/equipment manuals, fault analysis charts, trouble shooting guides, inspection reports; electronic e.g. monitoring equipment (temperature and oil pressures gauges, telemetry), manufacturer's data (online, CD ROM), test instruments, currency of source; on-board vehicle data (data logging/self-diagnostics equipment); oral e.g. user feedback, colleague, supervisor

Diagnostic techniques: sensory e.g. sight, sound, smell, touch; measurements and readings e.g. inputs/outputs; function testing methods e.g. unit substitution, half split or six point techniques

3 Be able to use diagnostic equipment to diagnose faults

Diagnostic equipment: pressure testing equipment e.g. pneumatic, hydraulic systems; multimeters; analysers e.g. noise, vibration, crack detection (ferrous/non-ferrous); analysis, diagnostic or exhaust analyser; gauges e.g. dial test indicator, feeler gauges, micrometer; temperature measurement; crack detection

Faults: e.g. impact damage to bodywork, failed bearings or linkages, lubrication or braking system leaks, internal engine component failure (gears, bearings, shafts), loose parts/components, malfunctioning parts/components

4 Be able to record test data and report results to enable rectification to be carried out

Recording and reporting: manufacturer's documentation e.g. warranty reports, corrective action report; printouts from IT-based diagnostic equipment; work-based documentation e.g. job cards (time, costs, action taken/required), body sheet, vehicle log/report (components to be replaced/repared, actual or expected service life records) reporting mechanism e.g. appropriate person (user, colleague, supervisor, manufacturer) and format (verbal, written, diagrammatic)

Assessment and grading criteria

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

Assessment and 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:
P1 prepare two vehicles for diagnostic checking [SM3, SM4]	M1 explain the importance of careful vehicle preparation	D1 review one of the vehicle preparation and diagnostic procedures carried out and make recommendations for improvement.
P2 carry out checks to identify faults [SM3, SM4]	M2 justify the choice of diagnostic equipment used including reference to the expected levels of accuracy of the results obtained	
P3 describe sources of information used to aid fault diagnosis	M3 describe the possible consequences of inaccurate diagnostic result records and reports.	
P4 describe three fault diagnostic techniques		
P5 use appropriate diagnostic equipment to diagnose two different faults on two different vehicles [SM3, CT1, CT5, SM4]		

Assessment and grading criteria

P6	record and report the diagnostic results for two different faults to the appropriate person in a suitable format [IE4, SM3, SM4]		
----	---	--	--

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key**IE – independent enquirers****CT – creative thinkers****RL – reflective learners****TW – team workers****SM – self-managers****EP – effective participators**

Essential guidance for tutors

Delivery

Delivery should focus on developing a fundamental understanding of the principles used when diagnosing faults and defects on engine and vehicle systems within a chosen sector (for example passenger, light or heavy goods, motor sport vehicles). A balance of theoretical and practical study is recommended. Delivery of this unit will rely on learner understanding of the purpose, function, and principles of operation of specific vehicle components. This aspect of prior knowledge and skills needs to be considered carefully when undertaking this unit or placing this unit within a programme of learning.

It is strongly recommended that most of the delivery of this unit takes place in a relevant workshop environment using practical investigation and appropriate equipment, such as rigs, units, components and live vehicles. This will help learners to relate their studies to their chosen sector and develop effective routines for carrying out efficient diagnostic procedures. It is expected that, irrespective of the approach taken, learner experience should be sufficiently varied to provide them with the underpinning knowledge and skills required to assist with routine fault- finding operations on any vehicle type.

The four learning outcomes are ordered logically and it would be reasonable to develop them sequentially through practical demonstration and practice. This will enable learners to understand the logic and routine behind effective fault-finding techniques before attempting to diagnose faults themselves.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ describe the health and safety regulations that relate to vehicle fault diagnosis
- ☐ explain and demonstrate methods for positioning and protecting vehicles and ensuring access to vehicle systems and components before carrying out fault-diagnostic checks
- ☐ explain and demonstrate relevant checks to be made to locate damage and faults

Practical workshop activities:

- ☐ preparing vehicles and carrying out checks to identify faults

Prepare for and complete Assignment 1: Carrying out Fault Diagnostic Checks (P1, P2, M1)

Whole-class teaching:

- ☐ explain and demonstrate the use of a range of information sources that can aid vehicle fault diagnosis
- ☐ explain and demonstrate the use of different diagnostic techniques

Individual learner activities:

- ☐ investigation of fault diagnostic techniques and related information sources

Whole-class teaching:

- ☐ explain and demonstrate the use of diagnostic equipment to diagnose a variety of faults

Practical workshop activities:

- ☐ practise and use of diagnostic equipment and techniques to diagnose faults on different vehicles

Individual learner activities:

- ☐ evaluation of preparation and diagnostic procedures to identify possible improvements

Prepare for and complete Assignment 2: Vehicle System Fault Diagnosis (P3, P4, P5, M2)

Topic and suggested assignments/activities and/assessment
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ explain the relevant documentation that needs to be completed for correct recording □ explain the appropriate mechanisms for reporting results <p>Small-group activities:</p> <ul style="list-style-type: none"> □ investigation and use of role play to practise recording and reporting of diagnostic test results
Prepare for and complete Assignment 3: Recording and Reporting Test Data (P6, M3)
Prepare for and complete Assignment 4: Reviewing Preparation and Diagnostic Procedures (D1)
Feedback to learners, unit evaluation and close

Assessment

Although theoretical study will be included, the emphasis in this unit is on developing practical diagnostic skills across a range of mechanical and electrical vehicle systems. Inherent in the learning outcomes and assessment criteria is the expectation that learners will have undertaken practical work on vehicles to support their theoretical studies. Learners should be given opportunities to diagnose faults and recommend repair strategies based on diagnostic information and other criteria such as cost, time, service life etc.

To achieve the assessment criteria, learners will need the opportunity to use and compare alternative diagnostic strategies and equipment in practical situations under a variety of conditions. Typical evidence for the unit as a whole will include logbook entries, notes, sketches, records or copies of source information with extracted data annotated, records of actual data gathered by the learner (for example documentary, test data, notes taken following feedback from users), printouts and records of the diagnostic procedures carried out together with supporting authentication by tutor/supervisor and records of tutor observation/oral questioning.

To achieve a pass, learners will need to prepare two vehicles for diagnostic checking and carry out the checks to identify faults. Along with providing descriptive evidence relating to sources of information and fault diagnostic techniques, learners need to select and use appropriate diagnostic equipment to diagnose two different faults and report and record the diagnostic results appropriately.

It is expected that the 'two different faults' will be on different vehicles at different times. The vehicles could however be of the same type (for example both goods vehicles or both motorsports vehicles if this is appropriate) or different types. The intention here is to enable learners to experience a diverse range of vehicle system faults across different vehicles so that they have the opportunity to satisfy all the assessment criteria with sufficient depth and rigour. The descriptions of the three fault diagnostic techniques (P4) could be applied across the two different faults required for P5 (for example one fault-diagnostic technique successfully used on the first vehicle followed by two techniques required to isolate a single fault or two faults on a second vehicle). All the pass criteria should be met through practical tasks involving preparation for, carrying out and recording of fault-diagnostic techniques and related results.

For the purpose of this unit learners are not expected to undertake the necessary repair identified by the fault diagnosis but are expected to provide sufficient information to enable such a repair to be carried out. However, if this unit is linked with others in the programme (for example *Unit 9: Routine Vehicle Maintenance Techniques*) then this could be the next natural step in the process.

To achieve a merit, learners should be able to explain the importance of careful vehicle preparation. This will be within the same context as for the pass criteria – health and safety, positioning, vehicle protection and component/system access. For example, when handling substances hazardous to health COSHH regulations must be applied, but why and what might the consequences be of not doing so within the context of the fault-diagnostic techniques being carried out? The learner should also be able to justify the choice of diagnostic equipment used and think about the results obtained in terms of the expected

levels of accuracy. The final merit criterion requires the learner to describe the possible consequences of inaccurate diagnostic result records and reports. This could be in terms of legal requirements, subsequent costs of rework, inappropriate components being ordered, or future misdiagnosis due to inaccurate service history records.

To achieve a distinction, learners should be able to review the preparation and diagnostic procedures (for example checks carried out, sources of information used, equipment selection and use, diagnosis carried out and the recording/reporting procedure) on one vehicle and make recommendations for possible improvement. The improvements could be in terms of health and safety, time, costs, reliability/competitiveness.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, M1	Carrying out Fault Diagnostic Checks	A technician needs to prepare a vehicle and carry out diagnostic checks to identify faults	A practical task supported by learners' written records and records of tutor observation and oral questioning
P3, P4, P5, M2	Vehicle System Fault Diagnosis	A technician needs to use diagnostic equipment to diagnose faults	A practical task supported by learners' written records and records of tutor observation and oral questioning
P6, M3	Recording and Reporting Test Data	A technician has to inform their supervisor of the results of the fault diagnosis tests carried out	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning
D1	Reviewing Preparation and Diagnostic Procedures	A technician needs to review the procedures used in their workshop to identify improvements that can be made	A written report

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Routine Vehicle Maintenance Techniques	
	Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	

This unit has links with many standards but particularly the Level 2 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit G4: Use of Hand Tools and Equipment in Motor Vehicle Engineering
- Unit LV01: Carry out Routine Motor Vehicle Maintenance
- Unit LV02: Remove and Replace Motor Engine Units and Components
- Unit LV03: Remove and Replace Motor Electrical Units and Components
- Unit LV04: Remove and Replace Motor Vehicle Chassis Units and Components.

Essential resources

Centres will need to provide learners with access to a range of components, assemblies, demonstration rigs, diagnostic equipment and suitable vehicles along with relevant information sources and manuals.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition
(Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	evaluating information when analysing and recording diagnostic results
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when preparing, checking and carrying out fault diagnosis on a vehicle
Creative thinkers	generating ideas, exploring possibilities and trying out new solutions when diagnosing faults

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Team workers	collaborating with others when working as part of a team to locate and diagnose vehicle system faults
Reflective learners	setting goals with success criteria for their development and work
Effective participators	presenting a persuasive case for action when reporting diagnostic results to an appropriate person

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	accessing appropriate data and information sources to aid fault diagnosis
ICT – Develop, present and communicate information	
Bring together information to suit content and purpose	recording and reporting diagnostic results
Present information in ways that are fit for purpose and audience	recording and reporting diagnostic results

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	listening to information provided by customers, colleagues and supervisors and reporting results of fault diagnosis
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading a variety of documentary information used to aid fault diagnosis
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing relevant documentation when recording and reporting results of fault diagnosis

Unit 8: Function and Operation of Vehicle Electrical Systems and Components

Unit code: F/503/1459

Level: 2

Credit value: 5

Guided learning hours: 30

Aim and purpose

The aim of this unit is to introduce learners to the main electrical components and systems found in a modern vehicle and enable them to identify and confirm system function and operation.

Unit introduction

This unit specifically considers the function and correct operation of lighting systems and their auxiliary components, and a vehicle's battery, alternator and starter systems.

The first part of the unit gives learners the opportunity to gain knowledge of the function of vehicle lighting and auxiliary systems. It specifically deals with how each system is operated and, through learning the correct working parameters, learners will be able to decide if they are working correctly or not. The second part of the unit deals with the function and operation of a lead acid battery and a vehicle's alternator and starter systems. Working closely with these systems will enable learners to develop further their ability to use test equipment to measure various electrical values and determine from the test results if each system is working correctly.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to identify the performance parameters of vehicle lighting and auxiliary electrical components
- 2 Be able to confirm the correct function of a vehicle's lead acid battery, alternator and starter system.

Unit content

1 Be able to identify the performance parameters of vehicle lighting and auxiliary electrical components

Performance: characteristics and operation e.g. legal requirements, function and operating procedures; checks for correct operation e.g. alignment, level, temperature levels, sensor activation; conformation that components are functioning and where relevant, within expected operating parameters e.g. auto-fade of interior lights on door closure, all doors central lock, cooling/heating fan adjusts to ambient temperatures

Lighting components: statutory e.g. side and rear, main and dip beam, front and rear fog lamps, stop lamp, reverse lamp, indicators, hazard warning; non-statutory e.g. interior, information panel

Auxiliary electrical components: general systems e.g. windscreen wipers, horn, window opening/closure, bonnet/boot releases; heating e.g. interior cabin, seats, rear screen, external mirrors, cold start systems; air conditioning; security e.g. central locking, vehicle alarm systems, parking sensors

2 Be able to confirm the correct function of a vehicle's lead acid battery, alternator and starter systems

Lead acid battery function and operation: action of a simple lead acid cell; connecting simple cells in series; factors affecting cell capacity e.g. plate area, number of plates; identification and naming of component parts e.g. materials used for case, terminal types, cell arrangements; connecting batteries in series and parallel; low maintenance and no maintenance batteries; battery performance e.g. use of battery test meters, battery state of charge indicators, battery acid relative density values and capacity; interpretation of test results

Safe working and handling: procedures for battery handling e.g. physical removal and replacement from a vehicle, storage, personal protective clothing; disconnecting from and reconnecting to a vehicle's electrical circuit; connecting and removing from charge; safe use of fast chargers and jump-start procedures; measurements of charge and specific gravity values

Alternator function and operation: application of magnetic principles to alternator operation e.g. increase of electromotive force (emf) by increasing rotor current and speed, use of diodes to convert ac to dc for battery charging, need for output voltage control; factors affecting current output; identification and naming of the component parts; maintenance and adjustments e.g. drive belt tension, checking drive belt condition, measure output voltage and current

Starter motor function and operation: the application of magnetic principles to starter and solenoid operation e.g. how rotary motion is generated within the starter motor; identification and naming of component parts of the starter motor e.g. armature, field coils, brushes, solenoid; starter circuit; identification and function of pinion and protection devices (roller clutch, armature brake); starter performance measurements (current drawn by starter motor, battery voltage under load, circuit voltage drop tests)

Test equipment: e.g. hydrometer, battery high rate discharge tester, ammeter, multimeter, analytical testers

Assessment and grading criteria

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

Assessment and 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:
P1 identify correct performance of a vehicle's lighting components	M1 explain the need for voltage control on an alternator and the consequence of a faulty regulator	D1 evaluate test data, from an alternator or starter system, to explain the impact that a fault would have on a vehicle's operation.
P2 identify correct performance of a vehicle's auxiliary components	M2 explain the need for a solenoid and protection devices in a starter system.	
P3 explain the function and operation of a lead acid battery		
P4 describe procedures for safe working and handling of a lead acid battery		
P5 explain the function and operation of an alternator		
P6 explain the function and operation of a starter motor		
P7 use test equipment to confirm correct function of battery, alternator and starter systems [SM3].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Learners should undertake this unit after completing *Unit 2: Vehicle Electrical and Electronic Principles* so they can apply the theory and principles from that unit to vehicle electrical components covered within this unit. It will also lay the foundation for further study of electrical systems in BTEC Level 3 qualifications.

The first learning outcome deals with how lighting and auxiliary systems are operated and function and will require the use of a modern vehicle(s) that includes at least the systems listed in the unit content.

The second learning outcome requires learners to explain the function of a vehicle's battery, alternator and starter motor. They should be able to name the internal components and appreciate the theory as applied to each system to explain basic operation (for example how the simple cell works, how the rotor and stator produces an emf, how the starter field coil (magnets) and armature produces motion). In addition, learners will need to know the function of the component parts and how they contribute to the overall functionality of each system. The use of safe working practices must be emphasised throughout, particularly in the case of working with batteries.

Once learners have the necessary basic knowledge and skills, a practical demonstrative/investigative approach using real or simulated systems should be adopted, wherever possible. It is important that the full breadth of the unit is delivered along with the underpinning concepts and principles implied in the unit content. The teaching and learning strategies used to deliver the unit must take into account the intention to assess this unit using both written and practical assignments.

Achievement of merit and distinction will be demonstrated through a learner's ability to compare and evaluate. Therefore, during the delivery/learning phase these skills need to be developed and encouraged. Formative assessment and feedback will play an important part in the general development of learners but especially their development of these higher level skills.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to unit content, overview of activities and assessment methodology
- explain the operation of statutory and non-statutory vehicle lighting systems
- explain the operation of general auxiliary electrical systems, heating, air conditioning and security systems
- explain and demonstrate the procedures for checking correct operation and confirming that components are functioning within expected parameters

Practical workshop activities:

- checking a range of vehicle lights and auxiliary electrical components and systems to identify correct operation

Prepare for and complete Assignment 1: Vehicle Lighting and Auxiliary Components (P1, P2)

Whole-class teaching:

- describe the relevant procedures for safely handling and working with batteries
- identify battery components, explain the action of a lead acid battery cell, the connection of cells in series and the factors affecting cell capacity
- explain connection of batteries in series and parallel, the differences between low maintenance and no maintenance batteries
- explain methods of measuring battery performance, using test equipment to confirm battery function and the interpretation of test results

Practical workshop activities:

- using test equipment to identify correct function of vehicle batteries

Topic and suggested assignments/activities and/assessment
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ identify alternator components □ explain the magnetic principles that apply to the rotor and stator and the effect of speed and strength of the rotor current □ explain the use of diodes for battery charging, the need for output control and the factors affecting output □ explain and demonstrate maintenance checks and adjustments that may be required to ensure correct alternator function <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ using test equipment to identify correct function of alternator systems
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ identify starter system components □ explain the magnetic principles that apply to starters and solenoids and explain the operation of a starter circuit □ explain and demonstrate use of test equipment to measure starter performance <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ using test equipment to identify correct function of starter systems
<p>Prepare for and complete Assignment 2: Function and Operation of Vehicle Batteries, Alternators and Starter Motors (P3, P4, P5, P6)</p>
<p>Prepare for and complete Assignment 3: Testing Vehicle Batteries, Alternators and Starter Systems (P7, M1, M2, D1)</p>
<p>Feedback to learners, unit evaluation and close</p>

Assessment

Evidence for this unit could come from a mixture of written and practical assessments. A range of written assessment methods should be explored including assignments and short time-constrained tests, particularly where the naming of parts is required. For practical evidence the learner should provide a description of the work undertaken, results generated and any conclusion reached. The assessor should authenticate the practical work through assessor or witness observation records. These should give details of what has been seen; any oral questioning that has taken place and the context within which the work was undertaken (for example on-the job, college repair workshop, simulated activity). If learners work in pairs (or more) then there must be a clear strategy to ensure that each learner produces relevant and individual evidence to satisfy the criteria.

To achieve a pass grade, learners should demonstrate their ability to identify the correct performance of the range of lights (P1) and auxiliary components (P2) found on a modern vehicle. Learners should have opportunities to identify operation outside the acceptable parameters. If a number of learners are using the same vehicle then simulated faults in the system should be changed to retain validity of the task. The function of a vehicle battery and the action of a simple cell (i.e. two dissimilar metals and an electrolyte) are required for P3. Learners also need to be able to name the various parts of the battery (for example casing, cells, separators, plates etc). This could be achieved through a gapped drawing, although this type of approach would be more appropriate to a time-constrained test.

Adopting bad practices when working with batteries may cause accidents and the need to work safely must be strongly emphasised. The evidence for P4 could be presented in various ways (for example use of checklists, posters, logbook, safety leaflet) but the task set should ensure that the learner recognises the dangers of working with and handling vehicle batteries (for example on and off vehicles, connecting/disconnecting, working under a bonnet and near a battery, manual handling, storing, use of slow and fast chargers, use of jump leads).

The evidence for P5 requires the learner to explain the function and operation of the alternator. They should use the names of the various internal parts (for example casing, rotor, stator, regulator, and rectifier) and explain how its output voltage is produced. The explanation of the latter should be limited to the application of magnetic principles (for example relative movement of magnetic field and coil) that apply to the rotor and stator, but the effect of speed and strength of the rotor current should also be included. As with the battery, a gapped drawing could be used for naming the parts and care should be exercised that the work is authentic and not directly copied from another source.

A similar level of detail is needed for the starter system (P6). Having explained its function and operation, possibly a gapped handout would be most appropriate to enable learners to name the various parts (for example solenoid, casing, armature, field coils/poles, brushes, pinion). Again, care must be taken to ensure that the responses are authentic. The explanation of starter operation should include how rotary movement is produced in the starter motor by applying the principle of the effect of two magnetic fields and relating it to the starter motor armature and fixed magnetic field.

The use of meters (P7) to attain values may be carried out on vehicles, but bench tests (battery) and use of running rigs would simplify access. Realistically, the task is likely to be divided into three parts (battery, alternator and starter) and in each case test values using two different meters/methods should be obtained. These should be compared with manufacturer's data and the system's integrity confirmed in each case. Typically, specific gravity/state of charge and capacity test values would be obtained from a battery; voltage and current from an alternator and current and voltage under load for a starter. The aim is to enable learners to measure test values, compare them with given values and judge the system for satisfactory performance.

The task for M1 could follow an investigation, under controlled conditions, of the effect of no voltage control or regulation in an alternator and from the result obtained learners could explain the consequence of this on the alternator, battery, lighting, ECUs and auxiliary components. The task for M2 should, for the first part, lead the learner to consider the reason for using a solenoid in the starter circuit (for example reducing long lengths of starter cable resulting in increased voltage drop, cost, space take up) and secondly, the effect on the starter performance and life if no protection devices are incorporated (for example roller clutches, armature brake).

To achieve a distinction, learners will need to evaluate the data obtained from tests carried out on a faulty alternator or starter system and explain the likely effect that the fault(s) may have on the vehicle. The response for D1 would be to critically analyse the test results, draw conclusions that can be derived from them and explain the effect the fault would have on the performance of the system and the vehicle overall (for example high output alternator/overcharged battery – reduction in life of both the component and other vehicle electrical components; high voltage drop in starter circuit/slow starter speed – engine will not start).

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2	Vehicle Lighting and Auxiliary Electrical Components	A technician needs to identify whether a vehicle's lights and auxiliary electrical equipment are functioning correctly	A practical task supported by learners' written records and records of tutor observation and oral questioning
P3, P4, P5, P6	Function and Operation of Vehicle Batteries, Alternators and Starter Motors	A technician needs to explain the operation of electrical systems to a new apprentice	A time-constrained test
P7, M1, M2, D1	Testing Vehicle Batteries, Alternators and Starter Systems	A technician needs to identify whether a vehicle's battery, alternator and starter system are functioning correctly	A practical task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle System Fault Diagnosis	
	Vehicle Electrical and Electronic Principles	

This unit has links with many standards but particularly the Level 2 and Level 3 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit LV01: Carry out Routine Motor Vehicle Maintenance
- Unit LV02: Remove and Replace Motor Engine Units and Components
- Unit LV03: Remove and Replace Motor Electrical Systems and Components
- Unit AE06: Diagnose and Rectify Motor Electrical Unit and Component Faults

Essential resources

In addition to the normal teaching, demonstration and investigational resources required to deliver a vehicle electrical component topic, centres will need to have access to small tools, test meters, a range of vehicles/working rigs, components and data/manufacturers' information.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition (Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	organising time and resources when using test equipment to confirm correct function of systems

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching and investigating the function and operation of vehicle electrical systems and components
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	explaining the function and operation of a vehicle's battery, alternator and starter motor

Unit 9: **Routine Vehicle Maintenance Techniques**

Unit code:	T/503/1460
Level:	2
Credit value:	10
Guided learning hours:	60

Aim and purpose

The aim of this unit is to enable learners to use appropriate information, tools and equipment to carry out routine vehicle maintenance and complete maintenance records correctly.

Unit introduction

A new vehicle must be in excellent running order when collected by the owner, and should be maintained regularly to guarantee optimum condition. As technology has advanced, systems that have previously been subject to manual adjustment are now adjusted automatically. The introduction of condition monitoring devices has reduced the need for frequent checking of some systems and, as material and lubrication technology has improved the maintenance interval requirements of most vehicles have extended. However, as a vehicle ages, invariably more maintenance will be required.

There are many different types of maintenance such as the pre-delivery inspection (conducted before the customer collects the vehicle following purchase), the first service, the interim service and the major service (each of which could be time based or mileage based).

Within the maintenance operation an extensive list of items are checked that are liable to wear over a period of time. Certain items are replaced, for example engine oil, filters, and spark plugs. Additional items may be replaced according to age and mileage, for example cam belt, anti-freeze and brake fluid. Regular maintenance is a preventative measure – often breakdowns or major problems arise because early warning signs were not detected.

The purpose of this unit is to enable learners to understand the procedures necessary for routine vehicle maintenance. This will include how to access and effectively use the range of information sources available. Learners will also gain an understanding of the effective use of maintenance procedures, the selection of appropriate tools and equipment, and the appropriate completion of maintenance documentation.

This unit deals with maintenance requirements in a generic way. The principles and practical aspects taught are transferable skills that can be applied to vehicles regardless of the vehicle's manufacturer or application.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to select information and data for routine maintenance
- 2 Be able to select appropriate equipment, components and materials for vehicle maintenance
- 3 Be able to carry out routine vehicle maintenance
- 4 Be able to complete maintenance records

Unit content

1 Be able to select information and data for routine maintenance

Information and data: vehicle technical data and repair processes; records of vehicle inspection; customer instructions; safety and legal requirements; schedules of inspection e.g. first, interim, major; service data e.g. on-board diagnostic displays, manufacturers' and non manufacturers' workshop manuals, microfiche, CD ROM, online information, technical service bulletins (TSBs); parts lists

Maintenance procedures: routine vehicle servicing e.g. first, interim, major service; vehicle breakdown repair e.g. component failure or wear

2 Be able to select appropriate equipment, components and materials for vehicle maintenance

Equipment: test instruments e.g. brake fluid hygroscopicity, tension measurement, brake efficiency; measuring equipment e.g. anti-freeze hydrometer, tyre tread depth gauge, emission test equipment, steering alignment equipment, wheel balancing equipment

Components and materials: filters e.g. air, oil, fuel, pollen; drive belts e.g. alternator, power steering, camshaft timing belt; spark plugs; wiper blades; brake linings and brake pads; lubricants and fluids e.g. engine oil, manual transmission oil, automatic transmission fluid (ATF), brake fluid, anti-freeze; gaskets and seals

3 Be able to carry out routine vehicle maintenance

Examination methods: aural; visual; functional; measurements

Maintenance requirements: e.g. for malfunction, damage, fluid levels, leaks, wear, security, condition and serviceability, component faults found outside the manufacturers'/workplace procedure requirements, conformity, corrosion

Adjustment and replacement: e.g. clearances, gaps, settings, alignment (lights, steering, body fittings), pressures, tension, speeds, levels, valves, ignition, fuel and emissions, brakes, transmission

Vehicle areas: e.g. engine, transmission, chassis, electrical, body

4 Be able to complete maintenance records

Records: e.g. job cards (manufacturer, fleet, company or customer), vehicle inspection, manufacturers' service history, warranty, customer recommendation, road test, pre-delivery inspections, workshop tests (smoke/emissions test, roller brake test, alignment tests)

Assessment and grading criteria

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

Assessment and 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:
P1 select relevant information and data for a given maintenance procedure [IE4]	M1 compare three different methods of accessing information and data for routine maintenance	D1 justify the selection of equipment and materials for a given maintenance activity.
P2 select appropriate equipment for a routine maintenance procedure	M2 explain the reasons for carrying out a maintenance activity.	
P3 select components and materials required for a routine maintenance procedure		
P4 use examination methods to identify maintenance requirements [IE1]		
P5 carry out necessary adjustments and replacement of vehicle components and materials for two given vehicle areas [SM3, SM4]		
P6 complete maintenance records in accordance with manufacturers'/ workplace requirements.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

This unit supports the skills, knowledge and understanding needed to carry out effective maintenance of vehicle systems. It is expected that learners will have an understanding of the procedures necessary to carry out maintenance of vehicle systems and sub-systems, the information sources available, the equipment required and the necessary recording documentation.

Delivery of this unit should focus on developing a fundamental understanding of the maintenance requirements of modern vehicles. A balance of theoretical and practical study is appropriate, although it is strongly recommended that a significant amount of delivery takes place in a workshop environment equipped with modern vehicles. It is expected that learner experience should be sufficiently varied to give them the underpinning knowledge and transferable skills to enable them to perform routine maintenance operations on a range of vehicles, regardless of the manufacturer.

Achievement at merit and distinction will be demonstrated through the autonomous review and analysis of the key stages in the maintenance process which should enable the learner to make informed recommendations and justifications. Specifically, a distinction will be achieved where learners demonstrate their ability to justify the selection of information, materials and equipment.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ explain the selection and use of different types of information and data that are required for vehicle maintenance
- ☐ describe the differences between routine maintenance procedures and vehicle breakdown repairs

Individual learner activities:

- ☐ investigation of information and data for routine maintenance

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- describe the use of test instruments and measuring equipment required for maintenance procedures
- describe the use of a range of components and materials for different maintenance procedures
- Individual learner activities:
- investigation of equipment, com40
- ponents and materials used for routine vehicle maintenance

Prepare for and complete Assignment 1: Preparing for Vehicle Maintenance (P1, P2, P3, M1, D1)

Whole-class teaching:

- explain and demonstrate the different examination methods that can be used to identify maintenance requirements
- explain the possible adjustments and components replacement that may be necessary
- explain relevant records that need to be completed following vehicle maintenance
- Practical workshop activities:
- investigation of a range of different maintenance requirements on different vehicles and vehicle areas, using examination methods to identify faults, damage and wear
- using relevant information and data, equipment, components and materials for vehicle maintenance
- making adjustments/replacing components as part of routine vehicle maintenance procedures
- complete maintenance records in accordance with relevant requirements

Prepare for and complete Assignment 2: Routine Vehicle Maintenance Procedures (P4, P5, P6, M2)

Feedback to learners, unit evaluation and close

Assessment

This unit requires a variety of evidence to be gathered to support assessment. Some will be in the form of written responses whilst other evidence will be process-based where practical documentation, witness statements or observation records will be required. The pass criteria focus on the activities before, during and after routine maintenance. The merit criteria then focus on the comparison and explanation of processes and activities. The distinction criterion brings together what has been learned, with learners demonstrating their ability to justify the selection of equipment and materials for a given maintenance activity.

To achieve a pass, learners need to demonstrate application of knowledge and understanding of the processes necessary to carry out routine maintenance and repair. They should select relevant information and data required for a given maintenance procedure (for example spark plug electrode gaps, tyre pressures, emission data from manuals, wall chart etc) and select the necessary equipment, components and materials. Learners will need to be able to effectively use examination methods (for example aural, visual, functional) to identify maintenance requirements and perform adjustments and replacement of components where necessary. Learners should also be able to complete maintenance records in accordance with manufacturers'/workplace requirements.

To achieve a merit, learners should be able to compare three different methods of accessing information and data prior to routine maintenance activities being conducted. Ideally, learners will have used a range of information sources during practical activities so that they may draw comparisons from their workshop experience. They should also be familiar enough with maintenance procedures to be able to explain the reasons for carrying out a particular maintenance activity.

To achieve a distinction, learners should be able make informed decisions to justify their selection of equipment and materials used for a maintenance activity.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1, D1	Preparing for Vehicle Maintenance	A vehicle technician has to locate relevant information and data and select suitable components and materials in preparation for a vehicle repair process	A practical task supported by learners' written records and records of tutor observation and oral questioning
P4, P5, P6, M2	Routine Vehicle Maintenance Procedures	A technician needs to carry out a vehicle maintenance procedure and complete relevant documentation	A practical task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Essential Working Practices for Vehicle Technology	Vehicle Fault Diagnosis
	Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems	

This unit has links with many standards but particularly the Level 2 and Level 3 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle:

- Unit G4: Use of hand tools and equipment in Motor Vehicle engineering
- Unit LV01: Carry out Routine Motor Vehicle Maintenance.
- Unit LV03: Remove and Replace Motor Electrical Systems and Components
- Unit AE06: Diagnose and Rectify Motor Electrical Unit and Component Faults

Essential resources

To deliver this unit, centres will need to provide learners with access to a range of equipment, components and materials necessary to carry out maintenance procedures. Centres will need access to workshops equipped with suitable vehicles and assemblies, rigs and diagnostic equipment.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition (Nelson Thornes, 2010) ISBN 978-1408515181

Bonnick, A and Newbold, D – *A Practical Approach to Motor Vehicle Engineering and Maintenance* (Butterworth-Heinemann, 2005) ISBN 9780750663144

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	identifying questions to answer and problems to resolve when identifying maintenance requirements analysing and evaluating information, judging its relevance and value when selecting information for a maintenance procedure
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when carrying out routine maintenance procedures

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work
Team workers	collaborating with others when working as part of a team to carry out routine vehicle maintenance

Functional Skills – Level 2

Skill	When learners are ...
English	
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	analysing and selecting information for maintenance procedures
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing maintenance records

Unit 10: Vehicle Science and Mathematics

Unit code: Y/502/6221

Level: 2

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to develop learner ability to apply mathematical and science principles to solve practical vehicle-related problems.

Unit introduction

In this unit learners will develop the understanding needed to solve a range of motor vehicle-related scientific and mathematical problems. The unit will cover a number of science and mathematical concepts involving the International System of Units (SI). Learners will then be able to apply these to relevant technology units in their programme of study.

Opportunities should be taken to link this unit closely with work in the more practical-based technology units to ensure vocational relevance and give currency to a subject area that can be problematic.

Whilst developing the use of the mathematical 'tools', this unit also links theory to practical activities. This gives currency to the development of the skills that are used throughout the industry on a regular basis. This can vary from basic calculations of percentages, such as VAT on invoices, to comparison of data, performance and measurements, that are an everyday occurrence in servicing, fault diagnosis and vehicle repair.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to solve vehicle-related problems mathematically
- 2 Be able to use an electronic scientific calculator
- 3 Be able to use science units, terms and principles when solving vehicle-related problems
- 4 Be able to apply the principles of energy to determine vehicle performance.

Unit content

1 Be able to solve vehicle-related problems mathematically

Mathematical methods: addition, subtraction, multiplication and division of whole and decimal numbers; ratio and proportion; percentage; use of the brackets, order, division, multiplication, addition, subtraction (BODMAS) rule, powers and roots of a number; expressing numbers using standard form and scientific notation e.g. 5.6×10^5 , 12×10^3 W, 12 kW

Transpose and evaluate: solution of problems that require the manipulation of simple equations including bracketed terms, roots and powers eg $V = IR$, $P = VI$, $RT = \text{Product/sum}$, $pV = c$, $v = u + at$, $s = \frac{1}{2}(u + v)t$, $P = I^2R$, $v = \sqrt{2gh}$,

$I = \sqrt{\frac{P}{R}}$; complex formulae e.g. $s = ut + \frac{1}{2}at^2$, $v^2 = u^2 + 2as$, $V = V_0 \sin 2\pi ft$, X_c

$= 1/2\pi fC$; combining formulae e.g. $\frac{1}{2}mv^2 = mgh$ find v

Area: areas of regular shapes, e.g. squares, rectangles, triangles, circles; the area of compound shapes e.g. L-shapes, parallelograms

Volume: regular solid bodies e.g. right rectangular prisms, cylinders, cones, spheres; compound solid bodies e.g. truncated prisms, piston and crown, cylinders with spherical ends

Graphs: linear relationships e.g. determining gradient, intercept, distance travelled, linear acceleration, work done; non-linear relationships e.g. inverse relationships, exponential growth and decay; basic principles (including scales, axes, straight line graphs, construction and plotting of curves from given data); use of manufacturers' data; interpolation and extrapolation of results related to vehicle performance

Trigonometry: Pythagoras' theorem; acute angle ratios; sine, cosine, tangent ratios; $\sin\theta/\cos\theta = \tan\theta$ relationship to solve right angle triangle problems triangles within a compound area or volume; complex shape e.g. a combined rectangle and triangle or pyramid; use trigonometry to solve unknown dimensions

2 Be able to use an electronic scientific calculator

Basic functions: add, subtract, multiply and divide whole numbers and decimal fractions

Special function keys: determine sine, cosine, and tangent ratios; powers; roots; enter and read numbers in standard form and scientific notation e.g. 5.6×10^5 , 12×10^3 W and 12 kW

Chained calculations: e.g. $v = \sqrt{u^2 + 2as}$ or similar equations in one continuous calculation

3 Be able to use science units, terms and principles when solving vehicle related problems

SI units: primary units; typical motor vehicle quantities and units; multiples and sub multiples; unit conversion e.g. cc to litres, mV to V

Force: types of forces, force and pressure

Moments: moment of a force, torque, types of levers, principle of moments, centre of gravity, simple gear ratios e.g. gear train, pinion to starter ring gear

Stress and strain: types of stress and strain; elasticity; Hooke's law; factor of safety; Young's Modulus

4 Be able apply the principles of energy to determine vehicle performance

Vehicle performance: simple linear equations of motion e.g. $v = u + at$; velocity; acceleration; Newton's laws; work; power

Practical activities: tests for torque, tests for brake power

Conversion of energy: e.g. chemical-mechanical-electrical, combustion process, electro-chemical

Impact: e.g. safety, friction, fuel consumption, heat generation

Assessment and grading criteria

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

Assessment and 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:
P1 use mathematical methods to transpose and evaluate simple formulae [IE4]	M1 transpose and evaluate complex formulae	D1 transpose and evaluate combined formulae
P2 determine the area of two regular shapes from given data [IE1]	M2 identify the data required and determine the area of two compound shapes	D2 carry out chained calculations using an electronic calculator
P3 determine the volume of two regular solid bodies from given data	M3 identify the data required and determine the volume of two compound solid bodies	D3 explain the impact of various types of forces on vehicle performance.
P4 plot a graph for linear and non-linear relationships from given data	M4 use trigonometry to solve complex shapes	
P5 solve right-angled triangles for lengths of sides and angles using Pythagoras' theorem, sine, cosine and tangent functions	M5 use vehicle related performance graphs and manufacturer's data to determine and compare vehicle performance.	
P6 perform calculations using the basic and special functions keys of an electronic scientific calculator [IE1]		

Table continues on next page

Assessment and grading criteria		
P7 solve vehicle related problems, quoting SI units involving force, moments, gear ratios, stress and strain		
P8 use Newton's laws to solve a vehicle performance problem		
P9 carry out practical activities to record torque and brake power		
P10 explain an example of energy conversion that occurs in a motor vehicle.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

It is expected that learners will develop an understanding of science and mathematical concepts in relation to their vocational area and that wherever possible calculations and problem solving should be integrated with more practical technology units.

The use of SI units should be encouraged throughout the teaching of this unit and safe working practice should be adhered to in any practical tasks.

Delivery of this unit should be strategically planned to highlight the vocational relevance of science and mathematics. This will be achieved by the inclusion/integration of elements of this unit with practical technology units. A good example of this would be when working within engine design and the identification of components, to measure bore size and stroke, and complete calculations on engine size and compare results to manufacturers' data. Linking theoretical maths and science and practical units can be adopted across the range of disciplines. For example, for the electrician, the calculations associated with the relationship between volts, ohms and amps can be both calculated and measured, similarly for the body repairer checking basic alignment against calculations of trigonometry. This would then reinforce the relationship of science and mathematics with the practical skills used in vehicle technology.

Evidence should be gathered in various formats to minimise the more formal and traditional classroom approach. Centres will determine their approach through an analysis of their learners' needs and through consideration of the range of commercial bodies that the centre is working with or preparing their learners to work with. Whichever approach is taken it is expected that learner experience should provide them with the underpinning knowledge to enable them to use techniques, tools, equipment and measuring instruments in most commercial settings.

Although not included in the unit content, there is an expectation that the safe and correct use of items of equipment will be emphasised before learners carry out any practical activities.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to the unit content, scheme of work and assessment strategy
- tutor-led revision of manual procedures for addition, subtraction, multiplication, division and calculation of ratio, proportion and percentage
- explain and apply BODMAS rule

Individual learner activity:

- exercises in arithmetical calculation

Whole-class teaching:

- explain powers and roots of a number and the rules of indices followed by how to express numbers in standard form and scientific notation
- tutor demonstration of use of electronic scientific calculator for basic functions and special function keys

Individual learner activity:

- exercises in use of electronic scientific calculator

Whole-class teaching:

- explain application of transposition rules and procedures for simple, complex and combined formulae

Individual learner activity:

- exercises in transposition and evaluation of formulae

Prepare for and complete Assignment 1: Mathematical Methods (P1, P6 (part), M1, D1, D2)

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- ☐ explain and demonstrate calculation of area of squares, rectangles, and triangles and use of radius and diameter for the calculation of area of circles
- ☐ explain and demonstrate calculation of area of compound shapes

Individual learner activity:

- ☐ exercise in calculation of areas

Whole-class teaching:

- ☐ explain and demonstrate the use of standard formulae for the calculation of volume of regular and compound solid bodies

Individual learner activity:

- ☐ exercises in calculation of volumes

Whole-class teaching:

- ☐ explain direct proportional and linear relationships followed by how to choose suitable scales and plot graphs from given data
- ☐ tutor demonstration of calculation of the gradient explaining the significance of both the gradient and intercept in the formation of the equation for a linear graph
- ☐ tutor demonstration of the calculation of the area under a graph and its significance in practical applications e.g. velocity-time graph

Individual learner activity:

- ☐ exercises in plotting linear and non-linear graphs

Prepare for and complete Assignment 2: Mensuration and Graphical Methods (P2, P3, P4, M2, M3)**Whole-class teaching:**

- ☐ demonstrate use of Pythagoras' theorem in solution of right angle triangles
- ☐ define tangent of an acute angle and explain use of TAN and TAN^{-1} function key on electronic calculators
- ☐ demonstrate determination of acute angles in right angle triangles and calculation of opposite and adjacent sides to an acute angle

Individual learner activity:

- ☐ exercises involving solution of right angle triangles

Whole-class teaching:

- ☐ define sine and cosine of an acute angle and explain use of SIN, SIN^{-1} , COS and COS^{-1} function keys on electronic calculators
- ☐ demonstrate determination of acute angles in given right angle triangles and solution of right angle triangles using appropriate trigonometrical ratio and Pythagoras' theorem

Topic and suggested assignments/activities and/assessment**Individual learner activity:**

- exercises involving solution of right angle triangles

Whole-class teaching:

- prove the relationship $\sin\theta/\cos\theta = \tan\theta$ and demonstrate calculation of dimensions within complex shapes containing right angle triangles

Individual learner activity:

- exercises involving calculation of dimensions

Prepare for and complete Assignment 3: Trigonometry (P5, P6 (part), M4)**Whole-class teaching:**

- explain origins of SI system of units, define fundamental units and explain the makeup of derived units
- explain multiples and sub-multiples and unit conversion
- Individual learner activity:
- exercises involving solution of problems involving multiples and sub-multiples

Whole-class teaching:

- define the derived unit of force and active and reactive forces, explain the occurrence of gravitational force and distinguish between mass and weight
- define pressure and its units and demonstrate calculation of weight and pressure
- explain the moment of a force, the principle of moments and applications of moments and torque in vehicle gear ratios
- demonstrate calculation of gear ratios, input and output speeds and input and output torque

Individual learner activities:

- solution of problems involving gear trains

Whole-class teaching:

- define direct stress and strain and briefly describe shear stress and strain
- explain Hooke's law and define modulus of elasticity and factor of safety

Individual learner activities:

- solution of problems on direct stress and strain

Prepare for and complete Assignment 4: Science Units, Terms and Principles (P7)

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- ☐ define displacement, velocity and acceleration
- ☐ explain distance – time and velocity – time graphs for a body with uniform acceleration
- ☐ derive the equations for uniform motion
- ☐ explain Newton's laws of motion and define work and power
- ☐ demonstrate solution of problems on motion with uniform acceleration/retardation and problems involving inertia, friction work and power related to motor vehicles

Individual learner activities:

- ☐ solution of problems on force, work and power

Prepare for and complete Assignment 5: Energy Principles (P8, P9, M5, D3)

Feedback to learners, unit evaluation and close

Assessment

Assessment will normally be carried out using a combination of written assessments, practical activities, and verbal questioning.

It is essential when planning the assessment process to recognise the links between grading criteria. For example, for P1, M1 and D1, to set mathematical tasks requiring the learner to transpose and evaluate formulae and then give learners the opportunity to work on both complex and combined formulae to generate evidence of higher level of skills.

Having gained the understanding for P1, learners would be expected to progress to meeting the requirements of P2 and P3. Further progression, development and assessment will then generate the evidence for solving trigonometry problems (P5), and more complex shapes (M4), and it would be expected that the use of the scientific calculator (P6) would be a natural progression. Once the development of the use of the calculator is established a further task could be given involving chained calculations (D2). It may be appropriate to record the use of the electronic scientific calculator with a witness statement or through learners representing the use on a flow chart/block diagram. When assessing this it must be remembered that this unit is assessing learners' mathematical skills and not their ability to draw diagrams. When setting tasks to address P5, Pythagoras' theorem should be used to find the lengths of sides of right-angled triangles. Trigonometry functions should be used to find both lengths of sides and values of angles for right-angled triangles.

Learners should be given opportunities to extend the evidence of what they have learned about using data to calculate volumes and areas through appropriate tasks to achieve M2 and M3. This will develop learners' use of the fundamental 'tools' and the appropriate ability whilst working with vehicle related problems.

Quoting SI units when solving problems on force (P7) may involve a starter motor to ring gear assessment for an electrical discipline, a gearbox for a light or heavy vehicle discipline, or the use of body rigs for body and paint or motorsports.

To achieve this application of mathematical tools, it is anticipated that having given learners an input on each 'tool', the attainment of the pass criteria will be an ongoing 'mapped and tracked' process and part of the planning should include integration into other subject areas. This will help learners to complete P8 and P10 through a combination of theoretical and practical activities including the use of both given and sourced material. Once this has been completed it would be appropriate to set a written task about vehicle performance and the forces present (D3). The practical activity required for P9 will help develop understanding of scientific principles when applied to engine performance. At this level however the criteria only requires that learners have carried out this practical work and made a record of torque and power-related features. Evidence of this is likely to be in the form of a table of results showing inputs that were varied and the outputs noted. A witness statement may be the best way to supplement the evidence to ensure it is clear that the learner carried out the activities correctly.

The grading criteria should be combined wherever possible. Having developed the skills of producing graphs (P4) learners can apply those skills for use in an assessment for vehicle related performance as set out in M5.

Assessment of this unit should be integrated with that of other units, such as Unit 1: Essential Working Practices for Vehicle Technology, Unit 2: Vehicle Electrical and Electronic Principles and Unit 7: Vehicle System Fault Diagnosis. This will help reiterate to learners the importance of maths and science to their vocational area and will maximise assessment opportunities and avoid replication.

In achieving a pass, learners will understand the value of maths in solving a variety of vehicle related problems. The range of answers to vehicle related problems involving arithmetic, area, volume, mass, algebraic laws, trigonometry, graphs, force, moments, gear ratios, stress and strain may be documented in a variety of formats. Learners should also be able to identify and apply scientific principles to solve problems related to vehicle performance. This will present opportunities to give autonomy to individual learners and to use set assessments covering multiple criteria, such as calculations on acceleration and distance travelled. With guidance in the selection of the data source for such a vehicle the learner could complete a variety of tasks (P9) not only in engines, but steering geometry, body panels or electrical components to help them see the relevance of mathematics when applied to vehicle applications.

Finally, learners should be able to identify examples where conversion of energy occurs within the motor vehicle. Wherever possible, problems should be set within a motor vehicle context. It is recommended that, at this level, guided practical activities could also be used to maintain learner interest and encourage investigative skills and techniques. The other technology-based units could provide a rich source of possible problems and activities.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P6 (part), M1, D1, D2	Mathematical Methods	A technician needs to transpose and evaluate formulae and use an electronic scientific calculator to solve vehicle-related problems	An assignment consisting of a series of written tasks supported by tutor observation records of calculator use
P2, P3, P4, M2, M3	Mensuration and Graphical Methods	A technician needs to calculate the area and volume of a range of shapes	A practical assignment supported by learners' written records
P5, P6 (part), M4	Trigonometry	A technician needs to determine lengths of sides and angles for right angled triangles	An assignment consisting of a series of written tasks supported by tutor observation records of calculator use
P7	Science Units, Terms and Principles	A technician needs to use science units, terms and principles when solving vehicle-related problems	A practical assignment supported by learners' written records
P8, P9, M5, D3	Energy Principles	A technician needs to determine vehicle performance	A practical assignment supported by learners' written records

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Essential Working Practices for Vehicle Technology	
	Vehicle Electrical and Electronic Principles	
	Vehicle System Fault Diagnosis	

Essential resources

Learners will need access to vehicle components and/or sub-assemblies, measuring equipment and data sources relevant to their chosen vehicle discipline. Scientific calculators will also need to be made available.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Bonnick A – *Automotive Science and Mathematics* (Butterworth-Heinemann, 2008) ISBN 9780750685221

Croft, A and Davison, R – *Mathematics for Engineers* (Prentice Hall, 2009) ISBN 9780273725497

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	analysing and evaluating information, judging its relevance and value

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Creative thinkers	trying out alternatives or new solutions to mathematical problems.
Reflective learners	reviewing progress when solving problems and acting on the outcomes to make corrections to understanding/solutions.
Team workers	collaborating with others when working on investigative group work to achieve a valid solution

Functional Skills – Level 2

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	solving routine electrical and mechanical problems set within engineering contexts and situations
Identify the situation or problem and the mathematical methods needed to tackle it	recognising the relevant parameters and formulae to be applied to given electrical and mechanical situations
Select and apply a range of skills to find solutions	selecting and applying formulae to solve electrical mechanical problems in engineering.
Use appropriate checking procedures and evaluate their effectiveness at each stage	checking the results of solutions to electrical and mechanical problems to evaluate their effectiveness and reality at each stage of the calculation
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	speaking with and listening to peers and supervisors to establish an understanding of mathematical concepts and issues in vehicle technology.
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	selecting, reading and using appropriate mathematical data sources to solve vehicle-related problems
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	taking notes and solving vehicle- related mathematical problems to communicate accurate solutions effectively

Unit 11:

Principles and Maintenance of Vehicle Wheels, Tyres, Steering and Suspension Systems

Unit code: D/503/1503

Level: 2

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to develop learner knowledge of the construction, function and operation of vehicle wheels, tyres, steering and suspension systems and will enable them to use appropriate data, tools and equipment to carry out repairs.

Unit introduction

Engine technology and its associated control systems have advanced rapidly in the last few years. Modern engines are now capable of outstanding performance compared to older, similar sized power units. This, together with advances in transmission design, means that the typical modern vehicle is capable of greater acceleration and a faster maximum speed than ever before. These factors have led to an increased need for wheel, tyre, steering and suspension technology that is able to cope with the forces associated with modern vehicle performance characteristics.

Almost all tyres are now low profile to ensure the maximum tyre contact with the road and hence improve traction. Some suspension systems now have different modes for the driver to select according to the terrain. The most sophisticated suspension systems can self-level, have yaw control to counteract cornering forces, 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 steering and suspension geometry that has been set in order to enhance the vehicle's road holding. Sports vehicles, family saloons, multi-purpose vehicles, off road vehicles, passenger service vehicles and haulage vehicles all have very different requirements for these systems to perform well in the environment they are intended for. It is vital that these systems interrelate with, and complement, each other to ensure the maximum comfort and safety of the driver and passengers.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the characteristics and construction of vehicle wheels and tyres
- 2 Know the function and operating principles of vehicle steering and suspension systems
- 3 Be able to examine a vehicle's wheels, tyres, steering and suspension systems and use appropriate data to effect repairs and adjustments
- 4 Be able to use appropriate tools and equipment to conduct repairs on wheels, tyres, steering and suspension systems.

Unit content

1 Know the characteristics and construction of vehicle wheels and tyres

Road wheels: wheel type e.g. alloy (cast and forged), steel, well based, specialist (wire spoke, flat-edge, double hump, divided, detachable flange); rim codes; wheel retention methods; wheel maintenance requirements; spare wheel arrangement e.g. space saver and 'run-flat' wheel assemblies

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

Condition of road wheels and tyres: defects e.g. physical damage to wheel (buckled wheels, damaged wheel rims, elongated/oval stud holes) or tyre (wear, delamination of tyres, bulges, estimated life); mechanical problems e.g. loose wheel nuts/studs, wrong wheel diameter/width, incorrect wheel fixing devices

2 Know the function and operating principles of vehicle steering and suspension systems

Steering systems: arrangements e.g. Ackermann steering principle, types of steering arrangement (rack and pinion, recirculating ball, worm and roller); non- and power assisted steering systems e.g. power assisted, electronically controlled; steering system components e.g. ball joints, swivel linkage arrangements, swivel joints, track rods, sealing arrangements; steering geometry checks e.g. camber angle, castor angle, king pin inclination (KPI), steering axis inclination (SAI), centre point steering, wheel alignment

Condition of steering system: wheel alignment; excessive play e.g. due to wear or maladjustment; non-assisted steering e.g. ball joints, swivel linkage arrangements, swivel joints, track rods; power assisted steering e.g. joints and swivel arrangement, level, leaks, belt wear/tension, hoses; deterioration e.g. dust caps, gaiters; function e.g. stiffness of operation, degree of power assistance

Suspension systems: suspension forces; vehicle stability terminology; suspension system arrangements; sprung and unsprung weight; spring types e.g. steel, laminated, helical, torsion bar, rubber and pneumatic; spring location devices e.g. U bolts, fixed shackle, swinging shackle; trailing arm; wishbone; ball joints; bump stops; track control arms; stabiliser bar/anti-roll bar; swinging arm, parallel links and Panhard rod, damper operation, independent front/rear suspension (IFS/IRS) and non-independent type suspension

Condition of suspension system: wear, excessive play, damage or corrosion of components e.g. ball joints, bushes, location fixings; loose components; leaks; function e.g. bounce test

3 Be able to examine a vehicle's wheels, tyres, steering and suspension systems and use appropriate data to effect repairs and adjustments

Wheel and tyre data: vehicle/rim/tyre manufacturer's recommendations eg types and applications of tyres, tyre pressures, use of spacers; data on causes of vibration through steering, heavy or light steering, poor traction, excessive tyre noise

Steering and suspension data: camber; castor; king pin inclination/steering axis inclination (KPI/SAI); positive and negative offsets; scrub radius; wheel alignment; thrust axis

4 Be able to use appropriate tools and equipment to conduct repairs on wheels, tyres, steering and suspension systems

Checks: e.g. visual and physical examination, MOT test procedures

Types of repair: wheels and tyres e.g. replacement of wheels or tyres, re-groove tyres, puncture repair, valve replacement, balancing of wheels; steering e.g. alignment, track rod end replacement, steering rack replacement; suspension e.g. removal/replacement of coil spring, leaf spring, shock absorber

Tools and equipment: relevant to repair tasks e.g. tyre inflation equipment (compressor, tyre cages), tread depth gauges, wheel alignment equipment (two and four wheel alignment), wheel balancing equipment, basic steering geometry equipment, use of suitable wheel braces, air operated equipment and the use of suitable jacking equipment, axle stands and ramp operations

Assessment and grading criteria

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

Assessment and 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:
P1 describe the characteristics and construction of a vehicle's road wheels and tyres	M1 compare the constructional differences between two different types of wheels and their tyres	D1 justify the selection of rectification strategies used for faults outside of specification
P2 describe the function and operating principles of a vehicle's steering system	M2 compare the constructional differences between two different types of steering system	D2 access information and carry out repairs to supervisor's/ manufacturer's instructions with limited supervision.
P3 describe the function and operating principles of a vehicle's suspension system	M3 compare the constructional differences between two different types of suspension system.	
P4 examine a defective wheel and tyre, using appropriate data to report on the corrective action required [SM3, IE4]		
P5 examine a defective steering system, using appropriate data to report on the corrective action required [SM3, IE4]		

Table continues on next page

Assessment and grading criteria		
P6 examine a defective suspension system, using appropriate data to report on the corrective action required [SM3, IE4]		
P7 use appropriate tools and equipment to carry out a repair on a defective wheel and its tyre [SM3, SM4]		
P8 use appropriate tools and equipment to carry out a repair on a defective steering system [SM3, SM4]		
P9 use appropriate tools and equipment to carry out a repair on a vehicle's defective suspension system [SM3, SM4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Delivery of this unit should focus on developing a fundamental understanding of the principles and procedures needed in the maintenance and repair of wheels, tyres, steering and suspension systems. It is expected that learners will have access to appropriate information sources (for example manufacturer's manuals and data books, CD ROM-based technical data, and online sources), tools and equipment.

A balance of theoretical and practical study is recommended and, wherever possible, systems and operating principles should be demonstrated through practical investigation using vehicles, components and specialist/manufacturer's equipment. It is strongly recommended that a significant amount of the unit is delivered in a workshop environment to ensure that learners can relate their studies to an industrial context and develop a practical, hands-on understanding of the unit content. It is expected that the centre's approach to delivery will give learners an experience that is sufficiently varied to provide them with sound underpinning knowledge and skills to enable them to perform routine wheel, tyre, steering and suspension maintenance in an industrial setting.

The four learning outcomes could be developed sequentially. In this way, the learner will understand the function and operating principles of each system before progressing to the examination of condition and subsequent maintenance procedures.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ describe the construction and characteristics of different types of road wheel
- ☐ describe different types of tyre including tyre profiles and markings, applications and valve types
- ☐ explain wheel and tyre maintenance requirements and typical defects and mechanical problems that can occur

Practical workshop activities:

- ☐ practical investigation of differing construction and characteristics of road wheels and tyres
- ☐ practical investigation of defective and non-defective road wheels and tyres

Prepare for and complete Assignment 1: Vehicle Wheels and Tyres (P1, P4, P7, M1)

Whole-class teaching:

- ☐ describe the operating principles of different steering arrangements
- ☐ describe the operation of power and non-power assisted steering systems
- ☐ describe the function of steering system components
- ☐ explain the faults that can occur in a steering system and the related checks and maintenance requirements

Practical workshop activities:

- ☐ investigate condition of steering systems and components

Prepare for and complete Assignment 2: Vehicle Steering Systems (P2, P5, P8, M2)

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- explain suspension system forces and principles of operation
- describe different suspension system arrangements and the function and operation of system components
- explain the faults that can affect the condition of a vehicle suspension system

Practical workshop activities:

- investigate condition of suspension systems and components

Prepare for and complete Assignment 3: Vehicle Suspension Systems (P3, P6, P9, M3)

Whole-class teaching:

- explain the purpose and use of a range of wheel, tyre, steering and suspension data

Individual learner activities:

- access and research appropriate data and its use when carrying out repairs and adjustments to vehicle wheels and tyres and steering and suspension systems

Whole-class teaching:

- explain the different types of repair that may be needed on vehicle wheels, tyres, steering and suspension systems
- explain and demonstrate how to carry out checks and use a range of tools and equipment to carry out repairs

Practical workshop activities:

- examination of defective vehicle wheels, tyres, steering and suspension systems, using data to identify corrective action needed
- carrying out repairs on defective wheels, tyres, steering and suspension systems

Prepare for and complete Assignment 4: Rectifying Faults Outside of Specification (D1, D2)

Feedback to learners, unit evaluation and close

Assessment

A mixture of practical and written evidence can be gathered to support assessment of this unit. For example, centres can devise written tests asking learners to describe the function and operating principles of systems, and set practical, investigative assignments where learners are asked to identify, examine, prepare and carry out repair tasks. The unit content is suited to a practical, hands-on approach and this should also be reflected in the assessment strategy wherever possible.

To achieve a pass, learners will need to describe the characteristics or function and operating principles of wheels, tyres (P1), steering (P2) and suspension systems (P3) and examine their condition (P4, P5, P6). They will need to demonstrate that they are able to use tools and equipment to carry out repairs (P7, P8, and P9). This could be achieved through an investigation of a vehicle where learners describe the systems found and the condition of the systems and then carry out a repair for each system, for which tutors will need to prepare pre-set faults, damage and defects. The evidence could be in the form of learner notes and research on the system investigated, photographic/written evidence of inspection and the learner's plan for the repair (for example tools required, methods to be used, alignment/adjustment data, replacement components required). These can be supported by tutor observation records. Tutors will need to ensure that the tasks set enable the full range of unit content to be covered. Where work-based or practical evidence is to be used, learners and their supervisors must be made aware of the requirements of the unit content for each of the systems investigated and repaired.

To achieve a merit, learners should be able to compare the constructional differences between two different types of wheels and their tyres (for example domestic and industrial or high performance). They will also need to compare the constructional differences between two different types of steering systems (for example power against non-power assisted systems). Finally, learners need to compare the constructional differences between two different types of suspension systems. This could be achieved by using the system investigated for the pass criteria as one of the systems and then comparing this with a significantly different system (either of the learner's choice or given by the tutor). The evidence for this comparative work will most likely be in the form of written reports. However, centres are encouraged to consider other methods such as presentations or producing information posters. These alternative methods have the added value of providing the group, as a whole, with the experience and knowledge of a wider range of systems.

To achieve a distinction, learners should demonstrate their ability to determine and undertake processes for rectification where a component or system deviates from manufacturer's recommendations, data, or legislative requirements (including the MOT test). Implicit in this requirement is the analysis and justification of the processes required for the conduct of the rectification procedure. It is unlikely that a suitable task to enable learners to meet this criterion will occur naturally and, therefore, it will need to be staged/prepared by the tutor. However, if it did happen naturally during the work for the pass criteria then centre systems should be flexible enough to capture such evidence for assessment.

D2 relates to the learner's ability to access information and carry out repairs to supervisor's/manufacturer's instructions with limited supervision. This is the ability to demonstrate their competence and independence when carry out prescribed tasks. At this level, the expected limited supervision would be the setting of the task for the learner to undertake, providing appropriate technical assistance (not to include technical information that the learner could reasonably be expected to determine from the data they are required to access) if necessary and receiving the report on completion of the work.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and psychic grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P4, P7, M1	Vehicle Wheels and Tyres	A technician needs to examine and repair a vehicle's wheel and its tyre	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning
P2, P5, P8, M2	Vehicle Steering System	A technician needs to examine and repair a vehicle's steering system with a given scenario, such as pulling or knocking	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning
P3, P6, P9, M3	Vehicle Suspension Systems	A technician needs to examine and repair a vehicle's suspension system with a given scenario, such as knocking or uneven ride	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning
D1, D2	Rectifying Faults Outside of Specification	A technician needs to rectify a system that deviates from specification	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Routine Vehicle Maintenance Techniques	

This unit has links with many standards but particularly the Level 2 IMI National Occupational Standards in Maintenance and Repair – Light Vehicle and Vehicle Fitting:

- Unit VF01: inspect, Repair and Replace standards Light Vehicle tyres
- Unit LV01: Carry out Routine Motor Vehicle Maintenance.
- Unit LV04: Remove and Replace Motor Vehicle Chassis Units and components

Essential resources

Centres will need to have access to a vehicle workshop equipped with appropriate vehicles to provide the range of wheels, tyres, steering and suspension systems identified in the unit content. Additionally, centres will need to provide a range of components and suitable tools and equipment with which learners can determine serviceability and effect repairs, replacement and adjustment.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Heisler, H – *Vehicle and Engine Technology* (Butterworth-Heinemann, 1998)
ISBN 9780340691861

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition
(Nelson Thornes, 2010) ISBN 978-1408515181

Newton R – *Wheel and Tyre Performance Handbook* (Motorbooks International, 2007) ISBN 9780760331446

Nunney, N J – *Light and Heavy Vehicle Technology* (Butterworth-Heinemann, 2006) ISBN 9780750680370

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	analysing and evaluating information, judging its relevance and value when using appropriate data to report on corrective action required for defective systems
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when carrying out repairs on vehicle wheels and tyres and steering and suspension systems

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Team workers	collaborating with others to work towards common goals when working in groups to carry out repairs on vehicle wheels, tyres, steering and suspension systems

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	using appropriate data to report on the corrective action required for the maintenance of vehicle wheels, tyres, steering and suspension systems
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing the characteristics and construction of a vehicle's road wheels and tyres describing the function and operating principles of a vehicle's steering and suspension systems
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	using appropriate data to report on the corrective action required for the maintenance of vehicle wheels, tyres, steering and suspension systems
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the characteristics and construction of a vehicle's road wheels and tyres describing the function and operating principles of a vehicle's steering and suspension systems

Unit 12: **Operation and Repair of Vehicle Braking Systems**

Unit code: J/503/1558

Level: 2

Credit value: 5

Guided learning hours: 30

Aim and purpose

This unit aims to provide learners with the knowledge and skills required to carry out fault diagnosis and routine maintenance on vehicle braking systems.

Unit introduction

In the modern motor vehicle environment, the vehicle fitting sector is increasing in size and importance, becoming a highly specialised market. In this unit learners will understand how to select, calibrate and use the correct tools for the task, working within strict safety guidelines and ensuring that government legislation and approved practice and procedures are adhered to at all times. This may include repair or replacement of components within the system for example brake shoes/pads, wheel cylinders.

The unit will develop learner understanding of the braking system in operation aligned to the legal requirements of braking efficiency under MOT testing regulations. Learners will also gain knowledge of safe working practices, which will not only prevent damage to vehicles but also ensure the safety of the learner, others in the workplace and the general public.

During this unit, the learner will demonstrate the ability to locate information on parts and find repair data from a variety of sources for example workshop manuals, computer-based information systems, parts manuals and microfiche systems.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the fundamental operating principles of braking systems
- 2 Be able to use data, tools and equipment to repair a braking system.

Unit content

1 Know the fundamental operating principles of braking systems

Braking systems and components: types of braking systems (mechanical, hydraulic); types of hydraulic brake layouts e.g. single line, divided line (front/rear split, X split, L split); drum brake arrangements e.g. fixed cam, floating cam brakes; brake shoe and drum arrangements e.g. leading/trailing shoe, twin leading shoes, self-servo action; brake shoes e.g. fitting methods, lining materials; mechanical brake adjusters e.g. snail cam (Girling), screwed plug (ATE), wedge and tappets (Girling); automatic brake adjusters e.g. forked pivot, ratchet and pawl, jacking-screw; wheel cylinders e.g. single, double piston; disc brake arrangement e.g. fixed caliper, floating caliper, single piston, dual piston, multi-piston calipers; brake discs e.g. solid, vented, drilled; brake pads e.g. fitting methods, lining materials; handbrake mechanisms e.g. driver controls, operating cables, equalizing mechanism consistency

Brake bleeding: types of brake fluid e.g. fluid specifications, freezing and boiling points, viscosity; brake bleeding methods e.g. manual, pressurised

Checking braking systems: brake lining wear, warning systems e.g. on-board, off-board; maintenance procedures for routine servicing and repair e.g. checking for correct operation/defects, cleaning, making adjustments, checking effectiveness of the service/repair work

Legal requirements: correct and secure mounting as per manufacturers' instructions; compliance with Health and Safety at Work Act, Ministry of Transport (MOT) braking standards

2 Be able to use data, tools and equipment to repair a braking system

Technical and parts data: manufacturers' technical manuals; braking system parts manuals; other specialist information sources e.g. diagnostic information, microfiche, CD ROM-based information and use of online information

Braking system repairs: main component replacement e.g. brake shoes, brake discs, brake pipes, brake adjusters (manual and automatic), wheel cylinders and expanders, single piston disc brakes, multi-piston disc brakes, handbrake mechanisms; brake bleeding (including precautions to be taken with anti-lock braking systems)

Tools and equipment: fitting tools and equipment e.g. for flaring, retracting of cylinders, removal of calipers, bleeding; system-checking equipment e.g. for satisfactory braking efficiency, disc run-out, lining thickness; specialist equipment e.g. roller brake tester; calibration of tools and equipment e.g. zeroing of Dais, venires; work area housekeeping e.g. cleaning of tools and work area, safe working practice e.g. safe disposal of hazardous materials, use of personal protective equipment (PPE)

Assessment and grading criteria

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

Assessment and 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:
P1 describe braking systems and their components	M1 explain the importance of checking the braking system for satisfactory operation	D1 locate data and carry out a brake system repair with a minimum of supervision.
P2 describe how to remove air from a hydraulic braking circuit (bleed brakes)	M2 compare different methods of accessing information and data for routine maintenance and repair of a braking system.	
P3 describe how to check a braking system for satisfactory operation to meet legal requirements		
P4 access and use technical and parts data to carry out a braking system repair [IE4, SM3]		
P5 use tools and equipment to carry out braking system repairs [SM3, SM4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

The delivery approach for this unit should be to support and develop the skills learners will need to undertake a range of practical activities (for example removal, examining, and replacing, where necessary, the components within a braking system and testing the effectiveness of the repair). It is expected that learner experience will be sufficiently varied to provide them with the underpinning knowledge and skills needed to work with the specialist tools, equipment, measuring instruments and assembly methods required for braking system servicing and repairs, while adhering to health and safety regulations within any given motor vehicle environment.

The learning outcomes should be delivered in order. This will enable learners to recognise a range of fundamental systems in operation and the information needed for the repair, adjustment or replacement of unserviceable components before actually working on braking systems. This will lead to an understanding of how to identify components and systems, select, calibrate and use appropriate tools and equipment whilst working in a safe environment. Delivery should, as far as possible, be practical rather than learners spending too much time on paper-based theory sessions. For example, a short introduction to a braking system component (or range of components), the function of the component within the larger assembly, the tools necessary to carry out the rectification, measurements or replacement of components and any health and safety considerations, followed by practical activity. Once learners have the knowledge and skills to identify components and their function, and to be able to work safely with a sufficient range of tools and specialist equipment (for example roller brake tester), then the other aspects, such as searching for data and carrying out given repair work, could be undertaken.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ introduction to unit content, overview of activities and assessment methodology □ describe the types of mechanical and hydraulic braking system arrangements and purpose and function of main system components □ describe the types of brake fluid and the procedure for bleeding brakes □ describe legal requirements that apply to vehicle braking systems including MOT requirements <p>Individual learner activities:</p> <ul style="list-style-type: none"> □ investigation of braking system layout and components □ researching legal requirements relevant to vehicle braking systems
<p>Prepare for and carry out Assignment 1: Braking System Operating Principles (P1, P2, P3)</p>
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ explain the use and methods of accessing different types of manuals, technical information and data □ explain safe working practices to be followed when inspecting and replacing braking systems and system components □ explain and demonstrate the use of fitting tools and equipment and system checking equipment and methods of inspecting and replacing the main components within a vehicle braking system <p>Individual learner activities:</p> <ul style="list-style-type: none"> □ accessing and using technical parts data <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ use of data, tools and equipment for inspection and replacement of braking systems
<p>Prepare for and carry out Assignment 2: Braking System Repairs (P4, P5, M1, M2, D1)</p>
<p>Feedback to learners, unit evaluation and close</p>

Assessment

A large proportion of the assessment for this unit could be achieved through tutor observation and oral questioning. To support the possible use of a high level of process evidence, centres will need to consider what product evidence (that often surrounds a process) could also be used. For example, learner job card or logbook records of the task(s) carried out. The job card or logbook could contain a description of the task the learner had undertaken, the instructions they were provided with (annotated to record progress or difficulties), the references and extracts from the identified source data, a list of tools provided/used for the task, relevant photographs that have been annotated to explain procedures/difficulties, etc. Such supporting product evidence would then validate the tutor or witness observation/oral questioning records and vice-versa.

The first three pass criteria could be achieved through written tests or using gapped handouts under controlled conditions. They could also be achieved through tutor observation and oral questioning in an appropriate brake repair workshop setting. When using this approach, care is needed to ensure that a sufficient record is maintained to cover all the required content (for example describe both mechanical and hydraulic types of braking systems and associated components). Another example for P2 would be for the tutor to ask the learner to talk them through how they are about to remove the air from a hydraulic braking circuit (bleed brakes) before actually carrying out the task for P5.

The last two criteria (P4 and P5) would need to be set within the context of a practical activity. Tutors may give learners direction as to where to find data (for example the location of the manuals, CD ROMs, microfiche) which they will then need to access and use the technical and parts data from within the source to enable them to effect a braking system repair. There is an obvious link here between the two criteria (P4 and P5). It should be noted that although P4 could be achieved using just one repair/service task, P5 requires the learner to carry out both a main component replacement, such as master cylinder, brake shoes or wheel cylinder and a brake bleeding (including precautions to be taken with anti-lock braking systems) to meet the requirements of the unit content.

To achieve a merit, the learner will need to apply their understanding and skills to explain the importance of checking the braking system for satisfactory operation. This could be achieved by learners thinking through the consequences of not checking (for example vehicle handling, stopping distances, vehicle or component damage, wear and tear). This could be a natural extension to the main component repair undertaken for P5. In addition to this, learners must be able to compare different methods of accessing information and data for routine maintenance and repair of a braking system. Learners will need the opportunity to examine different sources from which to access information and therefore make their comparisons. This may be based on the readiness and currency of data and information, its ease of use in terms of clarity of layout or data referencing, etc.

To achieve a distinction, the learner is required to demonstrate their ability to work independently as they locate data and carry out a brake system repair with a minimum of supervision. This is about the learner taking responsibility for undertaking a task from start to finish – recognising what needs to be done, finding the source and data required to carry out the task, carrying out the braking system repair, checking their own work and reporting that the task has

been completed. Although not explicit in the criterion, centres should consider the industry requirements for the amount of time typically allocated to undertake the task that is set. With this in mind, it is expected that achievement of this criterion would be based on a time constrained activity and that the learner's approach to the task would be carefully monitored to ensure effective and safe working practices that would be acceptable within the industry.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3	Braking System Operating Principles	A technician needs to explain to a new apprentice how to bleed brakes and check a braking system for satisfactory operation	Written assignment
P4, P5, M1, M2, D1	Braking System Repairs	A technician needs to carry out a repair on a vehicle braking system from a given scenario, such as a customer complaining of losing fluid	A practical task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle Design and Operation of Vehicle Systems	
	Routine Vehicle Maintenance Techniques	

The unit contributes towards the knowledge and understanding needed for the IMI Level 2 National Occupational Standards in Maintenance and Repair – Light Vehicle and Vehicle Fitting, particularly:

- Unit LV04: Remove and Replace Motor Vehicle Chassis Units and components
- Unit VF12: Inspect, Adjust and Replace Light Vehicle Braking Systems and Components.

Essential resources

To deliver this unit, centres will need access to a range of vehicles and components to enable learners to carry out the practical aspects of the unit as defined by the content and grading criteria. Centres will need a sufficient range of tools, equipment and measuring instruments to support the cohort size undertaking the unit.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition
(Nelson Thornes, 2010) ISBN 978-1408515181

Nunney, N J – *Light and Heavy Vehicle Technology* (Butterworth-Heinemann, 2006) ISBN 9780750680370

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	analysing and evaluating parts data, judging its relevance and value when carrying out a braking system repair
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when carrying out a braking system repair

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work
Team workers	collaborating with others when working as part of a team to carry out vehicle braking system repairs

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing braking systems, how to bleed brakes and how to check a braking system for satisfactory operation
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	accessing and using technical information and data
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing braking systems, how to bleed brakes and how to check a braking system for satisfactory operation

Unit 13:

Inspection and Replacement of Vehicle Exhaust Systems

Unit code: M/503/1523

Level: 2

Credit value: 5

Guided learning hours: 30

Aim and purpose

The aim of this unit is to develop the knowledge and skills needed to inspect and replace a vehicle exhaust system.

Unit introduction

In the modern motor vehicle environment, the vehicle fitting sector is increasing in size and importance, becoming a highly specialised market. In this unit learners will understand how to select, calibrate and use the correct tools for the routine maintenance of vehicle exhaust systems. They will work within strict safety guidelines and ensure that government legislation and approved practice and procedures are adhered to at all times. This may include repair or replacement of components within the system, for example rear silencer replacement or vibration damping components.

The unit will develop learner understanding of the legally permitted levels of pollutants allowed under MOT testing regulations. Learners will also gain knowledge of safe working practices, which will not only prevent damage to vehicles but also ensure the safety of the learner, others in the workplace and the general public.

During this unit, learners will demonstrate their ability to locate information on parts and repair data from a variety of sources (for example workshop manuals, computer-based information systems, parts manuals and microfiche).

Learning outcomes

On completion of this unit a learner should:

- 1 Know the main components, function and layout of a vehicle exhaust system
- 2 Be able to use data, tools and equipment for the inspection and replacement of an exhaust system.

Unit content

1 **Know the main components, function and layout of a vehicle exhaust system**

Main components: mountings and fittings e.g. chassis/body supports, rubber mounts, flanges, bolts, gaskets; exhaust manifold arrangements e.g. multi branch, divided branch; down-pipe arrangements e.g. single, dual and high performance; catalytic converter e.g. two-way, dual-bed, three-way

Layout and function: exhaust system arrangement e.g. front silencer, rear silencer, tail pipe, intermediate pipe, gaskets, seals, clamps; typical exhaust emissions and legal requirements for spark ignition (SI) and compression ignition (CI) engines e.g. carbon dioxide (CO), hydrocarbons (HC), nitrogen oxides (NO_x)

2 **Be able to use data, tools and equipment for the inspection and replacement of an exhaust system**

Technical and parts data sources: manufacturers' technical manuals; exhaust system parts manuals; other specialist information sources e.g. diagnostic information, microfiche, CD ROM, online data

Inspection and replacement: main components e.g. silencers, mountings and fittings, manifolds, damaged threads; safe working practice e.g. safe disposal of waste items, personal protective equipment (PPE), housekeeping of tools and work area

Legal requirements: correct and secure mounting to manufacturers' instructions; compliance with Health and Safety at Work Act; MOT emissions standards

Tools and equipment: fitting tools and equipment e.g. for mountings, exhaust manifold, down-pipe, catalytic converter, silencers, tail pipe, intermediate pipe, gaskets, seals, clamps, vehicle lifts and supports; system-checking equipment e.g. for satisfactory sealing, exhaust emissions such as CO, HC, NO_x

Assessment and grading criteria

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

Assessment and 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:
P1 describe the main components of a vehicle exhaust system	M1 compare different methods of accessing information and data for inspection and replacement of an exhaust system	D1 justify the information and processes required to carry out inspection and replacement of a typical exhaust system
P2 describe the layout and function of an exhaust system		
P3 use technical and parts data for the inspection and replacement of an exhaust system [IE4, SM3]	M2 explain the importance of inspecting the exhaust system for satisfactory operation.	
P4 inspect an exhaust system for satisfactory sealing, condition and adherence to legal requirements [SM3]		
P5 use tools and equipment to carry out a typical exhaust system replacement procedure [SM3, SM4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Delivery of this unit could be centred around the work in a specialist area of a vehicle fitting operation. However, a generic approach that covers a range of practical activities (for example removal, testing, examining, and replacing exhaust systems components) in a training workshop could be equally effective. Centres will determine their approach through an analysis of their learners' needs and in particular through consideration of the range of industries that the centre is working with or preparing their learners to work with. Whichever approach is taken should be sufficiently varied to provide learners with sound underpinning knowledge and the skills needed to work with specialist tools, equipment, measuring instruments and exhaust assembly methods, adhering to health and safety regulations within any given motor vehicle environment.

The learning outcomes are ordered logically and it would be reasonable to deliver them in order. In this way, the learner will begin to recognise a range of fundamental operating principles of vehicle exhaust systems. This will include identifying the information and data necessary for the repair, adjustment or replacement of unserviceable components. It will culminate in understanding how to select, calibrate and use appropriate tools and equipment whilst working in a safe environment at all times. Delivery should, as far as possible, be practical rather than spending too much time in theory lessons. For example, a short introduction to a component, its function, the tools needed to carry out the rectification, measuring or replacement of components within the given system, and any health and safety considerations – followed by practical activities. Once learners have the necessary knowledge and skills to work with a sufficient range of tools and specialist equipment (for example exhaust gas analysing) the other aspects can be introduced. This may include working to instructions, quality-checking own/other's work and checking compliance with given standards and specifications (for example MOT testing regulation).

Achievement at merit and distinction will be demonstrated through the learner's ability to work more analytically with information and exhaust system faults. Therefore, it is important that development of these skills is encouraged during the delivery/learning phase. Formative assessment and feedback will play an important part in the general development of learners but especially their achievement of the higher-level grades.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> <input type="checkbox"/> introduction to unit content, overview of activities and assessment methodology <input type="checkbox"/> describe exhaust system mountings and fittings, manifold and down-pipe arrangements and types of catalytic converter <input type="checkbox"/> describe the layout and function of an exhaust system arrangement <input type="checkbox"/> describe exhaust emissions and legal requirements for SI and CI engines <p>Individual learner activities:</p> <ul style="list-style-type: none"> <input type="checkbox"/> investigation of exhaust system layout and components
<p>Prepare for and carry out Assignment 1: Function and Layout of Vehicle Exhaust Systems (P1)</p>
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> <input type="checkbox"/> explain the use and methods of accessing different types of manuals, technical information and data <input type="checkbox"/> explain safe working practices to be followed when inspecting and replacing exhaust systems and system components <input type="checkbox"/> explain the legal requirements that apply to the inspection and replacement of vehicle exhaust systems <input type="checkbox"/> explain and demonstrate the use of fitting tools and equipment and system checking equipment and methods of inspecting and replacing the main components within an exhaust system <p>Individual learner activities:</p> <ul style="list-style-type: none"> <input type="checkbox"/> accessing and using technical parts data and researching legal requirements relevant to vehicle exhaust systems <p>Practical workshop activities:</p> <ul style="list-style-type: none"> <input type="checkbox"/> use of data, tools and equipment for inspection and replacement of exhaust systems
<p>Prepare for and carry out Assignment 2: Carrying Out Exhaust System Repairs Using Technical and Parts Data (P2, P4, M1, D1)</p>
<p>Prepare for and carry out Assignment 3: Inspecting Vehicle Exhaust Systems (P3, M2)</p>
<p>Feedback to learners, unit evaluation and close</p>

Assessment

A large proportion of the assessment for this unit will occur naturally through tutor observation and oral questioning. To support this high level of process evidence centres will need to consider what additional product evidence (that often surrounds a process) could be used. For example, the use of a job card for the task(s) carried out. The job card, produced and maintained by the learner, could contain a description of the task undertaken, the instructions provided (annotated to record progress or difficulties), a list of tools and equipment required, records/copies of data obtained, relevant photographs that have been annotated to explain procedures/difficulties, etc. Such supporting product evidence would then validate the tutor or witness observation/oral questioning records and vice-versa.

The pass criteria could be brought together in a series of tasks. For example:

- Task 1 – the learner is given an exhaust system to research and describe in terms of its components, layout and function (P1 and P2)
- Task 2 – technical and parts data is obtained to enable the learner to inspect an exhaust system and effect a replacement (P3). The replacement is carried out using the appropriate tools and equipment (P5)
- Task 3 – following replacement, the system is inspected for satisfactory sealing, condition and adherence to legal requirements (P4).

To achieve a merit, learners will need to compare different methods of accessing information and data for routine inspection and replacement of an exhaust system. Centres may need to make a range of information and data available to enable learners to achieve this criterion. If it did happen naturally then, of course, this evidence can be captured for the individual learner's summative assessment records but this should not be left to chance.

To enable the learner to achieve M2, they should be given the opportunity to analyse a vehicle under differing conditions (for example idle, fast idle, cruising) to enable them to explain the importance of inspecting the exhaust system for satisfactory operation.

To achieve a distinction, the learner needs to be able to build on the evidence gathered for P2 and M1, by reviewing and justifying the information and processes required to inspect and carry out inspection and replacement of a typical exhaust system.

Assessment will normally be carried out through a combination of observed practical activity, written evidence (for example job cards) and verbal questioning. It is recommended that much of the evidence is gathered through workshop activities. Practical workshop tasks will provide evidence for dealing with the selection of appropriate tools and for the maintenance and repair of exhaust systems.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1	Function and Layout of Vehicle Exhaust Systems	A technician needs to show a new apprentice the layout and function of a vehicle exhaust system	A written assignment
P2, P4, M1, D1	Carrying Out Exhaust System Repairs Using Technical and Parts Data	A technician needs to access and use relevant data and carry out an exhaust system repair after a customer complains of excessive noise or fumes	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning
P3, M2	Inspecting Vehicle Exhaust Systems	A technician has to inspect an exhaust system, inspecting other's work and writing a report	A practical maintenance task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Essential Skills for Vehicle Repair	
	Vehicle engine Principles and operation	

The unit contributes towards the knowledge and understanding needed for the IMI Level 2 National Occupational Standards in Maintenance and Repair – Light vehicle and Vehicle Fitting, particularly:

- LV02 – Remove and Replace Light Vehicle Engine Units and Components
- VF09: Inspect and Replace Light Vehicle Exhaust Components.

Essential resources

To deliver this unit, centres will need access to a range of vehicles, exhaust system components, fitting tools and equipment and relevant technical data.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition (Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	analysing and evaluating parts data, judging its relevance and value when carrying out exhaust system repair
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when carrying out an exhaust system repair

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work
Team workers	collaborating with others when working as part of a team to carry out exhaust system repairs

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing the main components, layout and function of an exhaust system
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	accessing and using technical parts information and data
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the main components, layout and function of an exhaust system

Unit 14: Non-Structural Vehicle Body Repair Processes

Unit code:	L/503/1562
Level:	2
Credit value:	10
Guided learning hours:	60

Aim and purpose

The aim of this unit is to enable learners to remove, refit and repair non-welded, non-structural vehicle body panels. It will also develop their understanding of the related safety, organisational procedures and customer requirements.

Unit introduction

Body repair is becoming an increasingly complex and specialised process within the automotive industry. Effective and efficient body repairs are fundamental to the functional use and overall life span of vehicles. This may cover a wide range of vehicle types such as light, goods and passenger carrying vehicles, agricultural and plant equipment in addition to vehicles used for sports and off road use. Methods of repair will depend on a number of factors such as the components being repaired, manufacturers' guidelines, health and safety issues, and cost. Additionally, for sports and off road vehicles competition regulations may dictate the joining process to be used, as will the facilities and equipment available.

In this unit learners will develop with the skills and knowledge needed to use tools/equipment to carry out a range of vehicle body repair processes. This will include the removal of a dent, repairing damage in a metal body panel and repairs to non-metallic components. The unit is devised to ensure that the learner will gain these experiences via practical learning exercises or working practices that can be evidenced and verified. Learners will practise the techniques on a variety of components relevant to their vocational pathway, but should not be restricted to this. Learners will also develop the underpinning knowledge related to the tasks and vehicles being worked on.

Safe working practices and good housekeeping will be recurrent themes throughout the work of the unit. The learner will be expected to demonstrate an understanding of their responsibility for their own safety and that of others in the workplace.

It is possible that the wide range of repair techniques cannot be used in one overall task. In which case, a range of tasks may be used to gather evidence. At all times the experiences and processes must be relevant to the learner's chosen pathway.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the safety precautions, organisational procedures and customer requirements to be met when carrying out non-structural body repairs
- 2 Be able to use tools and materials for vehicle body repair processes
- 3 Be able to remove and refit a non-welded, non-structural vehicle body panel
- 4 Be able to repair a non-welded, non-structural vehicle body panel to relevant quality standards.

Unit content

1 Know the safety precautions, organisational procedures and customer requirements to be met when carrying out non-structural body repairs

Safety: personal protection e.g. clothing, barrier cream, removal of loose items and jewellery, protective footwear, eye protection, gloves; preparation of working area e.g. ventilation, protection of others, cleanliness of work area; good housekeeping e.g. removal of waste materials, storage of materials and tools; maintenance of access e.g. keeping walkways and emergency exits clear and accessible; regulations e.g. Control of Substances Hazardous to Health (COSHH) Regulations, Provision and Use of Work Equipment Regulations (PUWER), Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR); positioning e.g. use of ramps, jacks, stands; vehicle protection e.g. covers, sheeting

Organisational procedures: recording repair activities e.g. pre vehicle inspection, reporting equipment damage, malfunctions, report vehicle damage; identifying and reporting delays or potential delays in job completion e.g. waiting for parts, unforeseen problems; relationships between time and costs e.g. removal and refitting of non-structural panels within agreed timescales, cost per unit hour

Customer requirements: completion on time e.g. meeting agreed timescales; protection of customer's personal property e.g. security or removal of possessions, use of protective coverings

2 Be able to use tools and materials for vehicle body repair processes

Tools: for removal e.g. sockets, spanners, grips, screwdrivers, sockets, electric drill; for repairs e.g. panel hammers, dollies, body spoons, body files, rubbing down blocks, beating files, dual action sanders, profile gauge, specialist dent removal tools, fume extractor; manufacturers' specialist tools; plastic repair tools e.g. thermal repair equipment

Materials: abrasive papers e.g. types, grades, application; filler materials e.g. plastics, glass-reinforced plastic (GRP), metals, properties, mixing, uses, application; solvents; detergents; body panels e.g. steels, aluminium, corrosion resistant; sealant; fixing devices e.g. captive bolts, adhesives, rivets

Maintenance of tools: prepare and maintain tools used for reshaping damaged areas e.g. correct assembly of equipment, correct adjustment and use; clean, restore and store all tools and equipment e.g. ensure any damaged tools are repaired or removed from service

3 **Be able to remove and refit a non-welded, non-structural vehicle body panel**

Body design: types e.g. chassis frame, integral, crumple zones; construction methods e.g. mass produced, limited manufacture, specialist manufacture

Panels: metal; plastic; GRP; non-stressed e.g. wings, doors, bonnets, boot lids, tailgates; stressed panels e.g. roof, sills, bulkhead

Sources of information: e.g. how to select, find, interpret and use information applicable to non-welded, non-structural body panels

Procedures: panel material recognition techniques e.g. metal, plastic, GRP; methods of removal e.g. reference to manufacturers' procedures; fitting e.g. correct sequence, fixing, use of fixing devices, sealing; alignment e.g. checking gaps and clearances, use of workshop resources to aid re-alignment, specialist equipment; damage avoidance e.g. use of panel protection, wing covers; use of fixing devices e.g. nuts and bolts, self tapping devices, metal and plastic fixings, rivets, adhesives, sealant; panel care (damage prevention, storage, care during transit e.g. racking, bubble wrap, foam, cardboard)

4 **Be able to repair a non-welded, non-structural body panel to relevant quality standards**

Preparation: vehicle contamination avoidance e.g. seat covers, sheeting, masking; vehicle system damage avoidance e.g. disconnection of electrical supply, working on and disconnecting electronic control units (ECUs), high voltage supplies; prepare damaged areas to facilitate repairs e.g. cleaning and degreasing

Repairs: panel damage; dent removal e.g. over 7 cms diameter, double curvature, swage lines; plastic components e.g. splits, scuffs

Techniques: panel pulling; panel beating e.g. direct, indirect, spring hammering, rough and metal finish; hot shrinking; metal finishing; body filling; plastic filling; plastic repair e.g. thermal, adhesive; reinstating e.g. anti-corrosion, sealant, sound deadening materials

Quality checking: adherence to manufacturers' repair procedures and standards; technical data e.g. books, databases and repair manuals; accurate repair profile e.g. visual inspection, profile gauges; standard of finish between repair stages e.g. surface finish, cleanliness, protection, clearances

Assessment and grading criteria

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

Assessment and 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:
P1 describe the safety precautions to be followed when carrying out non-structural body repairs	M1 explain the critical factors to be considered when preparing materials for the repair of non-structural body panels	D1 analyse the reasons for a poor quality non-structural body repair
P2 describe the organisational procedures and customer requirements to be met when carrying out non-structural body repairs	M2 compare a range of fixing devices that may be used to attach non-welded, non-structural body panels to the vehicle.	D2 justify the process and techniques chosen to complete a non-structural body repair.
P3 use appropriate tools and materials for a given vehicle body repair process		
P4 maintain tools used for a body repair process		
P5 identify different types of vehicle body design, construction and panels		
P6 use information and procedures to remove and refit non-welded panels [IE4, SM3, SM4]		

Table continues on next page

Assessment and grading criteria		
P7 prepare a vehicle for non-structural body repair [SM3]		
P8 use relevant techniques to repair a non-structural body panel [SM3, SM4]		
P9 check the quality of a non-structural body panel repair [SM3, SM4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers
	CT – creative thinkers
	RL – reflective learners
	TW – team workers
	SM – self-managers
	EP – effective participators

Essential guidance for tutors

Delivery

The delivery approach for this unit could be one of working in a specialist area only (for example light vehicle body repair). However, the basic skills that learners will develop are generic in nature and can be applied to a range of occupational areas (for example light and heavy vehicle, passenger carrying vehicles, agricultural vehicles, off road vehicles, sports vehicles). Centres will determine their approach through an analysis of their learners' needs and through consideration of the occupational areas that the centre is working with or preparing their learners to work with. It is expected that whichever approach is adopted, learner experience should be sufficiently varied to provide them with the underpinning knowledge and skills to enable them to use tools, equipment and techniques in most industrial settings.

It is anticipated that delivery will concentrate on the development of practical skills and be based around realistic or designed workshop tasks. However, it is important not to neglect the development of learners' underpinning knowledge where a formal theoretical input is required. Learners may also be given opportunities to work individually or collectively on tasks and assignments outside the guided learning hours for this unit.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ describe the precautions that need to be taken to ensure safety of staff, customers and vehicles when carrying out non-structural body repairs
- ☐ describe the organisational procedures relating to recording repairs and identifying and reporting delays
- ☐ describe the relationships between time and costs
- ☐ explain the importance of customer requirements in terms of meeting agreed timescales and ensuring protection of their personal property

Individual learner activities:

- ☐ investigate relevant safety and organisational procedures

Prepare for and complete Assignment 1: Safety Precautions, Organisational Procedures and Customer Requirements (P1, P2)

Whole-class teaching:

- ☐ explain types of vehicle body design and construction
- ☐ describe the main body panels and the materials from which they are made

Practical workshop activities:

- ☐ investigate a range of vehicles to identify body design and panel features

Prepare for and complete Assignment 2: Vehicle Body Design and Construction (P5, M2)

Whole-class teaching:

- ☐ explain the selection, use and maintenance of a range of removal and repair tools including specialist tools and those used for plastic repairs
- ☐ explain the selection and use of a range of materials for vehicle body repair
- ☐ explain and demonstrate procedures for preparing vehicles for body repair

Practical workshop activities:

- ☐ prepare and maintain tools and materials for body repair
- ☐ prepare a vehicle for non-structural body repairs

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- explain use of information relevant to non-welded, non-structural body panels
- explain methods of preventing vehicle panel damage
- explain and demonstrate procedures for removing and refitting vehicle body panels

Practical workshop activities:

- use of information and tools for removal and refitting of vehicle panels

Whole-class teaching:

- explain and demonstrate use of techniques for removing dents and repairing damage to metal panels and plastic components

Practical workshop activities:

- use of repair techniques for a range of damaged non-welded, non-structural body panels

Whole-class teaching:

- explain and demonstrate purpose and methods of checking quality of body panel repairs

Practical workshop activities:

- check a variety of non-welded, non-structural body repairs for adherence to quality and manufacturers' requirements

Prepare for and complete Assignment 3: Non-structural Body Repairs (P3, P4, P6, P7, P8, P9, M1, D1, D2)

Feedback to learners, unit evaluation and close

Assessment

A large proportion of the unit assessment will be naturally occurring and evidenced through tutor observation, oral questioning, and completion of set tasks. Wherever possible, assessment tasks should be related to 'live' vehicles and not rely purely on 'test' panels, components or training vehicles. To support the high level of process evidence, centres will also need to consider what additional product evidence (that often surrounds a process) could be used. For example, learners could compile a logbook record of the task(s) carried out. This could contain a description of the task undertaken, the instructions provided (annotated to record progress or difficulties), a list of tools selected and their condition, written tool/equipment defect reports, annotated photographs to explain procedures/difficulties, health and safety issues and vehicle protection etc. Such supporting product evidence would then validate the tutor or witness observation/oral questioning records and vice versa.

For summative assessment it is unlikely that group work would be appropriate unless a very large vehicle, such as a people carrier, minibuss or small coach, were to be repaired. To achieve the unit each learner must provide individual evidence of achievement for all the learning outcomes and all the pass criteria.

The majority of evidence for this unit can be generated from the practical tasks, ie removing and refitting panels (P6) and repairing non-structural body panels (P8).

Evidence for P1 and P2 can be in the form of a written assessment but it is likely that some could be captured during practical work. Evidence for P3 and P4 could also be captured during assessment for P6, P7 and P8. Evidence of maintaining tools (P4) could be generated by including tools/equipment that are not fit for purpose in the learner's toolbox. This would require the learner to identify the need to report the fault, replace or carry out the maintenance before use. Typically, P3 would be satisfied during the task(s) provided for P6 and P8 where the learner, depending on the repair, would select and use the correct tools and materials to carry out a repair on metallic and non-metallic components. P5 requires the learner to identify body design, construction and panels. Evidence could be provided by asking the learner to name various components on a gapped handout, or possibly naming various parts during a workshop session. The latter would need an assessor observation and a record of the responses provided.

Preparation of the vehicle during the repair process (P7) is vital and again it is likely that the evidence would be captured within the tasks carried out for P7 and P8. To satisfy P8, evidence of removing and refitting a metal, plastic and GRP panel must be provided. The assessment opportunities should be such that the content indicated within the *Procedures* section of learning outcome 3 is covered, including panel care (i.e. damage prevention, storage, during transit).

The assessment task(s) for P8 would typically require the learner to remove a dent, repair damage in a metal panel and undertake a repair in a plastic component. The task(s) should provide an opportunity to demonstrate the techniques indicated in the content for *Techniques* and the application of knowledge included in *Preparation*. An essential part of any repair is maintaining quality and it is expected that the evidence for P9 would include details of the quality checks that the learner has undertaken on the repair regarding correct component function, alignment, gaps, repair profile and finish.

Evidence for P6, P7, P8 and P9 could be provided through observations and well- documented, authenticated job cards or logs. Where necessary, additional tasks should be used to ensure appropriate coverage of the unit content. Within tasks for P6 and P8 there may be opportunities to generate all the evidence for P1, P2, P3, P4 and P5. However, these criteria may need to be covered on more than one occasion to ensure content coverage.

It is for the tutor to determine the range of assessment opportunities. Having done so, they then need to decide when they (the assessor) are confident that the learner would be able to demonstrate the criteria in any future context and indicate to the learner what has been achieved and what needs further evidence.

To achieve M1 learners could include a flow chart to indicate the critical factors to be taken into account when preparing materials for the repair of non-welded non-structural body components (for example panel/component material, shape, severity/type of damage, location, health and safety consideration). The comparison of a range of fixing devices (M2) could be achieved by inspecting typical non-welded, non-structural panels/components which use different fixing devices (nuts and bolts, self-tapping devices, metal and plastic fixings, rivets, adhesives etc), comparing their properties, commenting on their suitability in each case and suggesting alternative types.

For D1, learners could be given an ineffective repair and be asked to analyse the reasons for its poor quality. Other methods such as pictures and descriptions of typical faults could be considered. D2 requires the learner to justify the process and techniques used during a non-structural body repair, which could be an extension of the work undertaken for P6 and P8.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2	Safety Precautions, Organisational Procedures and Customer Requirements	A technician needs to explain to a new apprentice the precautions and procedures that need to be met when carrying out body repairs	A written assessment
P5, M2	Vehicle Body Design and Construction	A technician needs to ensure that a new apprentice is familiar with vehicle body design and construction	A written assessment
P3, P4, P6, P7, P8, P9, M1, D1, D2	Non-structural Body Repairs	A technician needs to repair a non-structural body panel and check the quality of the repair	A practical repair task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Vehicle Body Preparation and Application of Foundation Materials	

The unit contributes towards the knowledge and understanding needed for the IMI Level 2 National Occupational Standards in Accident Repair – Body, particularly:

- Unit G2: Reduce Risks to Health and Safety in the Motor Vehicle Environment
- Unit BP02: Remove and Fit Non Permanently Fixed Motor Vehicle Body Panels
- Unit BP06: Repair Minor Motor Vehicle Exterior Body Panels.

Essential resources

To deliver this unit, centres will need access to workshops equipped with vehicles, components and equipment so that learners can demonstrate vehicle body repair processes and techniques. Centres will also need a suitable range of tools, equipment and materials to support the cohort size undertaking the units.

It is imperative that owing to the dangers associated with repairing vehicles and the use of fillers and solvents etc, all the relevant health and safety requirements are in place. This includes, where necessary, specialised equipment for removing dust and fumes from the environment in addition to personal protective equipment.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) — www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Robinson, A and Livesey, A – *Repair of Vehicle Bodies* (Butterworth-Heinemann, 2005) ISBN: 9780750667531

Health and Safety Executive – *Health and Safety in Motor Vehicle Repair and Associated Industries* (Health and Safety Executive, 2009) ISBN: 0717604837

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Independent enquirers	analysing and evaluating information required for non-welded, non-structural vehicle body repair
Self-managers	organising time and resources, prioritising actions when carrying out repairs on vehicle non-welded, non-structural panels

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing safety precautions, organisational procedures and customer requirements to be met when carrying out non-welded, non-structural body repairs
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching and investigating information relevant to non-welded, non-structural body repair processes
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing safety precautions, organisational procedures and customer requirements to be met when carrying out non-welded, non-structural body repairs

Unit 15:

Preparation and Application of Vehicle Body Foundation Materials

Unit code: J/503/1530

Level: 2

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to develop the knowledge and skills required to prepare vehicle panels to accept foundation materials and topcoats and to apply these materials in accordance with organisational and safety procedures.

Unit introduction

Body repair is becoming an increasingly complex and specialised process within the automotive industry. Effective and efficient body repairs are fundamental to the functional use and overall life span of vehicles. This unit is designed to cover a wide range of vehicle types such as light, goods and passenger carrying vehicles, agricultural and plant equipment in addition to vehicles used for sports and off road use. Methods of repair may depend on a number of factors such as components being repaired, manufacturers' guidelines and health and safety issues. Additionally, for sports and off road vehicles, competition regulations may dictate the process to be used as well as the facilities and equipment available.

The unit is devised to ensure that learners gain these skills through practical exercises or working practices. Learners should have the opportunity to practise these techniques on a variety of metallic and non-metallic materials that are appropriate to their vocational pathway. This is not to say learning should be restricted to this since, at this level, it is also essential that learners have the widest possible range of experience to build on.

Safe working practices and good housekeeping will be recurrent themes throughout the work of the unit. Learners will be expected to demonstrate an understanding of their responsibility for their own safety and that of others in the workplace.

Learning outcomes

On completion of this unit a learner should:

- 1 Know the organisational and safety procedures to be followed when applying foundation materials
- 2 Be able to select tools, equipment and materials for the preparation and application of foundation materials
- 3 Be able to prepare substrates and ancillary components to accept foundation materials
- 4 Be able to apply foundation materials and topcoats.

Unit content

1 Know the organisational and safety procedures to be followed when applying foundation materials

Organisational procedures: compliance with legal requirements e.g. with respect to Control of Substances Hazardous to Health (COSHH) Regulations, Environmental Protection Act (EPA), use of respiratory equipment, use of materials, operation and use of booths and ventilation equipment; use of technical data e.g. manufacturers' repair procedures and standards, reference books, databases and repair manuals; record keeping e.g. pre-repair vehicle inspection reports, reporting equipment damage or malfunctions, reporting vehicle damage; identifying and reporting delays or potential delays in job completion e.g. waiting for parts, unforeseen problems; relationships between time and costs e.g. completing repairs within agreed timescales, cost per unit hour; protection of customers' personal property e.g. ensure security of valuables removed from vehicle, use of protective covering

Safety procedures: personal protective equipment (PPE) e.g. barrier creams, removing loose items of clothing and jewellery, protective footwear, eyewear, gloves; preparation of assembly area e.g. ventilation, protection of others; good housekeeping e.g. cleanliness of work area, removal of waste materials, storage of materials and tools; maintenance of access e.g. keeping walkways and emergency exits clear and accessible

2 Be able to select tools, equipment and materials for the preparation and application of foundation materials

Selection of tools and equipment: hand tools e.g. hand sanders, paint rollers, masking equipment; power tools e.g. power sanders; paint preparation and application equipment e.g. mixing equipment, viscosity measuring equipment, fume extraction, dust extraction, spray guns, air-fed breathing apparatus; preparation and maintenance of tools and equipment e.g. correct assembly of equipment, testing operation prior to use, correct adjustment and use (spray operation, spray gun defaults, rectification), cleaning and storage of tools and equipment; recognising damaged or unserviceable tools and equipment

Selection of materials: recognition of type of panel being prepared e.g. repaired, electro coated, plastic components, steel, aluminium, previously primed panels, original manufacturer's finish, zinc coated panels; selection of foundation materials e.g. etch primers, primer fillers, primer surfacers, stoppers, anti stone-chip treatments, anti-corrosion treatments; chemicals e.g. cleaners, dilutants and hardeners, conditioning agents, adhesion promoters; disposal of waste materials e.g. correct methods with respect to health, safety and environmental regulations

3 **Be able to prepare substrates and ancillary components to accept foundation materials**

Substrates and ancillary components: panels e.g. wings, doors, bonnets, boot lids, tailgates; ancillary components e.g. plastic bumpers, spoilers, side skirts, mirror housings

Materials and preparation processes: factors governing preparation of panel e.g. zinc coated, aluminium, steel, plastics; avoiding contamination e.g. protecting adjacent panels, masking (avoiding wastage, material selection – paper, sheet, plastic film); use of preparation materials e.g. when, where, what and how to select for task being undertaken; correct methods and techniques e.g. reference to manufacturers' procedures and data; preparation of new and repaired panels (use of feathering out, degreasing, flatting using guided coats, plastic preparation, tacking off); storage of components e.g. identification and removal of components likely to be affected by preparation process

Surface defects: recognition of defects e.g. stone chips, scratches, pinholes

4 **Be able to apply foundation materials and topcoats**

Equipment preparation: e.g. testing and adjusting of equipment prior to use, use of mixing and viscosity measuring equipment

Materials preparation: mixing paint e.g. suitability and compatibility, use of data and ratios, additives, hardeners, thinners; limiting factors e.g. properties of foundation materials, curing and drying recommendations for various fillers; identification of approved methods

Application: correct application and use of types of fillers/stoppers; application, drying and curing of foundation materials and topcoats; quality checks e.g. visual inspection, standards of finish in order to proceed to next stage surface finish, cleaned and protected

Waste disposal: requirements of COSHH regulations in respect to disposal of foundation materials; storage and handling of waste; good housekeeping in the work area

Assessment and grading criteria

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

Assessment and 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:
P1 describe the organisational and safety procedures that need to be followed when applying foundation materials	M1 identify and report defective tools and equipment	D1 compare the factors affecting the adhesion of a foundation material to a metallic substrate to that of a non-metallic ancillary component
P2 select appropriate tools, equipment and materials for the application of foundation materials	M2 compare the processes, tools and equipment used for a substrate and an ancillary component	D2 explain the possible causes of the poor finish of a foundation material.
P3 identify the different substrates and ancillary components of a vehicle for repair	M3 select data from relevant information sources for the preparation and application of a foundation material.	
P4 identify foundation materials and preparation processes for substrates and ancillary components		
P5 apply the correct type of filler and stopper to rectify a surface defect on a panel and an ancillary component [SM3, SM4]		

Table continues on next page

Assessment and grading criteria		
P6 prepare a panel and a fitting to accept foundation materials [SM3, SM4]		
P7 prepare equipment and materials for the application of foundation materials [SM3, SM4]		
P8 apply foundation materials and topcoat [SM3, SM4]		
P9 dispose of waste materials in accordance with workplace regulations [SM4].		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

The delivery approach for this unit could be to work in a specialist area only (for example light vehicle body repair). However, a generic approach that covers a range of occupational areas (for example light and heavy vehicle, passenger carrying vehicles, agricultural vehicles, off road vehicles, sports vehicles) is more likely. Centres will determine their approach through an analysis of their learners' needs and in particular through consideration of the range of industries that the centre is working with or preparing their learners to work with. Whichever approach is taken learner experience should be sufficiently varied to provide them with the understanding and skills necessary to enable them to work with the tools, equipment, paint, filler materials and techniques that would be appropriate in most industrial settings.

The learning outcomes are ordered logically and it would be reasonable to deliver them sequentially. In this way, the learner will gain an understanding of organisational and safety procedures before progressing to tools and equipment and then applications. It is expected that delivery will focus on the development of practical skills and be based around realistic workshop tasks. However, it is important not to neglect the development of the underpinning knowledge.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to unit content, overview of activities and assessment methodology
- describe the legislative and legal requirements that need to be met when working with foundation materials
- explain the use of technical data and the importance of correct record keeping
- describe the organisational procedures relating to recording repairs and identifying and reporting delays
- describe the relationships between time and costs
- explain the importance of customer requirements in terms of meeting agreed timescales and ensuring protection of their personal property
- describe the precautions that need to be taken to ensure safety of staff, customers and vehicles when applying foundation materials

Individual learner activities:

- investigation of relevant safety and organisational procedures

Prepare for and complete Assignment 1: Organisational Procedures and Safety Precautions (P1)

Whole-class teaching:

- explain the selection and use of hand tools, power tools and paint preparation and application equipment
- explain correct methods of cleaning and maintaining equipment
- explain the selection and application of foundation materials and chemicals in relation to the panel or component being prepared
- explain correct methods of disposal of waste materials

Individual learner activities:

- investigation of applications of tools, equipment and materials

Topic and suggested assignments/activities and/assessment
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ describe the factors that need to be taken into account when preparing panels and components to accept foundation materials □ explain and demonstrate preparation processes for panels and components □ describe the different types of surface defect that can occur and demonstrate the related rectification methods <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ selecting tools equipment and materials □ rectifying panel and component surface defects <p>preparation of panels and components to accept foundation materials</p>
<p>Prepare for and complete Assignment 2: Preparing Vehicle Substrates and Ancillary Components (P2, P3, P4, P5, P6, M1, M2, M3)</p>
<p>Whole-class teaching:</p> <ul style="list-style-type: none"> □ explain and demonstrate equipment and material preparation processes □ explain and demonstrate correct application of foundation materials and topcoats and checking quality of finish □ demonstrate methods of correct storage, handling and disposal of materials <p>Practical workshop activities:</p> <ul style="list-style-type: none"> □ preparation of equipment and materials and applying foundation materials and topcoats to a range of panels and components
<p>Prepare for and complete Assignment 3: Applying Foundation Materials (P7, P8, P9, D1, D2)</p>
<p>Feedback to learners, unit evaluation and close</p>

Assessment

A large proportion of the assessment for this unit will occur naturally through tutor observation and oral questioning during the completion of set tasks. Where possible, tasks should be completed on actual vehicles and not on test panels, components or training vehicles. To support the high level of process evidence, centres will need to consider what additional product evidence (that often surrounds a process) could be used. For example, the use of a logbook record, maintained by the learner, of the task(s) carried out. The log could contain a description of the task undertaken, the instructions provided (annotated to record progress or difficulties), a list of tools provided and their condition and relevant photographs annotated to explain procedures/difficulties. Such supporting product evidence would then validate the tutor or witness observation/oral questioning records and vice versa.

For summative assessment, group work would be inappropriate unless a very large vehicle, such as a people carrier, minibuss or small coach, was to be used. To achieve the unit each learner must provide individual evidence of achievement for all the pass criteria.

To achieve a pass, the learner will need to describe organisational and safety procedures to be followed when applying foundation materials in a mechanical assembly. In particular this will need to focus on compliance with the legal aspects of applying foundation materials (for example COSHH, EPA)(P1). Learners can then develop their knowledge of tools, equipment and materials, the different substrates and ancillary fittings, foundation materials and preparation processes for substrates and ancillary components.

The major practical tasks will require the application of the correct type of filler and stopper to rectify a surface defect on a panel and a fitting to accept foundation materials and the preparation of equipment and materials for the application of foundation materials. Finally, the learner should be able to use appropriate tools, equipment and materials to apply the foundation materials and topcoat in addition to correctly disposing of waste materials associated with the task in accordance with workplace regulations.

It is unlikely that any one task could completely fulfil the requirements of all the assessment criteria. For this reason it may be necessary to identify a range of tasks and for the learner to maintain a logbook to note where and how the criteria and content have been covered. For example, one task that the learner might reasonably undertake would be to repair some minor stone damage to a vehicle's bonnet. To achieve this, the learner would need to identify the substrate to be repaired (P3) and the correct foundation materials and preparation processes for that substrate (P4). They could then select tools, equipment and materials for the task (P2), fill and stop the damaged area as necessary (P5), prepare surfaces for the application of foundation materials (P6), prepare equipment and materials (P7) and apply foundation materials (P8). Finally, learners should dispose of waste materials in accordance with workplace regulations (P9). Although this task is relevant and realistic, and meets most of the pass criteria (not P1), it would not cover all of the unit content. The most obvious omission would be the requirement of P6 to prepare a panel and a fitting. This could be overcome by adding 'stone chips on a vehicle's bonnet and mirror housing'. Even this, however, would not meet all the content requirements. Additional tasks should be used to give learners a range of vehicles to work on, taking into account their chosen occupational pathway, and to ensure the depth and breadth of content coverage.

It is for the tutor to determine the range of assessment opportunities. Having done so, they then need to decide when they (the assessor) are confident that the learner would be able to demonstrate the criteria in any future context and indicate to the learner what has been achieved and what needs further evidence. It is essential that the assessment information provided for a specific task makes clear to the learner the assessment and grading criteria being covered and any limitations that may occur in terms of content coverage. For example, P6 could not be achieved until both a panel and a fitting had been prepared for repair.

To achieve a merit, learners will need to, in the course of their work, identify and report defective tools and equipment (M1). Achievement of this criterion should be based around the range of tools and equipment identified in the unit content but it is not expected that defects should be found on all of these, as this would be unrealistic. Again, it is for the centre to determine the range of opportunities for learners to achieve this criterion and to identify when they feel the learner has sufficiently demonstrated the level of independence and responsibility when working with tools and equipment. M2 requires the learner to compare the processes, tools and equipment used for a substrate and an ancillary component. It is essential that the chosen vehicle components provide the learner with the opportunity for detailed comparison. This could be achieved by ensuring the components are of widely differing material types or shape. Finally, M3 requires the learner to select data from relevant information sources for the preparation and application of a foundation material. At pass level, it is expected that this data and information would be made available to the learner. To achieve M3, it is expected that the learner would need to decide from the task being undertaken what data and information is required, access it, select the information required and then carry out the task making use of the information.

To achieve a distinction, the learner needs to compare the factors affecting the adhesion of a foundation material to a metallic substrate to that of a non-metallic ancillary component. In addition, the learner must explain the possible causes of the poor finish of a foundation material. Both of the distinction criteria are intended to demonstrate the learner's deeper understanding of the processes carried out at pass level and of the need for stringent quality control measures to ensure an effective repair.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1	Organisational Procedures and Safety Precautions	A vehicle workshop needs an information leaflet describing the organisational and safety procedures to be followed when applying foundation materials	Written assignment
P2, P3, P4, P5, P6, M1, M2, M3	Preparing Vehicle Substrates and Ancillary Components	A technician needs to prepare for the application of foundation materials	Practical assignment supported by learners' written records and tutor observation
P7, P8, P9, D1, D2	Applying Foundation Materials	A technician needs to apply foundation materials and topcoats to vehicle panels and components	Practical assignment supported by learners' written records and tutor observation

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

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Non-structural Body Repair Processes	

The unit contributes towards the knowledge and understanding needed for the IMI Level 2 National Occupational Standards in Accident Repair – Paint, particularly:

- Unit PO4: Preparing Metal and Pre-painted Surfaces in the Motor Vehicle Environment
- Unit PO5: Applying Fillers and Foundation Materials in the Motor Vehicle Environment.

Essential resources

To deliver this unit, centres will need access to workshops equipped with vehicles, components and equipment so learners can demonstrate repair processes and techniques as defined by the unit content. Centres will also need a suitable range of tools, equipment and materials to support the cohort size undertaking the units.

It is imperative that owing to the dangers associated with repairing vehicles and the use of fillers and solvents all the relevant health and safety requirements and equipment are in place and available to the learner. This includes, where necessary, specialised equipment for removing dust and fumes from the environment in addition to PPE.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Health and Safety Executive – *Health and Safety in Motor Vehicle Repair and Associated Industries* (Health and Safety Executive, 2009) ISBN 0118856715

Robinson, A and Livesey, A – *Repair of Vehicle Bodies* (Butterworth-Heinemann 2006) ISBN 0750667532

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when preparing substrates and ancillary components and applying foundation materials and topcoats

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing organisational procedures and safety precautions that need to be followed when applying foundation materials
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing organisational procedures and safety precautions that need to be followed when applying foundation materials

Unit 16:

Welding and Assembly Techniques for Vehicle Maintenance and Repair

Unit code: A/503/1556

Level: 2

Credit value: 5

Guided learning hours: 30

Aim and purpose

The aim of this unit is to develop the skills needed to produce vehicle mechanical assemblies and welded joints safely.

Unit introduction

The practice of welding and joining is fundamental to the repair and maintenance of vehicles. This may cover a wide range of vehicle types such as light, goods, passenger carrying vehicles, agricultural, plant equipment and vehicles used for sports and off-road use. Methods of joining may depend on a number of factors such as the components being repaired or joined, manufacturers' guidelines and health and safety issues. Additionally, for sports vehicles, competition regulations may dictate the joining processes to be used as will the facilities and equipment available.

In this unit learners will develop the skills and knowledge needed to use tools and equipment to carry out a range of joining techniques on a variety of materials. Learners should have the opportunity to practise joining techniques on a variety of metallic and non-metallic materials that are appropriate to their vocational pathway. This is not to say learning should be restricted to this. Owing to the unit length it is expected that the main emphasis will be on the use of metal inert/active gas (MIG/MAG) and plastic welding, with only light use or appreciation of gas and bronze welding.

Safe working practices and good housekeeping will be recurrent themes throughout the unit. Learners will be expected to demonstrate an understanding of their responsibility for their own safety and that of others in the workplace.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to safely carry out assembly operations to produce a mechanical assembly
- 2 Be able to safely carry out a welding activity to produce welded joints.

Unit content

1 Be able to safely carry out assembly operations to produce a mechanical assembly

Safety precautions: personal protective equipment (PPE) e.g. protective footwear, eye protection, gloves, barrier creams, remove loose items and jewellery; preparation of assembly area e.g. ventilation, protection of others; good housekeeping e.g. cleanliness of work area, removal of waste materials, storage of materials and tools; maintenance of access e.g. keeping walkways and emergency exits clear and accessible

Assembly operations: tidy work area (floor, vehicle, bench); plan assembly area layout e.g. sufficient room, check availability of services, power and air; preparation e.g. correct components, tools and safety equipment; checking e.g. threads for damage, joints for cleanliness, sealants, solvents and resins are in date, extraction for operation

Mechanical assembly: specific assembly procedures e.g. how to position panels and components for joining, securing components for joining; use of appropriate fastening devices e.g. screws, nuts, bolts, washers, rivets, adhesives; checking for operation e.g. correct torque, operating clearances, alignments; components e.g. wing, number plate, mirror, trim

2 Be able to safely carry out a welding activity to produce welded joints

Safety precautions: personal protective equipment e.g. protective footwear, eye protection, gloves, barrier creams, remove loose items and jewellery; preparation for welding e.g. ventilation, protection of others; good housekeeping e.g. cleanliness of work area, removal of waste materials, storage of materials and tools; maintenance of access e.g. keeping walkways and emergency exits clear and accessible; safely storing equipment e.g. cables, gas hoses, cylinders, welding sets, filler wires, electrodes, hand tools; returning and storing safety equipment

Welding activities: use of welding equipment e.g. oxy fuel gas, plastic welding, MIG/MAG, bronze welding; use of materials e.g. plastics, carbon steel, stainless steel and/or steels with protective coatings, aluminium; positions e.g. flat down hand, horizontal, vertical; procedures for closing down equipment e.g. electrical supply, extinguishing welding flame, turning off gas cylinders/supply

Welded joints: butt joints; spot welded joints; other joints e.g. fillet lap, tee fillet, close corner, spot welded lap; welds e.g. stop restart; 200 mm long; materials up to 5 mm thick e.g. appropriate use of materials for occupational route being followed – light vehicle body repair will require thinner gauge than an agricultural vehicle; run welds e.g. single run, multi-run

Checking joints: visual defects e.g. for slag inclusions, uneven ripple formation; dimensional defects e.g. positional accuracy, size, profile of weld

Assessment and grading criteria

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

Assessment and 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:
P1 describe the safety precautions to be taken when carrying out assembly operations	M1 describe the use of assembly operations to produce a mechanical assembly	D1 justify the selection of an appropriate welding activity for a given vehicle application.
P2 safely carry out assembly operations to produce a mechanical assembly [SM3, SM4]	M2 compare the use of two welding activities to produce a welded joint.	
P3 describe the safety precautions to be taken when carrying out welding activities		
P4 safely carry out welding activities to produce three welded joints [SM3, SM4]		
P5 check two welded joints for visual and dimensional defects.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

Delivery of this unit could focus on only one occupational area for example light vehicle body repair. However, a generic approach that covers a range of occupational areas (for example light and heavy vehicle, passenger carrying vehicles, agricultural vehicles, off road vehicles, sports vehicles) is more likely. Centres will determine their delivery approach through an analysis of their learners' needs and in particular through consideration of the range of industries that the centre is working with or preparing their learners to work with. However, it is expected that learner experience should be sufficiently varied to provide them with the underpinning knowledge and skills to enable them to work with tools, equipment, methods and techniques in most industrial settings.

Owing to its short length the unit is designed to be practical and any underpinning knowledge should be delivered through the practical exercises. Learners may be given opportunities to work individually or collectively to obtain underpinning knowledge via tasks and assignments outside the guided learning hours for this unit.

The main practical activities should focus on the development of MIG/MAG and plastic welding techniques in order that the learner can reach a sufficient level to complete the required summative assignment piece(s). However, an appreciation of the use of gas welding and the setting up and shutting down of the equipment in the unit is expected to be taught. Bronze welding should also be demonstrated and the reasons for its use explained, although at this level learners will not be required to develop the skills needed to use this equipment. However, centres should have access to this equipment for demonstration and development for further levels of study.

Achievement at merit and distinction will be demonstrated through the learner's autonomy when carrying out tasks, plus their ability to know when to seek advice. Therefore, it is important that during the delivery/learning phase development of these skills is encouraged. Formative assessment will play an important part in the general development of learners but especially their achievement of the higher-level grades.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ describe the use of relevant PPE for assembly operations and the importance of correct preparation, good housekeeping and maintaining clear access
- ☐ industrial visit to view assembly operations in a vehicle context

Individual learner activity:

- ☐ multiple-choice test on safety precautions to be taken when carrying out assembly operations

Practical workshop activities:

- ☐ tutor-led activities to ensure work area is tidy and correctly laid out and that components and tools have been prepared and checked prior to starting assembly operations
- ☐ tutor-led activities to familiarise learners with assembly procedures and correct use of appropriate fastening devices for different components
- ☐ checking assembly for correct operation/fastening etc

Whole-class teaching:

- ☐ describe the use of relevant PPE for welding processes and the importance of correct preparation, good housekeeping, maintaining clear access and storing and returning all equipment
- ☐ explain safe and correct use of different types of welding equipment and materials for production of welded joints
- ☐ describe the different types of welds and welded joints including different welding positions

Individual learner activity:

- ☐ multiple-choice test on safety precautions to be taken when carrying out welding activities

Practical workshop activities:

- ☐ tutor-led activities in the use of a range of welding equipment and materials to produce a variety of welded joints in different positions
- ☐ checking welds for visual or dimensional defects

Topic and suggested assignments/activities and/assessment

Prepare for and complete Assignment 1: Vehicle Assembly and Welding Operations (P2, P4, P5, M1, M2, D1)

Prepare for and complete Assignment 2: Safety Precautions for Vehicle Assembly and Welding (P1, P3)

Feedback to learners, unit evaluation and close

Assessment

A large proportion of the assessment for this unit will naturally be through tutor observation, oral questioning and the completion of practical tasks. These tasks should be vehicle related and not be too reliant on pure test piece production. To support the high level of process evidence, centres will also need to consider what additional product evidence (that often surrounds a process) could be used. For example, the use of a logbook record, maintained by the learner, of the assembly task(s) carried out. The log could contain a description of the task undertaken, the instructions provided (annotated to record progress or difficulties), a list of tools provided and their condition, written tool/equipment defect reports, relevant photographs that have been annotated to explain procedures/difficulties, etc. Such supporting product evidence would then validate the tutor or witness observation/oral questioning records and vice versa.

For summative assessment it is unlikely that group work would be appropriate and each learner must provide individual evidence of achievement of the criteria.

It can be seen from the assessment grid that three main tasks need to be carried out to meet all the criteria:

- safely carry out assembly operations to produce a mechanical assembly (P2)
- safely carry out a welding activities to produce three welded joints (P4)
- check joints for visual and dimensional defects (P5).

For example, this could be approached for task 1as follows.

Following an accident the front bumper of a vehicle needs to be plastic welded prior to refinishing. Remove the bumper, repair by welding (P4) and refit after refinishing (P2). Check for defects and correct fitment and alignment (P5).

These three main activities are supported by the two other pass criteria (P1 and P3) which may mean that they could also be claimed as part of this process providing they are built into the task. Another written task could however be used to assess these two criteria which ask for descriptions of safety precautions.

It is for the tutor to determine the range of assessment opportunities. Having done so, they then need to decide when they (the assessor) are confident that the learner would be able to demonstrate the criteria in any future context and indicate to the learner what has been achieved and what needs further evidence.

To achieve a merit, learners need to describe the use of operations to produce a mechanical assembly (M1) and compare the use of two welding activities in producing a welded joint (M2).

To achieve a distinction, the learner needs to justify the selection of a welding activity, including use of equipment, materials and position, for a given vehicle application.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P2, P4, P5, M1, M2, D1	Vehicle Assembly and Welding Operations	A technician needs to make repairs to a vehicle following an accident	A practical task supported by learners' written records and records of tutor observation and oral questioning
P1, P3	Safety Precautions for Vehicle Assembly and Welding	A technician needs to describe relevant safety precautions to a new apprentice	A written report

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Routine Vehicle Maintenance Techniques	

The unit contributes towards the knowledge and understanding needed for the IMI Level 2 National Occupational Standards in Accident and Repair – Body, particularly:

- Unit BP19: Motor Vehicle Body MIG/MAG Welding Operations
- Unit BP24: Motor Vehicle Body Mechanical Fastening Operations.

Essential resources

Centres will need access to the range of safety equipment, components, assemblies and welding equipment as defined by the unit content.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.lsnlearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk

Indicative reading for learners

Textbooks

Farnsworth S – *Welding for Dummies* (John Wiley and Sons, 2010)
ISBN 9780470455968

Websites

The Welding Institute – www.twi.co.uk

The Health and Safety Executive – www.hse.gov.org

Learn How to Weld – www.learn-how-to-weld.com

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Self-managers	organising time and resources and anticipating and managing risks when carrying out vehicle assembly and welding activities

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work
Team workers	collaborating with others when working as part of a team to produce mechanical assemblies and welded joints

Functional Skills – Level 2

Skill	When learners are ...
English	
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the safety precautions to be taken when carrying out assembly operations and welding activities

Unit 17: Motorsport Vehicle Preparation and Inspection Techniques

Unit code:	J/503/1561
Level:	2
Credit value:	5
Guided learning hours:	30

Aim and purpose

The aim of this unit is to develop the skills needed to prepare and inspect a motorsport vehicle during an event.

Unit introduction

The correct inspection of motorsport vehicles helps to ensure their reliability, performance and safety during events. Inspection of a vehicle is required prior to, during and on completion of an event. Inspection and checks are needed to ensure that safety is not compromised and optimum performance is achieved within engine, transmission, steering, suspension, braking and electronic systems. These systems are found in many different design configuration on a variety of motorsport vehicles used in competitive events for example single seater, rallying, sports cars, karts, historic, motorcycles, circuit and off-road.

This unit focuses on the technical skills and qualities needed to become a competent and valued member of a motorsport team. These will include the preparation of the vehicle, the use and care of tools, an appreciation of the safety requirements involved and the ability to work under supervision and as a member of a team. Learners will develop a range of techniques for pre-competition inspection of motorsport vehicles and for final inspection during an event. They will also be able to complete the correct post-inspection documentation and ensure that the correct person is informed of inspection results.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to prepare a vehicle, tools and equipment for a motorsport event
- 2 Be able to inspect a vehicle during a motorsport event.

Unit content

1 Be able to prepare a vehicle, tools and equipment for a motorsport event

Health and safety: safe use and handling of lubricants and fluids; lifting and handling techniques; safe working practices with regard to inspecting motorsport vehicles eg application of relevant regulations and legislation (Health and Safety at Work Act, Control of Substances Hazardous to Health (COSHH) Regulations, Provision and Use of Work Equipment Regulations (PUWER), motorsport specific), safe disposal of waste materials, scrap components, hydraulic fluids, contaminated fuel

Personal protective equipment (PPE): basic equipment e.g. overalls, safety shoes, gloves; specialist motorsport equipment e.g. fire protection, hearing and eye protection, communications equipment

Tools and equipment: hand tools e.g. spanners, sockets, screwdrivers, torque wrenches, pressure gauges and specialist tools; relevant equipment e.g. vehicle lifts and stands, auxiliary engine starting devices; safety checks e.g. correct operation, serviceable condition, correctly stored and accounted for (shadow boards, tool control methods)

Vehicle preparation: removal/storage of covers e.g. bodywork, fairings, hatches; selection of service fluids and lubricants; cleaning vehicle e.g. removal of dirt, dust, oil, track debris; obtaining relevant inspection documentation e.g. job sheets, set-up sheets, inspection check sheets (importance of working to critical times and correct procedures when carrying out inspections); safely support and protect vehicle ready for inspection

2 Be able to inspect a vehicle during a motorsport event

Pre-competition vehicle inspection: security of fastenings using a torque wrench eg nuts, bolts, critical securing devices; fuelling vehicle e.g. correct capacity/weight; tyres e.g. suitability, condition, pressures; lubrication and coolant system levels and pressures e.g. warm up, operating temperature; testing throttle settings and operation e.g. idle, full throttle; hydraulic fluid system levels, leaks and operation e.g. for clutch, steering, brakes; vehicle brake balance settings; setting suspension dampers to suit event; transmission system operation e.g. function of clutch and gearbox through all gears; electrical system operation; running gear e.g. spherical bearings, wheel bearings; reporting of faults e.g. loss of fluid, abnormal pressure, excessive wear

Motorsport event: e.g. taking part in an event as a member of a service team for a single seater, rally, sports car, karting, historic, motorcycle, on or off road competition

Final vehicle inspection: security of bodywork (fairings, wings, covers, hatches); driver positioning and restraining system e.g. seat positioning, seat belts; fire extinguisher (secure, full and armed); wheels secure and locking devices in place; driver information provided e.g. fuel quantity, tyre details, track conditions, geometry settings, brake balance and condition; clean surfaces e.g. bodywork, fairings, wings, windscreen; check work area is free from obstructions e.g. tools, equipment, foreign objects

Documentation: test data e.g. set-up sheets, pressures; relevant paperwork for event type; inform appropriate person(s) e.g. driver/rider, team manager, chief mechanic, No 1 mechanic, track officials

Assessment and grading criteria

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

Assessment and 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:
P1 describe the health and safety procedures to be followed when preparing and inspecting a motorsport vehicle	M1 carry out a survey of an inspection area and identify strengths and threats to the safety of self and others	D1 use inspection results and performance assessments to propose ways of improving future reliability and competitiveness of a motorsport vehicle.
P2 use appropriate personal protective equipment when preparing and inspecting a motorsport vehicle [SM4]	M2 assess own performance following a motorsport event pre- and final vehicle inspection	
P3 check all tools and equipment needed for an inspection	M3 assess the performance of other team members following a motorsport event pre- and final vehicle inspection.	
P4 prepare a motorsport vehicle for inspection [SM3, SM4]		
P5 carry out a pre-competition vehicle inspection during a motorsport event [TW1, SM3, SM4]		

Table continues on next page

Assessment and grading criteria

P6	carry out a final vehicle inspection before the vehicle leaves the pit area during a motorsport event [TW1, SM3, SM4]		
P7	complete appropriate post inspection documentation.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key

IE – independent enquirers

CT – creative thinkers

RL – reflective learners

TW – team workers

SM – self-managers

EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit should focus on developing learner understanding of the importance of preparing a vehicle before a competitive motorsport event and the relevance of the final preparation of a vehicle on the day of an event. Learners must be familiar with all aspects of the particular vehicle selected and the type of event that the vehicle and driver will be participating in. In addition, learners should practise their role in the inspection procedure until they are fully competent in all tasks required of them and, therefore, will be an asset to the team during an event.

To ensure learners have the opportunity to meet all the criteria, centres will need to select a suitable motorsport event that will enable the learner to take an active and competitive role. An alternative approach would be for the centre to develop effective links with a local or national participant(s) in a particular type of motorsport and secure the inclusion of learners as part of the team at an event.

Learners will need to practise the required skills, until they are competent, during supervised workshop sessions, either at the centre or at pre-event team selection sessions at the race team's headquarters.

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

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- ☐ introduction to unit content, overview of activities and assessment methodology
- ☐ explain the importance of preparing a vehicle prior to a motorsport competitive event
- ☐ explain the health and safety processes and procedures that need to be followed when preparing and inspecting a motorsport vehicle
- ☐ explain correct use of appropriate personal protective equipment
- ☐ explain and demonstrate preparation and checking of tools and equipment
- ☐ explain and demonstrate processes for preparing a vehicle for inspection

Practical workshop activities:

- ☐ practise correct use of PPE, checking tools and equipment and preparing a vehicle for inspection during a motorsport event

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- explain and demonstrate the checks that need to be carried out as part of a pre-competition vehicle inspection
- explain and demonstrate the key processes for a final vehicle inspection
- explain the appropriate post inspection documentation that needs to be completed

Practical workshop activities:

- practise correct use of PPE and procedures for pre-competition and final vehicle inspection

Attendance at motorsports event(s):

- view motorsport vehicle preparation and inspection as performed by a motorsports team under competitive conditions

Whole-class teaching:

- analyse the performance of a motorsport team

Prepare for and carry out Assignment 1: Preparing a Motorsport Vehicle for Inspection (P1, P2, P3, P4, M1)**Prepare for and carry out Assignment 2: Inspecting a Motorsport Vehicle (P5, P6, P7, D1)****Prepare for and carry out Assignment 3: Evaluating a Motorsport Team's Performance (M2, M3)**

Feedback to learners, unit evaluation and close

Assessment

Assessment of this unit will be set exclusively within the context of motorsport events. To meet the pass criteria learners will need to prepare some written work based on their own observations (for example describe health and safety procedures), but assessment will mainly be through tutor observation and/or witness statements. Centres will need to ensure that process evidence (for example observation records) is targeted and fully meets the requirements of the assessment criteria in addition to providing coverage of relevant unit content. The merit and distinction criteria provide an opportunity for learners to reflect on their experiences of motorsport competition and to carry out an analysis focusing on competitive improvements.

To achieve a pass, learners need to describe the health and safety procedures for an identified event to prepare for the pre-event inspection (P1). During the actual inspection, the learner will need to use appropriate PPE (P2). Learners are required to prepare the vehicle for inspection (P4), check the required tools and equipment (for example a range of hand tools, hoists and stands) (P3) and complete appropriate documentation (P7). For P5 and P6, the learners will need to be observed carrying out a pre-competition vehicle inspection and a final vehicle inspection before the vehicle leaves the pit area. At this level, supervision is expected but this should only be to ensure overall safety rather than directive supervision (i.e. it is the learner who should be making appropriate choices of PPE, relevant tools and equipment and procedures to follow).

To achieve a merit, learners should be able to carry out a survey of an inspection area and identify strengths and threats to the safety of self and others (M1). This does not need to be carried out under the pressures of competition but should be set within a realistic motorsport vehicle inspection environment. Where simulation is used, or there is more than one learner carrying out a survey of the same area, care needs to be taken in terms of the authenticity of the evidence (for example small but significant changes to the area could be made in between each assessment such as equipment moved, new health and safety hazards introduced). Learners are also required to prepare an assessment of their own performance (M2) and the performance of other team members (M3) following a motorsport event pre and final vehicle inspection. It is expected that this will be carried out following a 'live' event. In reality, it may take more than one event for learners to reach a level of competence that is sufficient to enable them to gather the information required to meet the merit criteria.

To achieve a distinction, learners should be able to use inspection results and performance assessments to propose ways of improving future reliability and competitiveness of a motorsport vehicle. As with M2 and M3, it is unlikely that learners will achieve this criterion through attending just one event. The essential aspect of the evidence will be a demonstration of the learner's ability to reflect on their experiences, gather data and synthesise the information into meaningful improvements for the competitiveness of a motorsport vehicle.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, P4, M1	Preparing a Motorsport Vehicle for Inspection	A technician needs to prepare a motorsport vehicle for inspection	A practical assessment evidenced through learners' work logs and tutor observation records, plus a written report of the survey of an inspection area
P5, P6, P7, D1	Inspecting a Motorsport Vehicle	A technician needs to carry out pre-competition and final vehicle inspections as part of a motorsport event	A practical assessment evidenced through learners' work logs and tutor observation records, plus written recommendations for improving vehicle reliability and competitiveness
M2, M3	Evaluating a Motorsport Team's Performance	A member of a motorsports team needs to evaluate the performance of themselves and their team	A written report

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

This unit forms part of the BTEC Engineering sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Stripping and Rebuilding Motorsport Engines	

This unit covers some of the knowledge and understanding within the SEMTA Level 2 National Occupational Standards in Performing Engineering Operations, particularly:

- Unit 57: Inspecting a Motorsport Vehicle During a Competition
- Unit 44: Diagnosing and Rectifying Faults on Motorsport Vehicles.

Essential resources

To deliver this unit, centres or teams will need to provide a suitable area for learners to prepare for, and carry out, an inspection of a vehicle. This includes access to all the relevant tools and equipment for the particular vehicle being inspected. A vehicle designed or modified to take part in a particular motorsport event will also be needed, as will suitably experienced and competent staff to assess the learner's ability to use the required specialist skills.

Employer engagement and vocational contexts

Centres should develop links with motorsport teams participating in local, regional or national events to give learners the opportunity to experience as wide a range of 'live' motorsport events as possible.

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition Book Edition (Nelson Thornes, 2010)

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Team workers	collaborating with others as part of a motorsports team when inspecting a motorsports vehicle
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when inspecting a motorsports vehicle

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing the health and safety procedures to be followed when inspecting a motorsport vehicle
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	describing the health and safety procedures to be followed when inspecting a motorsport vehicle completing appropriate post inspection documentation

Unit 18: **Stripping and Rebuilding Motorsport Engines**

Unit code:	R/503/1630
Level:	2
Credit value:	10
Guided learning hours:	60

Aim and purpose

The aim of this unit is to enable learners to prepare, strip and rebuild a motorsport engine, test motorsport engine components and use correct documentation prior to a motorsport event.

Unit introduction

Stripping and rebuilding motorsport engines is necessary to ensure safety, reliability and performance. The task may be carried out before every event or periodically depending on the level and type of motorsport. Each team will adopt a procedure that suits their particular sporting event, finances and resources. Nevertheless, teams must have the ability to ensure the vehicle is event ready and able to meet relevant motorsport governing body standards.

In this unit learners will demonstrate competence in stripping and rebuilding motorsport engines and in the use of specialist tools and equipment in a particular motorsport area. These areas might include single seat, rally, sports, karts, historic vehicles, motorcycles, circuit or off-road competition vehicles. Stripping and rebuilding of motorsport engines will involve learners in the dismantling and removal of engine components, inspection and checking for faults and excessive wear and potential problems, replacement of components and rebuilding the engine using hand tools, specialist tools and test equipment. Safety will be an important consideration as will the use of the correct documentation to guide the rebuild or report the outcomes.

Learning outcomes

On completion of this unit a learner should:

- 1 Be able to prepare a motorsport engine for stripping and rebuilding prior to an event
- 2 Be able to remove and replace, strip and rebuild motorsport engine components and assemblies
- 3 Be able to perform relevant test procedures on motorsport engine components
- 4 Be able to perform motorsport engineering tasks and complete relevant documentation to meet specific standards.

Unit content

1 Be able to prepare a motorsport engine for stripping and rebuilding prior to an event

Health and safety requirements: safe handling and use of tools, equipment and materials e.g. lubricants and fluids (release of fuel and other liquids), lifting and handling techniques (engine support, working height and position); use of procedures that comply with current legislation and regulations (Health and Safety at Work Act, Control of Substances Hazardous to Health (COSHH) Regulations, Provision and Use of Work Equipment Regulations (PUWER)) and other related legislation or guidelines; selection and use of personal protective equipment (PPE); safety of self and others

Preparing the engine: access to the engine e.g. removal from vehicle or transportation container, mounting of engine on stand; cleaning (dirt, oil, track debris from engine externals) and checking for external damage; removal of covers and cowlings; draining of fluids; selection of appropriate storage containers (for safe keeping of removed parts); use and importance of correct documentation prior to disassembly e.g. engine manuals, system diagrams, engineering drawings, engine records/history

2 Be able to remove and replace, strip and rebuild motorsport engine components and assemblies

Techniques: removal and replacement of parts e.g. hoses and pipes, electrical connections, mechanical fasteners; proof marking/labelling components to aid reassembly; inspecting components for damage and/or wear e.g. indicating whether serviceable, for repair or replacement; storage and labelling of removed components to aid re-assembly or replacement; re-assembly techniques e.g. use of nuts and bolts, quick release fasteners, circlips, rivets, locking devices (split pins, wire locking, lock nuts, adhesives); use of assembly techniques e.g. checking bearing clearances using engineer's blue or compressible strips, lapping-in valves, torque setting bolts and fittings (consideration of sequence), replacement of sealing devices ('O' rings, seals, gaskets, sealing compounds); positioning, aligning, setting and adjusting replaced components; replenish fluid systems e.g. coolant, engine oil; disposal of waste materials and scrap components

Engine areas and components: engine ancillary components e.g. exhaust primaries and silencers, airboxes, engine mounts, filters; clutch eg clutch covers, driven plate(s), thrust bearings; cam timing e.g. pulleys, belts, gears, adjusters; electrical e.g. generation, starting, ignition, engine management, data control boxes, electronic control units (ECUs), wiring looms; system components e.g. sensors, regulators, safety devices, gauges

Engine component assemblies: cylinder head e.g. valves, valve springs, valve spring heights, rockers, valve stem seals, spark plugs; engine block e.g. crankshafts, connecting rods, pistons, rings, main bearings, big end bearings; lubrication system e.g. oil pumps, oil filters, scavenge pumps, oil tanks, pressure relief valves; fuel system e.g. carburettors, ECU, injectors, high and low pressure, fuel pumps, fuel filters, metering units, fuel rails, pressure relief valves

3 Be able to perform relevant test procedures on motorsport engine components

Inspection and testing techniques: crack detection (ferrous, non-ferrous metal components); sensory testing e.g. sight, sound, smell, touch; mechanical measurements; connecting and setting an engine to a dynamometer installation

Test procedures: compression test; cylinder leakage; inlet vacuum test; ignition timing; electrical charging system test; other specific tests e.g. static and dynamic balance, pressure tests

4 Be able to perform motorsport engineering tasks and complete relevant documentation to meet specific standards

Standards: e.g. BS or ISO standards and procedures, race association regulations, vehicle manufacturer's specification, customer standards and requirement, team/company standards and procedures, specific engine system requirements

Documentation: e.g. job sheets, computer records, vehicle preparation sheets, post competition strip down sheet, engineer/team records, engine rebuild sheet, formal risk assessment documentation

Assessment and grading criteria

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

Assessment and 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:
P1 explain the health and safety requirements relevant to each of the motorsport engine stripping and rebuilding tasks carried out	M1 explain the action to be taken when health and safety issues arise during engine stripping and rebuilding tasks	D1 strip and rebuild a motorsport engine component assembly accurately and independently with limited supervision or guidance
P2 prepare an engine for stripping and rebuilding	M2 explain the importance of correct preparation and using suitable techniques for stripping and rebuilding an engine component assembly.	D2 evaluate the methods and techniques used to dismantle and reassemble a motorsport engine component assembly and make a proposal for improvement.
P3 use relevant engineering methods for removal replacement, stripping and rebuilding of engine components and assemblies [TW1, SM3, SM4]		
P4 remove and replace motorsport engine components from three different engine areas		

Table continues on next page

Assessment and grading criteria		
P5 strip and rebuild three different motorsport engine component assemblies		
P6 use crack detection and two other different inspection and testing techniques when carrying out tests procedures to check the function of rebuilt components [SM3, SM4]		
P7 carry out tasks on motorsport engines to given relevant standards, specifications or specified requirements [TW1, SM3, SM4]		
P8 complete relevant documentation to record and report outcomes of the engine stripping and rebuilding tasks undertaken.		

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers CT – creative thinkers RL – reflective learners TW – team workers SM – self-managers EP – effective participators
------------	---

Essential guidance for tutors

Delivery

This is primarily a hands-on unit and should be delivered through practical activities. It is expected that each activity will include relevant health and safety instructions and supporting technical theory, which should preferably be delivered in the workshop alongside the relevant vehicle engine, components or assemblies. The four learning outcomes are interdependent and delivery will touch on each learning outcome at the various stages of learners' formative development. For example (LO1), take learners through the task to be undertaken (for example removal of cylinder head) by identifying health and safety issues, supporting documentation, tools and equipment and engineering methods to be used, the standard(s) to be followed plus any final documentation that will be needed to complete the task. Learners then independently, but with guidance and support, complete the task (LO2). Learners are given feedback and then practise the task again (to gain competence and speed) or moves onto the next planned task, etc. Centres will need to determine the range and order of the tasks to be undertaken and how these can be resourced for the particular cohort size and to meet all the requirements of the unit content.

The unit could be delivered using engines from a single motorsport vehicle type (for example single seat racing cars) or using engines from a range of motorsport vehicle types (for example rally cars, karts, sports cars, motorcycles, historic vehicles or other specific approved competition vehicles). Centres will need to ensure that learners are fully aware of the appropriate methods of working for the motorsport area(s) chosen. If a specialist approach is taken it is not necessary to cover the methods of working (such as replacement of sealing devices, locking devices and health and safety processes) in the other areas. However, the skills developed should be transferable given appropriate induction to the new engine type, motorsport area standards and methods of working.

At this level it is expected that learners will be supervised and their work carried out under the direction of a competent person, although learners should be allowed a degree of autonomy. The delivery phase should enable learners to practise new skills to a level at which they can achieve the tasks within acceptable time constraints that reflect the demands of the motorsport sector(s). Learners should be expected to take responsibility for the time taken to carry out the tasks and for the quality of the work, but be subject to supervisory checks. During delivery of the unit, teamwork should be encouraged and, in particular, learners should be encouraged to seek assistance from peers or their supervisor at any point where risks to safety or damage to the engine, engine components or assemblies could result.

Note that the use of 'e.g.' 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 'e.g.' needs to be taught or assessed.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment

Whole-class teaching:

- introduction to unit content, overview of activities and assessment methodology
- explain the health and safety procedures that need to be adhered to when preparing an engine for disassembly
- demonstrate process for accessing and cleaning a motorsport engine, removing covers and cowlings and draining fluids prior to stripping and rebuilding
- explain the importance and use of correct documentation prior to disassembly

Practical workshop activities:

- preparation of motorsport engines for stripping and rebuilding

Prepare for and complete Assignment 1: Preparing an Engine for Stripping and Rebuilding (P2)

Whole-class teaching:

- explain the health and safety procedures to be followed when removing, replacing, stripping and rebuilding engine components and assemblies
- demonstrate techniques for the removal and replacement of parts and components including marking and labelling of components
- explain importance of checking components for damage
- demonstrate re-assembly techniques, checking alignment of components and ensuring fluid systems are replenished
- demonstrate removal and replacement of components from a range of different engine areas
- explain importance of correct disposal of waste materials and components
- explain the relevant standards, procedures and specifications that need to be followed when working on motorsport engines
- explain the documentation that needs to be completed to record outcomes of stripping and rebuilding motorsports engines

Practical workshop activities:

- tutor-led activities to strip and rebuild engine assemblies and the related components
- learners work in small groups to practise use of techniques for removing, replacing, stripping and rebuilding motorsport engine components and assemblies

Topic and suggested assignments/activities and/assessment**Whole-class teaching:**

- explain and demonstrate use of a range of inspection and testing techniques for carrying out test procedures, including crack detection

Practical workshop activities:

- practise and use of inspection and testing techniques

Prepare for and carry out Assignment 2: Stripping and Rebuilding a Motorsport Cylinder Head (P1, P3, P4, P5, P6, P7, M1, M2, D1, D2)

Prepare for and carry out Assignment 3: Stripping and Rebuilding a Motorsport Engine Block (P1, P3, P4, P5, P6, P7)

Prepare for and carry out Assignment 4: Stripping and Rebuilding a Motorsport Lubrication System (P1, P3, P4, P5, P6, P7)

Prepare for and carry out Assignment 5: Stripping and Rebuilding a Motorsport Fuel System (P1, P3, P4, P5, P6, P7)

Feedback to learners, unit evaluation and close

Assessment

The interdependence of the unit content and assessment criteria means that centres need to plan their assessment strategy very carefully. In particular, it would not be possible for any of the pass criteria (except P2) to be met in any one assignment task/activity. The assignment briefs and assessment decisions need to make clear to learners that the criteria are being met only 'in-part'. Centres will also need to take care in their tracking of learner evidence to ensure full coverage of each criterion and related content over a period of time and range of assignments. Criterion P2 could be met through one planned assignment but, in reality, each removal or rebuilding assignment/activity may also have the potential to provide further assessment opportunities if required.

In effect, there are six main tasks to be undertaken. Three tasks to remove and refit engine components from different engine areas (for example ancillary components – such as an exhaust; cam timing – such as a pulley; system component – a gauge), and three engine component assemblies to strip and rebuild (for example a cylinder head assembly). These could be combined to reduce the overall number of tasks carried out for summative assessment. For example, the removal of the exhaust manifold (component removal) from the cylinder head to enable the head to be removed, stripped and rebuilt before reassembly and then the refitting of the exhaust manifold. During such tasks, the other criteria, i.e. health and safety, use of relevant techniques, test procedures, use of standards and finally, the completion of relevant documentation, could naturally be built into the assignment.

To achieve a pass, learners need to explain the health and safety requirements relevant to each of the motorsport engine stripping and rebuilding tasks that they carry out. On at least one occasion learners need to be assessed while preparing an engine for stripping and rebuilding. The main focus of assessment for a pass will be on the removal and refitting of motorsport engine components from three different engine areas and the stripping and rebuilding of three different motorsport engine component assemblies. To achieve this learners must be able to independently select and use relevant techniques (sufficient to cover the unit content) for the removal, refitting, stripping and rebuilding of engine components and assemblies. During these tasks, learners should have opportunities to use crack detection and two other inspection and testing techniques when carrying out test procedures, to check the function of the components that have been rebuilt. Learner work on motorsport engines should be carried out to, and checked against, given and relevant standards, specifications or specified requirements. Finally, learners should be able to complete relevant documentation to record and report outcomes of the engine stripping and rebuilding tasks undertaken.

To achieve a merit, learners will need to explain the action to take when health and safety issues arise during engine stripping and rebuilding tasks. This merit criterion is an extension to the related pass criterion (P1) and should enable learners to demonstrate their ability to apply health and safety in their work practices as issues arise (for example, unexpectedly, a badly damaged component has to be flame-cut from an engine to release it – what are the additional health and safety issues to be considered?). The second merit criterion requires learners to explain the importance of using correct preparation procedures and engineering methods when stripping and rebuilding an engine component assembly. Learners could use any of the three tasks associated with P4 to meet this criterion. The key issue for assessment will be that the learner is able to show that not only have they been able to complete

the task (the what and how of P4) but have also taken time to reflect on what they have done from the start to the finish and what were the most important and critical steps in that process (the why). Clearly, the focus of the merit criteria is to enable learners to demonstrate their ability to deal with the non-routine (M1) and to reflect on the task undertaken (M2), therefore showing a level of increased autonomy over and above that expected at pass.

To achieve a distinction, learners need to demonstrate the ability to strip and rebuild a motorsport engine component assembly accurately and independently with limited supervision or guidance. At this level, learners are demonstrating that they are able to engage in self-directed activity and take responsibility for the quality of their own work. In addition, they should be able to evaluate the methods and techniques used to dismantle and reassemble a motorsport engine component assembly and make a proposal for improvement.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Pearson assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P2	Preparing an Engine for Stripping and Rebuilding	A technician needs to prepare an engine prior to stripping and rebuilding	A practical repair task supported by learners' written records and records of tutor observation and oral questioning
P1 (part), P3 (part), P4 (part), P5 (part), P6 (part), P7 (part), M1, M2, D1, D2	Stripping and Rebuilding a Motorsport Cylinder Head	A technician needs to strip and rebuild a cylinder head, removing and refitting components and checking the function of rebuilt components	A practical repair task supported by learners' written records and records of tutor observation and oral questioning
P1 (part), P3 (part), P4 (part), P5 (part), P6 (part), P7 (part)	Stripping and Rebuilding a Motorsport Engine Block	A technician needs to strip and rebuild an engine block, removing and refitting components and checking the function of rebuilt components	A practical repair task supported by learners' written records and records of tutor observation and oral questioning

Criteria covered	Assignment title	Scenario	Assessment method
P1 (part), P3 (part), P4 (part), P5 (part), P6 (part), P7 (part)	Stripping and Rebuilding Motorsport Lubrication System	A technician needs to strip and rebuild a lubrication system, removing and refitting components and checking the function of rebuilt components	A practical repair task supported by learners' written records and records of tutor observation and oral questioning
P1 (part), P3 (part), P4 (part), P5 (part), P6 (part), P7 (part)	Stripping and Rebuilding Motorsport Fuel System	A technician needs to strip and rebuild a fuel system, removing and refitting components and checking the function of rebuilt components	A practical repair task supported by learners' written records and records of tutor observation and oral questioning

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

This unit forms part of the BTEC Vehicle Technology sector suite. This unit has particular links with:

Level 1	Level 2	Level 3
	Motorsport Vehicle Preparation and Inspection Techniques	Motorsport Workshop Practices
		Motorsport Vehicle Preparation and Inspection
		Professional Practice and Logistics for Motorsports

Essential resources

To deliver this unit, centres will need to provide learners with access to a vehicle workshop equipped with a range of suitable engines and related components, assemblies, rigs and diagnostic equipment.

Employer engagement and vocational contexts

Much of the work for this unit can be set in the context of learners' work placements or be based on case studies of local employers. Further information on employer engagement is available from the organisations listed below:

- Work Experience/Workplace learning frameworks – Centre for Education and Industry (CEI-University of Warwick) – www.warwick.ac.uk/wie/cei/
- Learning and Skills Network – www.vocationallearning.org.uk
- Network for Science, Technology, Engineering and Maths Network Ambassadors Scheme – www.stemnet.org.uk
- National Education and Business Partnership Network – www.nebpn.org
- Local, regional Business links – www.businesslink.gov.uk
- Work-based learning guidance – www.aimhighersw.ac.uk/wbl.htm

Indicative reading for learners

Textbooks

Hillier, V – *Hillier's Fundamentals of Motor Vehicle Technology* 6th Edition (Nelson Thornes, 2010) ISBN 978-1408515181

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Team workers	collaborating with others as part of a motorsports team when stripping and rebuilding motorsports engines
Self-managers	organising time and resources, prioritising actions and anticipating and managing risks when stripping and rebuilding motorsports engines

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Reflective learners	setting goals with success criteria for their development and work

Functional Skills – Level 2

Skill	When learners are ...
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	explaining the health and safety requirements relevant to motorsport engine stripping and rebuilding
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	reading and interpreting standards, procedures and manufacturers' specifications
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	explaining the health and safety requirements relevant to motorsport engine stripping and rebuilding completing relevant documentation

Further information and useful publications

To get in touch with us visit our 'Contact us' pages:

- Edexcel, BTEC and Pearson Work Based Learning contact details: qualifications.pearson.com/en/support/contact-us.html
- books, software and online resources for UK schools and colleges: www.pearsonschoolsandfecolleges.co.uk

Key publications:

- *Adjustments for candidates with disabilities and learning difficulties – Access and Arrangements and Reasonable Adjustments, General and Vocational qualifications (Joint Council for Qualifications (JCQ))*
- *Equality Policy (Pearson)*
- *Recognition of Prior Learning Policy and Process (Pearson)*
- *UK Information Manual (Pearson)*
- *UK Quality Vocational Assurance Handbook (Pearson).*

All of these publications are available on our website.

Publications on the quality assurance of BTEC qualifications are available on our website at qualifications.pearson.com

Our publications catalogue lists all the material available to support our qualifications. To access the catalogue and order publications, please go to qualifications.pearson.com

Additional resources

If you need further learning and teaching materials to support planning and delivery for your learners, there is a wide range of BTEC resources available.

Any publisher can seek endorsement for their resources, and, if they are successful, we will list their BTEC resources on our website, qualifications.pearson.com

How to obtain National Occupational Standards

To obtain the National Occupational Standards go to www.ukstandards.org.uk.

Professional development and training

Pearson supports UK and international customers with training related to BTEC qualifications. This support is available through a choice of training options offered on our website: qualifications.pearson.com

The support we offer focuses on a range of issues, such as:

- planning for the delivery of a new programme
- planning for assessment and grading
- developing effective assignments
- building your team and teamwork skills
- developing learner-centred learning and teaching approaches
- building in effective and efficient quality assurance systems.

The national programme of training we offer is on our website at: qualifications.pearson.com. You can request centre-based training through the website or you can contact one of our advisers in the Training from Pearson UK team via Customer Services to discuss your training needs.

BTEC training and support for the lifetime of the qualifications

Training and networks: our training programme ranges from free introductory events through sector-specific opportunities to detailed training on all aspects of delivery, assignments and assessment. We also host some regional network events to allow you to share your experiences, ideas and best practice with other BTEC colleagues in your region.

Regional support: our team of Curriculum Development Managers and Curriculum Support Consultants, based around the country, are responsible for providing advice and support in centres. They can help you with planning and curriculum developments.

To get in touch with our dedicated support teams please visit: qualifications.pearson.com

Your Pearson support team

Whether you want to talk to a sector specialist, browse online or submit your query for an individual response, there's someone in our Pearson support team to help you whenever – and however – you need:

- **Subject Advisors:** find out more about our subject advisor team – immediate, reliable support from a fellow subject expert
- **Ask the Expert:** submit your question online to our Ask the Expert online service and we will make sure your query is handled by a subject specialist.

Please visit, qualifications.pearson.com/en/support/contact-us.html

Annexe A

The Pearson BTEC qualification framework for the automotive sector

Progression opportunities within the framework.

Level	BTEC vocationally-related qualifications	BTEC specialist qualification/ professional	NVQ/competence
5	BTEC Level 5 HND Diploma in Vehicle Operations Management		
4	BTEC Level 4 HNC Diploma in Vehicle Operations Management		
3	Pearson BTEC Level 3 Subsidiary Diploma in Vehicle Technology Pearson BTEC Level 3 Diploma in Vehicle Technology Pearson BTEC Level 3 Extended Diploma in Vehicle Technology	Pearson BTEC Level 3 Diploma in Light Vehicle Maintenance and Repair Principles Pearson BTEC Level 3 Diploma in Heavy Vehicle Maintenance and Repair Principles Pearson BTEC Level 3 Diploma in Auto Electrical and Mobile Electrical Principles Pearson BTEC Level 3 Diploma in Vehicle Fitting Supervisory Principles Pearson BTEC Level 3 Diploma in Vehicle Accident Repair Body Principles Pearson BTEC Level 3 Diploma in Vehicle Accident Repair Paint Principles	Pearson Edexcel Level 3 Diploma in Light Vehicle Maintenance and Repair Competence Pearson Edexcel Level 3 Diploma in Heavy Vehicle Maintenance and Repair Competence Pearson Edexcel Level 3 Diploma in Auto Electrical and Mobile Electrical Competence Pearson Edexcel Level 3 Diploma in Vehicle Fitting Supervisory Competence Pearson Edexcel Level 3 Diploma in Vehicle Accident Repair Body Competence Pearson Edexcel Level 3 Diploma in Vehicle Accident Repair Paint Competence

Level	BTEC vocationally-related qualifications	BTEC specialist qualification/ professional	NVQ/competence
3		<p>Pearson BTEC Level 3 Diploma in Lift Truck Maintenance & Repair Principles</p> <p>Pearson BTEC Level 3 Diploma in Motorcycle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 3 Diploma in Vehicle Sales Principles</p> <p>Pearson BTEC Level 3 Diploma in Body Building Principles</p> <p>Pearson BTEC Level 3 Diploma in Light Vehicle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 3 Diploma in Heavy Vehicle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 3 Diploma in Auto Electrical Maintenance and Repair Principles</p>	<p>Pearson Edexcel Level 3 Diploma in Lift Truck Maintenance & Repair Competence</p> <p>Pearson Edexcel Level 3 Diploma in Motorcycle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 3 Diploma in Vehicle Sales Competence</p> <p>Pearson Edexcel Level 3 Diploma in Body Building Competence</p> <p>Pearson Edexcel Level 3 Diploma in Light Vehicle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 3 Diploma in Heavy Vehicle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 3 Diploma in Auto Electrical Maintenance and Repair Competence</p>
2	<p>Pearson BTEC Level 2 Certificate in Vehicle Technology</p> <p>Pearson BTEC Level 2 Extended Certificate in Vehicle Technology</p> <p>Pearson BTEC Level 2 Diploma in Vehicle Technology</p>	<p>Pearson BTEC Level 2 Diploma in Light Vehicle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 2 Diploma in Heavy Vehicle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 2 Diploma in Auto Electrical and Mobile Electrical Principles</p> <p>Pearson BTEC Level 2 Diploma in Vehicle Fitting Principles</p>	<p>Pearson Edexcel Level 2 Diploma in Light Vehicle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Heavy Vehicle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Auto Electrical and Mobile Electrical Competence</p>

Level	BTEC vocationally-related qualifications	BTEC specialist qualification/ professional	NVQ/competence
2 <i>cont'd</i>		<p>Pearson BTEC Level 2 Diploma in Vehicle Accident Repair Paint Principles</p> <p>Pearson BTEC Level 2 Diploma in Vehicle Accident Repair Body Principles</p> <p>Pearson BTEC Level 2 Diploma in Auto Electrical Maintenance and Repair Principles</p> <p>Level 2 Diploma in Lift Truck Maintenance and Repair Principles</p> <p>Pearson BTEC Level 2 Diploma in Motorcycle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 2 Diploma in Vehicle Sales Principles</p> <p>Pearson BTEC Level 2 Diploma in Vehicle Accident Repair Mechanical, Electrical and Trim (MET) Principles</p> <p>Pearson BTEC Level 2 Diploma in Body Building Principles</p> <p>Pearson BTEC Level 2 Diploma in Heavy Vehicle Trailer Maintenance and Repair Principles</p> <p>Pearson BTEC Level 2 Diploma in Heavy Vehicle Maintenance and Repair Principles</p> <p>Pearson BTEC Level 2 Diploma in Light Vehicle Maintenance and Repair Principles</p>	<p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Vehicle Accident Repair Paint Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Vehicle Accident Repair Body Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Auto Electrical Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Lift Truck Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Motorcycle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Vehicle Sales Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence</p>

Level	BTEC vocationally-related qualifications	BTEC specialist qualification / professional	NVQ / competence
			<p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Vehicle Accident Repair Mechanical, Electrical and Trim (MET) Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Body Building Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Heavy Vehicle Trailer Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Heavy Vehicle Maintenance and Repair Competence</p> <p>Pearson Edexcel Level 2 Diploma in Vehicle Fitting Competence Edexcel Level 2 Diploma in Light Vehicle Maintenance and Repair Competence</p>

Annexe B

Grading domains: BTEC Level 2 generic grading domains

Grading domain 1	Indicative characteristics — merit	Indicative characteristics — distinction
Application of knowledge and understanding (Learning outcome stem <i>understand</i> or <i>know</i>)	<ul style="list-style-type: none"> □ Show depth of knowledge and development of understanding in given situations (for example explain why, make judgements based on analysis). □ Apply and/or select relevant concepts. □ Apply knowledge to different contexts. □ Apply knowledge to non-routine contexts (i.e. assessor selection). □ Make comparisons. □ Show relationships between pass criteria. 	<ul style="list-style-type: none"> □ Synthesise knowledge and understanding across pass/merit criteria. □ Evaluate concepts/ideas/actions. □ Analyse/research and make recommendations. □ Judges implications of application of knowledge/understanding. □ Applies knowledge and understanding to complex activities/context.
Grading domain 2	Indicative characteristics — merit	Indicative characteristics — distinction
Development of practical and technical skills (Learning outcome stem <i>be able to</i>)	<ul style="list-style-type: none"> □ Use advanced techniques/processes/skills successfully. □ Act under limited supervision/demonstrate independence (note: pass cannot require support). □ Apply to non-routine activities. □ Demonstrate within time and/or resource constraints. □ Produce varied solutions (including non-routine). □ Modify techniques/processes to situations. 	<ul style="list-style-type: none"> □ Demonstrate creativity/originality/own ideas. □ Apply skill(s) to achieve higher order outcome. □ Select and use successfully from a range of advanced techniques/processes/skills. □ Reflects on skill acquisition and application. □ Justifies application of skills/methods. □ Makes judgements about risks and limitations of techniques/processes. □ Innovates or generates of application of techniques/processes for new situations.

Grading domain 3	Indicative characteristics — merit	Indicative characteristics — distinction
Personal development for occupational roles (Any learning outcome stem)	<ul style="list-style-type: none"> □ Takes responsibility in planning and undertaking activities. □ Reviews own development needs. □ Finds and uses relevant information sources. □ Acts within a given work-related context showing understanding of responsibilities. □ Identifies responsibilities of employers to the community and the environment. □ Applies qualities related to the vocational sector. □ Internalises skills/attributes (creating confidence). 	<ul style="list-style-type: none"> □ Manages self to achieve outcomes successfully. □ Plans for own learning and development through the activities. □ Analyses and manipulates information to draw conclusions. □ Applies initiative appropriately. □ Assesses how different work-related contexts or constraints would change performance. □ Takes decisions related to work contexts. □ Applies divergent and lateral thinking in work-related contexts. □ Understands interdependence.
Grading domain 4	Indicative characteristics — merit	Indicative characteristics — distinction
Application of generic skills (Any learning outcome stem)	<ul style="list-style-type: none"> □ Communicates using appropriate technical/professional language. □ Makes judgements in contexts with explanations. □ Explains how to contribute within a team. □ Makes adjustments to meet the needs/expectations of others (negotiation skills). □ Select and justify solutions for specified problems. 	<ul style="list-style-type: none"> □ Presents self and communicates information to meet the needs of a typical audience. □ Takes decisions in contexts with justifications. □ Produces outputs subject to time/resource constraints. □ Reflects on own contribution to working within a team. □ Generate new or alternative solutions to specified problems.

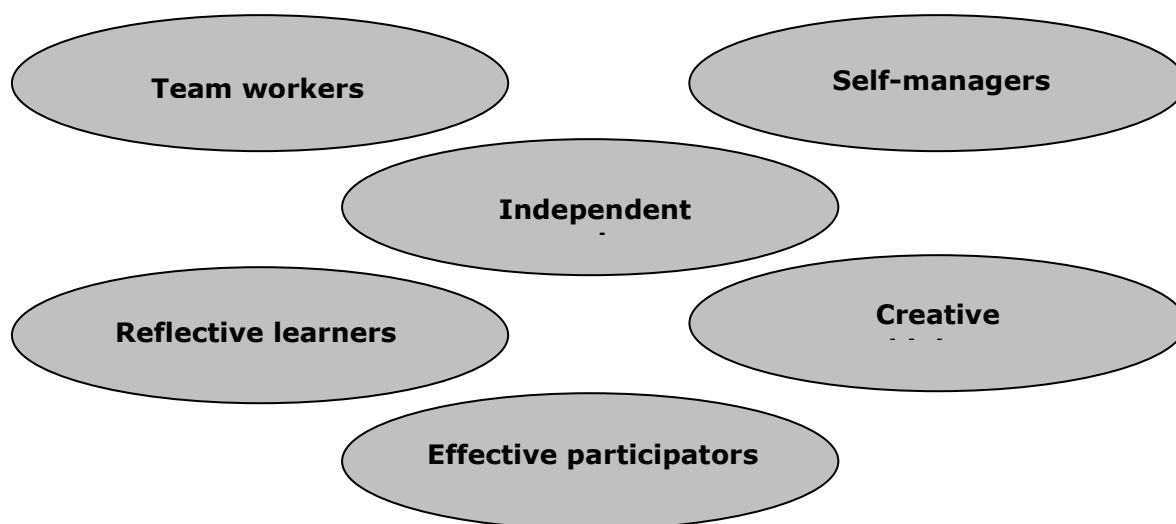
Annexe C

Personal, learning and thinking skills

A FRAMEWORK OF PERSONAL, LEARNING AND THINKING SKILLS 11-19 IN ENGLAND

The framework comprises six groups of skills that, together with the Functional Skills of English, mathematics and ICT, are essential to success in learning, life and work. In essence the framework captures the essential skills of: managing self; managing relationships with others; and managing own learning, performance and work. It is these skills that will enable young people to enter work and adult life confident and capable.

The titles of the six groups of skills are set out below.



For each group there is a focus statement that sums up the range of skills. This is followed by a set of outcome statements that are indicative of the skills, behaviours and personal qualities associated with each group.

Each group is distinctive and coherent. The groups are also inter-connected. Young people are likely to encounter skills from several groups in any one learning experience. For example an independent enquirer would set goals for their research with clear success criteria (reflective learner) and organise and manage their time and resources effectively to achieve these (self-manager). In order to acquire and develop fundamental concepts such as organising oneself, managing change, taking responsibility and perseverance, learners will need to apply skills from all six groups in a wide range of learning contexts 11-19.

The Skills

Independent enquirers

Focus:

Young people process and evaluate information in their investigations, planning what to do and how to go about it. They take informed and well-reasoned decisions, recognising that others have different beliefs and attitudes.

Young people:

- ☐ identify questions to answer and problems to resolve
- ☐ plan and carry out research, appreciating the consequences of decisions
- ☐ explore issues, events or problems from different perspectives
- ☐ analyse and evaluate information, judging its relevance and value
- ☐ consider the influence of circumstances, beliefs and feelings on decisions and events
- ☐ support conclusions, using reasoned arguments and evidence

Creative thinkers

Focus:

Young people think creatively by generating and exploring ideas, making original connections. They try different ways to tackle a problem, working with others to find imaginative solutions and outcomes that are of value.

Young people:

- ☐ generate ideas and explore possibilities
- ☐ ask questions to extend their thinking
- ☐ connect their own and others' ideas and experiences in inventive ways
- ☐ question their own and others' assumptions
- ☐ try out alternatives or new solutions and follow ideas through
- ☐ adapt ideas as circumstances change.

Reflective learners

Focus:

Young people evaluate their strengths and limitations, setting themselves realistic goals with criteria for success. They monitor their own performance and progress, inviting feedback from others and making changes to further their learning.

Young people:

- ☐ assess themselves and others, identifying opportunities and achievements
- ☐ set goals with success criteria for their development and work
- ☐ review progress, acting on the outcomes
- ☐ invite feedback and deal positively with praise, setbacks and criticism
- ☐ evaluate experiences and learning to inform future progress
- ☐ communicate their learning in relevant ways for different audiences.

Team workers

Focus:

Young people work confidently with others, adapting to different contexts and taking responsibility for their own part. They listen to and take account of different views. They form collaborative relationships, resolving issues to reach agreed outcomes.

Young people:

- ☐ collaborate with others to work towards common goals
- ☐ reach agreements, managing discussions to achieve results
- ☐ adapt behaviour to suit different roles and situations, including leadership roles
- ☐ show fairness and consideration to others
- ☐ take responsibility, showing confidence in themselves and their contribution
- ☐ provide constructive support and feedback to others.

Self-managers

Focus:

Young people organise themselves, showing personal responsibility, initiative, creativity and enterprise with a commitment to learning and self-improvement. They actively embrace change, responding positively to new priorities, coping with challenges and looking for opportunities.

Young people:

- ☐ seek out challenges or new responsibilities and show flexibility when priorities change
- ☐ work towards goals, showing initiative, commitment and perseverance
- ☐ organise time and resources, prioritising actions
- ☐ anticipate, take and manage risks
- ☐ deal with competing pressures, including personal and work-related demands
- ☐ respond positively to change, seeking advice and support when needed
- ☐ manage their emotions, and build and maintain relationships.

Effective participators

Focus:

Young people actively engage with issues that affect them and those around them. They play a full part in the life of their school, college, workplace or wider community by taking responsible action to bring improvements for others as well as themselves.

Young people:

- ☐ discuss issues of concern, seeking resolution where needed
- ☐ present a persuasive case for action
- ☐ propose practical ways forward, breaking these down into manageable steps
- ☐ identify improvements that would benefit others as well as themselves
- ☐ try to influence others, negotiating and balancing diverse views to reach workable solutions
- ☐ act as an advocate for views and beliefs that may differ from their own.

PLTS performance indicator (suggested recording sheet)

Name:	Date:				
	Level of success 1 = low, 5 = high				
Independent enquirers					
Identify questions to answer and problems to resolve	1	2	3	4	5
Plan and carry out research, appreciating the consequences of decisions	1	2	3	4	5
Explore issues, events or problems from different perspectives	1	2	3	4	5
Analyse and evaluate information, judging its relevance and value	1	2	3	4	5
Consider the influence of circumstances, beliefs and feelings on decisions and events	1	2	3	4	5
Support conclusions, using reasoned arguments and evidence	1	2	3	4	5
Creative thinkers					
Generate ideas and explore possibilities	1	2	3	4	5
Ask questions to extend their thinking	1	2	3	4	5
Connect their own and others' ideas and experiences in inventive ways	1	2	3	4	5
Question their own and others' assumptions	1	2	3	4	5
Try out alternatives or new solutions and follow ideas through	1	2	3	4	5
Adapt ideas as circumstances change	1	2	3	4	5
Reflective learners					
Assess themselves and others, identifying opportunities and achievements	1	2	3	4	5
Set goals with success criteria for their development and work	1	2	3	4	5
Review progress, acting on the outcomes	1	2	3	4	5
Invite feedback and deal positively with praise, setbacks and criticism	1	2	3	4	5
Evaluate experiences and learning to inform future progress	1	2	3	4	5
Communicate their learning in relevant ways for different audiences	1	2	3	4	5

Team workers					
Collaborate with others to work towards common goals	1	2	3	4	5
Reach agreements, managing discussions to achieve results	1	2	3	4	5
Adapt behaviour to suit different roles and situations, including leadership roles	1	2	3	4	5
Show fairness and consideration to others	1	2	3	4	5
Take responsibility, showing confidence in themselves and their contribution	1	2	3	4	5
Provide constructive support and feedback to others	1	2	3	4	5
Self-managers					
Seek out challenges or new responsibilities and show flexibility when priorities change	1	2	3	4	5
Work towards goals, showing initiative, commitment and perseverance	1	2	3	4	5
Organise time and resources, prioritising actions	1	2	3	4	5
Anticipate, take and manage risks	1	2	3	4	5
Deal with competing pressures, including personal and work-related demands	1	2	3	4	5
Respond positively to change, seeking advice and support when needed	1	2	3	4	5
Manage their emotions, and build and maintain relationships	1	2	3	4	5
Effective participators					
Discuss issues of concern, seeking resolution where needed	1	2	3	4	5
Present a persuasive case for action	1	2	3	4	5
Propose practical ways forward, breaking these down into manageable steps	1	2	3	4	5
Identify improvements that would benefit others as well as themselves	1	2	3	4	5
Try to influence others, negotiating and balancing diverse views to reach workable solutions	1	2	3	4	5
Act as an advocate for views and beliefs that may differ from their own	1	2	3	4	5

Note to learner: The circled number represents an indication of your PLTS performance so far.

Note to tutor: Indicate the level of success by circling the appropriate number during your feedback with the learner

Annexe D

Generic examples of calculating qualification grade above pass grade

This annexe shows the principles of calculating qualification grade above pass.

Pearson will automatically calculate the qualification grade for your learners when your learner unit grades are submitted.

The generic examples below demonstrate how the qualification grade above pass is calculated using the following two tables which are also shown in the section earlier in the specification *Calculation of the qualification grades above pass grade*.

Points available for credits achieved at different levels and unit grades

The table below shows the **number of points scored per credit** at the unit level and grade.

Unit level	Points per credit		
	Pass	Merit	Distinction
Level 1	3	4	5
Level 2	5	6	7
Level 3	7	8	9

Learners who achieve the correct number of points within the ranges shown in the 'qualification grade' table below will achieve the qualification merit or distinction or distinction* grade.

Qualification grade

Qualification	Points range above pass grade		
	Merit	Distinction	Distinction*
BTEC Level 2 Certificate	85-94	95-99	100 and above
BTEC Level 2 Extended Certificate	170-189	190-199	200 and above
BTEC Level 2 Diploma	340-379	380-399	400 and above

Example 1

Achievement of pass qualification grade

A learner completing a 15-credit Pearson BTEC Level 2 Certificate achieves the credit required to gain a pass qualification grade and does not achieve the points to gain a merit grade.

	Level	Credit	Grade	Grade points	Points per unit = credit x grade
Unit X	2	5	Pass	5	$5 \times 5 = 25$
Unit X	2	5	Pass	5	$5 \times 5 = 25$
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Qualification grade totals		15	Pass		80

Example 2

Achievement of merit qualification grade

A learner completing a 15-credit Pearson BTEC Level 2 Certificate achieves the points required to gain a merit qualification grade.

	Level	Credit	Grade	Grade points	Points per unit = credit x grade
Unit X	2	5	Pass	5	$5 \times 5 = 25$
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Qualification grade totals		15	Merit		85

Example 3

Achievement of distinction qualification grade

A learner completing a 15-credit Pearson BTEC Level 2 Certificate achieves the points required to gain a distinction qualification grade.

	Level	Credit	Grade	Grade points	Points per unit = credit x grade
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Unit X	2	5	Distinction	7	$5 \times 7 = 35$
Qualification grade totals		15	Distinction		95

Example 4

Achievement of merit qualification grade

A learner completing a 30-credit Pearson BTEC Level 2 Extended Certificate achieves the points required to gain a merit qualification grade.

	Level	Credit	Grade	Grade points	Points per unit = credit x grade
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Unit X	2	5	Pass	5	$5 \times 5 = 25$
Unit X	2	5	Distinction	7	$5 \times 7 = 35$
Unit X	2	10	Pass	5	$10 \times 5 = 50$
Unit X	3	5	Pass	7	$5 \times 7 = 35$
Qualification grade totals		30	Merit		175

Example 5

Achievement of merit qualification grade

A learner completing a 60-credit Pearson BTEC Level 2 Diploma achieves the points required to gain a merit qualification grade.

	Level	Credit	Grade	Grade points	Points per unit = credit x grade
Unit X	2	5	Merit	6	$5 \times 6 = 30$
Unit X	2	5	Pass	5	$5 \times 5 = 25$
Unit X	2	5	Distinction	7	$5 \times 7 = 35$
Unit X	2	10	Merit	6	$10 \times 6 = 60$
Unit X	1	5	Merit	4	$5 \times 4 = 20$
Unit X	2	10	Distinction	7	$10 \times 7 = 70$
Unit X	2	10	Merit	6	$10 \times 6 = 60$
Unit X	2	10	Merit	6	$10 \times 6 = 60$
Qualification grade totals		60	Merit		360

November 2017

**For information about Edexcel, BTEC or LCCI qualifications visit
qualifications.pearson.com**

BTEC is a registered trademark of Pearson Education Limited

**Pearson Education Limited. Registered in England and Wales No. 872828
Registered Office: 80 Strand, London WC2R 0RL.
VAT Reg No GB 278 537121**