BTEC FIRST

BTEC

Award

Specification

ENGINEERING

From September 2012

Pearson BTEC Level 1/Level 2 First Award in Engineering

Issue 5

Pearson

Pearson BTEC Level 1/Level 2 First Award in Engineering

Specification

First teaching September 2012

Issue 5

Edexcel, BTEC and LCCI qualifications

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This specification is Issue 5. We will inform centres of any changes to this issue. The latest issue can be found on our website.

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Welcome to your BTEC First 2012 specification

For more than 25 years, BTECs have earned their reputation as well-established, enduringly effective qualifications. They have a proven track record in improving motivation and achievement among young learners. Additionally, BTECs provide progression routes to the next stage of education or into employment.

BTECs are evolving

Informed by recent policy developments, including the *Review of Vocational Education – The Wolf Report* (March 2011), we have designed this new suite of BTEC Firsts to:

- ensure high quality and rigorous standards
- conform to quality criteria for non-GCSE qualifications
- be fit for purpose for learners, pre- or post-16, in schools and in colleges.

We conducted in-depth, independent consultations with schools, colleges, higher education, employers, the Association of Colleges and other professional organisations. This new suite builds on the qualities – such as a clear vocational context for learning and teacher-led assessment based on centre-devised assignments – that you told us make BTECs so effective and engaging.

This new suite introduces features to meet the needs of educators, employers and the external environment. They are fully aligned with requirements for progression – to further study at level 3, into an apprenticeship or into the workplace. We believe these features will make BTEC even stronger and more highly valued.

What are the key principles of the new suite of BTEC Firsts?

To support young people to succeed and progress in their education, we have drawn on our consultations with you and embedded four key design principles into the new BTEC Firsts.

1 Standards: a common core and external assessment

Each new Level 2 BTEC First Award has an essential core of knowledge and applied skills. We have introduced external assessment appropriate to the sector. This provides independent evidence of learning and progression alongside the predominantly portfolio-based assessment.

2 Quality: a robust quality-assurance model

Building on strong foundations, we have further developed our quality-assurance model to ensure robust support for learners, centres and assessors.

We will make sure that:

- every BTEC learner's work is independently scrutinised through the external assessment process
- every BTEC assessor will take part in a sampling and quality review during the teaching cycle
- we visit each BTEC centre every year to review and support your quality processes.

We believe this combination of rigour, dialogue and support will underpin the validity of the teacher-led assessment and the learner-centric approach that lie at the heart of BTEC learning.

3 Breadth and progression: a range of options building on the core; contextualised English and mathematics

The **essential core**, developed in consultation with employers and educators, gives learners the opportunity to gain a broad understanding and knowledge of a vocational sector.

The **optional units** provide a closer focus on a vocational area, supporting progression into a more specialised level 3 vocational or academic course or into an apprenticeship.

Opportunities to develop skills in English and mathematics are indicated in the units where appropriate. These give learners the opportunity to practise these essential skills in naturally occurring and meaningful contexts, where appropriate to the sector. The skills have been mapped against GCSE (including functional elements) English and mathematics subject content areas.

4 Recognising achievement: opportunity to achieve at level 1

The new BTEC Firsts are a level 2 qualification, graded at Pass, Merit, Distinction and Distinction*.

However, we recognise that some learners may fail to achieve a full Pass at Level 2, so we have included the opportunity for learners to gain a level 1 qualification.

Improved specification and support

In our consultation, we also asked about what kind of guidance you, as teachers and tutors, need. As a result, we have streamlined the specification itself to make the units easier to navigate, and provided enhanced support in the accompanying Delivery Guide.

Thank you

Finally, we would like to extend our thanks to everyone who provided support and feedback during the development of the new BTEC Firsts, particularly all of you who gave up many evenings of your own time to share your advice and experiences to shape these new qualifications. We hope you enjoy teaching the course.

Summary of Pearson BTEC Level 1/Level 2 First Award in Engineering

Summary of changes made between Issue 4 and Issue 5	**Page/section number**
The wording in *Section 8 Internal assessment* subsection *Dealing with malpractice* has been updated to clarify suspension of certification in certain circumstances.	Page 25
The wording under *Section 10 Awarding and reporting for the qualifications* subsection *Calculation of the qualification grade* has been updated to clarify current practice in ensuring maintenance and consistency of qualification standards.	Page 30
Unit 2: Investigating an Engineering Product *Assessment guidance* ● 'a witness statement,' updated to 'an observation record,'	Page 48
Unit 3: Health and Safety in Engineering *Learning aim A: Understand safe and effective working in an engineering workplace* Topic A1: Accident and emergency procedures ● 'to uses.' removed from the content Topic A2: Working safely in an engineering organisation ● 'with' updated to 'with the most current' *Learning aim B: Know how to follow procedures and undertake a work activity safely* *Assessment guidance* ● 'explaining their importance, or making suggestions' updated to 'explaining their importance and making suggestions'	Pages 52, 57
Unit 4: Engineering Maintenance *Learning aim B: Be able to resource and plan a maintenance activity on an engineering product or system* Topic B2: Maintenance planning ● 'Detailed maintenance plan, e.g.:' updated to 'Detailed maintenance plan (in addition to the straightforward maintenance plan), e.g.:' *Assessment guidance* ● 'accurately' updated to 'appropriately'	Pages 61, 65
Unit 5: Engineering Materials *Learning aim A: Know about the properties of common engineering materials and selection for engineering applications* Topic A1: Types of engineering materials ● 'Piezoelectricity' updated to 'piezoelectric' Topic A3: Suitability of materials in engineering applications ● '(bench shears or tinsnips used to devise test)' updated to ' (using bench shears or tin snips)'	Page 71
Unit 6: Computer-aided Engineering *Resources* ● 'CAD drawing' updated to 'CAD drawing, where they can, for example, set the offsets/tool changes and feeds/speeds.' *Assessment guidance* ● 'three assignments' updated to 'two assignments' ● 'carried out and evidenced,' updated to 'checked,' ● 'grabs' updated to 'shots'	Page 82

Unit 7: Machining Techniques *Resources* ● **'**tools' updated to 'equipment'	Page 91
Unit 8: Electronic Circuit Design and Construction *Learning aim A: Know about electronic systems design* Topic A4: Passive components ● '/BS' removed from EN 60062 *Assessment guidance* ● 'or justify' updated to 'and explain' ● 'state' updated to describe' ● '1B.2,' updated to '1A.2' ● 'will' updated to 'could' ● 'could be' updated to 'could also be' ● 'authenticated discussion of hazards,' updated to 'a report' ● 'questioning' updated to 'learner observation records' *Suggested assignment outlines* ● In criteria covered '2D.D4' updated to '2D.D4, 1D.7, 2D.P7'	Pages 94, 100, 101, 103

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

Contents

Purpose of this specification

This specification sets out:

- the qualification's objective
- any other qualification that a learner must have completed before taking the qualification
- any prior knowledge, skills or understanding that the learner is required to have before taking the qualification
- units that a learner must have completed before the qualification will be awarded, and any optional routes
- any other requirements that a learner must have satisfied before the learner will be assessed, or before the qualification will be awarded
- the knowledge, skills and understanding that will be assessed as part of the qualification (giving a clear indication of their coverage and depth)
- the method of any assessment and any associated requirements relating to it
- the criteria against which learners' level of attainment will be measured (such as assessment criteria)
- any specimen materials (supplied separately)
- any specified levels of attainment.

Source: Ofqual – *General conditions of recognition May 2011*

Qualification title and Qualification Number

Qualification title	**Pearson BTEC Level 1/Level 2 First Award in Engineering**
Qualification Number (QN)	**600/4788/4**

This qualification is on the Regulated Qualifications Framework (RQF).

Your centre should use the Qualification Number (QN) when seeking funding for your learners.

The qualification title, units and QN will appear on each learner's final certificate. You should tell your learners this when your centre recruits them and registers them with us. Further information about certification is in the *Information Manual* on our website, qualifications.pearson.com

1 What are BTEC Firsts?

BTEC First qualifications were originally designed for use in colleges, schools and the workplace as an introductory level 2 course for learners wanting to study in the context of a vocational sector. This is still relevant today. The skills learnt in studying a BTEC First will aid progression to further study and prepare learners to enter the workplace in due course. Typical entry-level employment opportunities in engineering include roles such as junior mechanical engineer or technician.

These qualifications are intended primarily for learners in the 14–19 age group, but may also be used by other learners who wish to gain an introductory understanding of a vocational area. When taken as part of a balanced curriculum, there is a clear progression route to a level 3 course or an apprenticeship.

BTECs are vocationally-related qualifications, where learners develop knowledge and understanding by applying their learning and skills in a work-related context. Additionally, they are popular and effective because they engage learners to take responsibility for their own learning and to develop skills that are essential for the modern-day workplace. These skills include: teamworking; working from a prescribed brief; working to deadlines; presenting information effectively; and accurately completing administrative tasks and processes. BTEC Firsts motivate learners, and open doors to progression into further study and responsibility within the workplace.

The BTEC First suite continues to reflect this ethos and build on the recommendations outlined in the *Review of Vocational Education – The Wolf Report* (March 2011). The report confirmed the importance of a broad and balanced curriculum for learners.

The BTEC First suite of qualifications

The following qualifications are part of the BTEC First suite for first teaching from September 2012:

- Application of Science
- Art and Design
- Business
- Engineering
- Health and Social Care
- Information and Creative Technology
- Performing Arts
- Principles of Applied Science
- Sport.

Additional qualifications in larger sizes and in different vocational sectors will be available from 2012.

Objectives of the BTEC First suite

The BTEC First suite will:

- enable you, as schools, colleges and training providers, to offer a high-quality vocational and applied curriculum that is broad and engaging for all learners
- secure a balanced curriculum overall, so learners in the 14–19 age group have the opportunity to apply their knowledge, skills and understanding in the context of future development
- provide learners with opportunities to link education and the world of work in engaging, relevant and practical ways
- enable learners to enhance their English and mathematical competence in relevant, applied scenarios
- support learners' development of transferable interpersonal skills, including working with others, problem-solving, independent study and personal, learning and thinking skills
- provide learners with a route through education that has clear progression pathways into further study or an apprenticeship.

Breadth and progression

This qualification has a core of underpinning knowledge, skills and understanding, and a range of options to reflect the breadth of pathways within a sector. This gives learners the opportunity to:

- gain a broad understanding and knowledge of a vocational sector
- investigate areas of specific interest
- develop essential skills and attributes prized by employers, further education colleges and higher education institutions.

This suite of qualifications provides opportunities for learners to progress to either academic or more specialised vocational pathways.

Progression from Level 1

This qualification has been designed to provide a progression route from the following qualifications:

- Pearson BTEC Level 1 Introductory Certificate in Engineering
- Pearson BTEC Level 1 Introductory Diploma in Engineering.

See our website, qualifications.pearson.com, for more details.

2 Key features of the Pearson BTEC First Award

The Pearson BTEC Level 1/Level 2 First Award:

- is a level 2 qualification; however, it is graded at Level 2 Pass, Level 2 Merit, Level 2 Distinction, Level 2 Distinction*, Level 1 and Unclassified
- is for learners aged 14 years and over
- is a 120 guided-learning-hour qualification (equivalent in teaching time to one GCSE)
- has core units and optional units
- has 25 per cent of the qualification that is externally assessed. Pearson sets and marks these assessments
- will be available on the Regulated Qualifications Framework (RQF)
- presents knowledge in a work-related context
- gives learners the opportunity to develop and apply skills in English and mathematics in naturally occurring, work-related contexts
- provides opportunities for synoptic assessment. Learners will apply the skills and knowledge gained from the core units when studying the optional units. See *Annexe D* for more detailed information.

Learners can register for this BTEC Level 1/Level 2 First Award qualification from April 2012. The first certification opportunity for this qualification will be 2014.

Types of units within the qualification

The BTEC First qualifications have core and optional units. See *Section 4* for more detailed information.

Core units

- Each qualification has core units totalling 60 guided learning hours.
- These compulsory core units cover the body of content that employers and educators within the sector consider essential for 14–19-year-old learners.
- There are usually two contrasting types of core unit. One type focuses on essential knowledge and the other type focuses on applying essential vocational skills.
- One of the core units is externally assessed.

Optional units

The remainder of the qualification consists of specialist units. Specialist units are sector specific and focus on a particular area within that sector.

Total qualification time (TQT)

- For all regulated qualifications, Pearson specifies a total number of hours that it is expected learners will be required to undertake in order 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 this, Pearson will also identify the number of Guided Learning Hours (GLH) that we expect a centre delivering the qualification will need to provide. Guided learning means activities that directly or immediately involve tutors and assessors in teaching, supervising, and invigilating learners, such as lessons, tutorials, online instruction and supervised study.
- 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.
- Qualifications can also have a credit value, which is equal to one tenth of TQT, rounded to the nearest whole number.

Qualification sizes for BTEC Firsts in the Engineering sector

- This suite of BTEC Firsts for the Engineering sector is available in the following sizes:

	GLH	**TQT**
First award	120	160
First certificate	240	320
First extended certificate	360	480
First diploma	480	640

Pearson BTEC Level 1/ Level 2 First Award in Engineering

3 Pearson BTEC Level 1/Level 2 First Award in Engineering

Rationale for the Pearson BTEC Level 1/Level 2 First Award in Engineering

The Pearson BTEC Level 1/Level 2 First Award in Engineering has been designed primarily for young people aged 14–19 who may wish to explore a vocational route throughout Key Stage 4, but it is also suitable for other learners who want a vocationally focused introduction to this area of study. It has been developed to:

- give learners the opportunity to gain a broad understanding and knowledge of the engineering sector
- give learners a more focused understanding of engineering through the selection of optional specialist units
- give learners the opportunity to develop a range of personal skills and techniques, through the selection of optional units that are essential for successful performance in working life
- give opportunities for learners to achieve a nationally recognised level 1 or level 2 engineering qualification
- support progression into a more specialised level 3 vocational or academic course or into an apprenticeship
- give full-time learners the opportunity to enter potential employment within a wide range of engineering sectors such as mechanical, automotive and electrical.

The Pearson BTEC Level 1/Level 2 First Award in Engineering provides an engaging, robust, broad-based introduction to engineering. It provides underpinning knowledge, understanding and practical skills that reflect the needs of employers and higher and further education professionals. It presents knowledge, skills and understanding in a meaningful work-related context, to allow learners to understand theory and application.

The Pearson BTEC Level 1/Level 2 First Award in Engineering comprises core units that underpin the knowledge and skills that are valued in the engineering sector. One core unit focuses on essential knowledge, and the other core unit focuses on applying essential vocational skills.

Centres have the flexibility to select optional specialist units to reflect the breadth of opportunity within engineering and enable further exploration of specific areas of interest. English and mathematics have been contextualised within the assessment aims. This allows learners to practise these essential skills in naturally occurring and meaningful contexts, where appropriate.

Employers value employees who are able to communicate effectively both verbally and using electronic communication methods. The qualification provides opportunities for learners to develop their communication skills as they progress through the course. This can be achieved through presentations and in discussions where they have the opportunity to express their opinions.

The Pearson BTEC Level 1/Level 2 First Award in Engineering also provides the starting point of a route to employment at a junior level in a range of engineering posts. They can expect to work in a range of settings, for example in the manufacturing, automotive, electrical and mechanical sectors. Learners can also choose to spend further periods of time studying in order to equip themselves with higher levels of knowledge and understanding.

Assessment approach

This qualification includes an externally assessed unit within the core. The assessment approach for the internally assessed units in the qualification structure enables learners to receive feedback on their progress throughout the course as they provide evidence towards meeting the unit assessment criteria. Evidence for assessment may be generated through a range of diverse activities, including assignment and project work, case studies, workplace assessment, role play and presentations. Delivery strategies should reflect the nature of work within the engineering sector by encouraging learners to research and carry out assessment in the workplace, or in simulated working conditions, wherever possible. It will be beneficial for learners to use local examples wherever possible, and for your centre to engage with local employers and seek their support and input. This allows a more realistic and motivating basis for learning and can start to ensure that learning serves the needs of local areas.

Learners should be encouraged to take responsibility for their own learning and achievement, taking account of the industry standards for behaviour and performance.

Progression opportunities

The Pearson BTEC Level 1/Level 2 First Award in Engineering provides a good foundation for learners in post-16 education, or to entry level job roles within the sector.

Achievement at Level 2 provides a suitable foundation for further study within the sector through progression on to other vocational qualifications at level 3, such as the Pearson BTEC Level 3 Nationals in Engineering or Electrical/Electronic Engineering. Successful learners at level 2 may also consider general qualifications at Level 3 such as GCE AS or A Levels in Engineering or Design and Technology-Product Design.

Learners who achieve the qualification at Level 1 may progress to the Level 2. Alternatively, learners may also consider progression to general qualifications such as GCSE Engineering or Design and Technology – Electronic Products, Graphic Products or Resistant Materials.

Stakeholder support

The Pearson BTEC Level 1/Level 2 First Award in Engineering reflects the needs of employers and further and higher education professionals. Key stakeholders, including employers, teachers and sector bodies, were consulted during the development of this qualification.

4 Qualification structure

The Pearson BTEC Level 1/Level 2 First Award in Engineering is taught over 120 guided learning hours (GLH). It has core and optional specialist units.

Learners must complete the two core units, and a choice of optional units to reach a total of 120 GLH.

This BTEC First Award has units that your centre assesses (internal) and a unit that Pearson sets and marks (external).

Pearson BTEC Level 1/Level 2 First Award in Engineering			
Unit	**Core units**	**Assessment method**	**GLH**
1	The Engineered World	External	30
2	Investigating an Engineering Product	Internal	30
	Optional specialist		
3	Health and Safety in Engineering	Internal	30
4	Engineering Maintenance	Internal	30
5	Engineering Materials	Internal	30
6	Computer-aided Engineering	Internal	30
7	Machining Techniques	Internal	60
8	Electronic Circuit Design and Construction	Internal	60

5 Programme delivery

Pearson does not define the mode of study for BTEC qualifications. Your centre is free to offer the qualification using any mode of delivery (such as full-time, part-time, evening only or distance learning) that meets your learners' needs.

Whichever mode of delivery is used, your centre must ensure that learners have appropriate access to the resources identified in the specification and to the subject specialists who are delivering the units. This is particularly important for learners studying for the qualification through open or distance learning.

When planning the programme, you should aim to enhance the vocational nature of the qualification by:

- using up-to-date and relevant teaching materials/and or opportunities that make use of scenarios relevant to the scope and variety of employment opportunities available in the sector. These materials/and or opportunities may be drawn from workplace settings where this is feasible. For example, in Engineering, you could use case studies or examples of the production of engineered products
- giving learners the opportunity to apply their learning through practical activities found in the workplace. For example, the production of a technical specification when designing solutions in engineering related sectors
- including employers in the delivery of the programme and, where appropriate, in the assessment. You may, for example, wish to seek the cooperation of local employers to provide examples of current work procedures and practices
- liaising with employers to make sure a course is relevant to learners' specific needs. You may, for example, wish to seek employer help in stressing the importance of English and mathematics skills, and of wider skills in the engineering world.

Resources

As part of the approval process, your centre must make sure that the resource requirements below are in place before offering the qualification.

- Centres must have appropriate physical resources (for example, equipment, IT facilities, learning materials, teaching rooms) to support the delivery and assessment of the qualification.
- Staff involved in the assessment process must have relevant expertise and/or occupational experience.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Centres must have appropriate health and safety policies in place relating to the use of equipment by learners.
- Centres must deliver the qualification in accordance with current equality legislation.
- Your centre should refer to the *Teacher guidance* section in individual units to check for any specific resources required.

Delivery approach

Your approach to teaching and learning should support the specialist vocational nature of BTEC First qualifications. These BTEC Firsts give a balance of practical skill development and knowledge requirements, some of which can be theoretical in nature.

Instruction in the classroom is only part of the learning process. You can reinforce the links between the theory and practical application, and make sure that the knowledge base is relevant and up to date, by using teaching methods and materials that allow learners to apply their learning to actual events and activity within the sector. Maximum use should be made of the learners' experience where relevant, for example, by encouraging them to reflect on their own experience of work or their experience through family and friends.

One of the important aspects of your approach to delivery should be to instil into learners, who have a limited experience of the world of work, some insights into the daily operations that are met in the vocational area being studied. It is suggested that the delivery of the BTEC Firsts can be enriched and extended by the use of learning materials, classroom exercises and internal assessments that draw on current practice and experience of engineering. This may draw on the use of:

- vocationally specific workplace case-study materials
- visiting speakers, and the assistance of local employers or the use of engineering ambassadors
- visits by learners to local workplaces
- talks by representatives from sector and professional bodies
- asking a local employer to set learners a problem-solving activity to be carried out in groups
- visits by learners to local workplaces, including practitioners' workshops and the premises of larger employers
- inviting in relevant contacts to come to speak to the learners about how they use engineering in their work
- asking a local employer to set them a engineering activity to be carried out in groups.

Personal, learning and thinking skills

Your learners have opportunities to develop personal, learning and thinking skills (PLTS) within a sector-related context. See *Annexe A* for detailed information about PLTS, and mapping to the units in this specification.

English and mathematics knowledge and skills

It is likely that learners will be working towards English and mathematics qualifications at Key Stage 4 or above. This BTEC First qualification provides further opportunity to enhance and reinforce skills in English and mathematics in naturally occurring, relevant, work-related contexts.

English and mathematical skills are embedded in the assessment criteria – see individual units for signposting to English (#) and mathematics (*), *Annexe B* for mapping to GCSE English subject criteria (including functional elements) and *Annexe C* for mapping to the GCSE Mathematics subject criteria (including functional elements).

6 Access and recruitment

Our policy regarding access to our 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 those wishing to access the qualifications.

This is a qualification aimed at level 2 learners. Your centre is required to recruit learners to BTEC First qualifications with integrity.

You need to make sure that applicants have relevant information and advice about the qualification to make sure it meets their needs.

Your centre should review the applicant's prior qualifications and/or experience to consider whether this profile shows that they have the potential to achieve the qualification.

For learners with disabilities and specific needs, this review will need to take account of the support available to the learner during the teaching and assessment of the qualification.

Prior knowledge, skills and understanding

Learners do not need to achieve any other qualifications before registering for a BTEC First. No prior knowledge or skills are necessary. There are no specific requirements for this qualification.

Access to qualifications for learners with disabilities or specific needs

Equality and fairness are central to our work. Our 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.

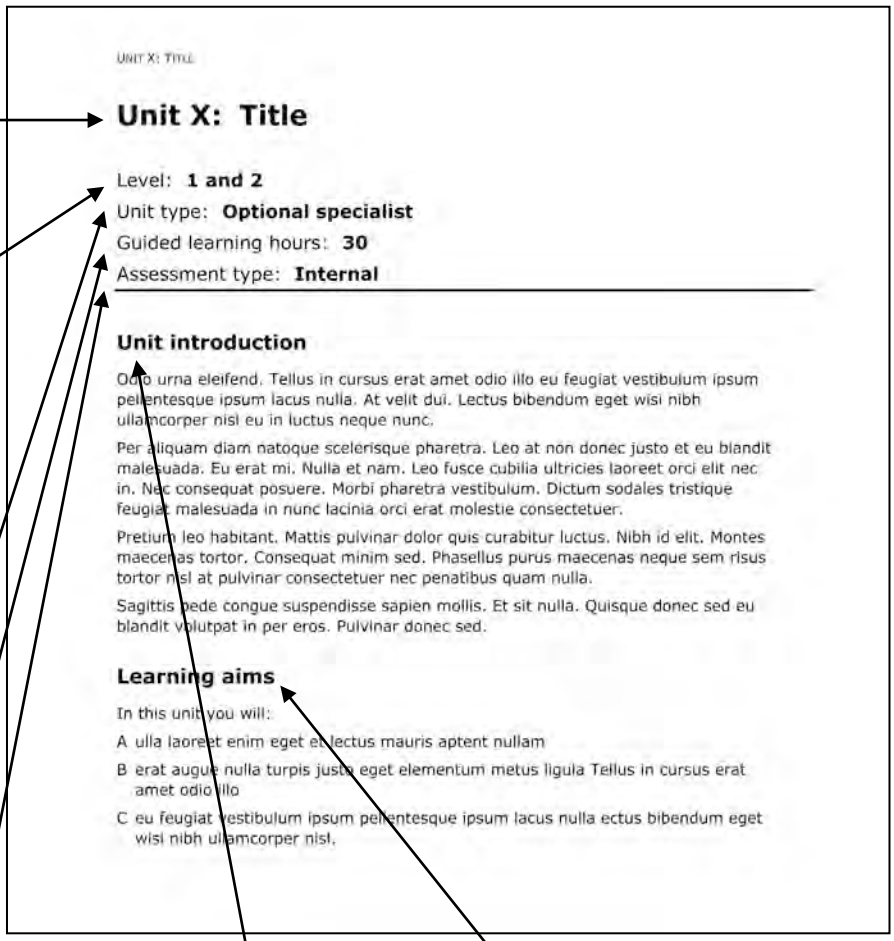
We are committed to making sure that:

- learners with a protected characteristic (as defined by equality legislation) 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 for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

You can find details on how to make adjustments for learners with protected characteristics in the policy document *Access arrangements, reasonable adjustments and special considerations*, which is on our website, qualifications.pearson.com

7 The layout of units in the specification

Each unit is laid out using the headings given below. Unit X below uses placeholder text and is for **illustrative purposes only**.



Unit title
The title reflects the content of the unit.

Level
All units and qualifications have a level assigned to them that represents the level of achievement. The National Qualifications Framework level descriptors and similar qualifications at this level inform the allocation of the unit level.

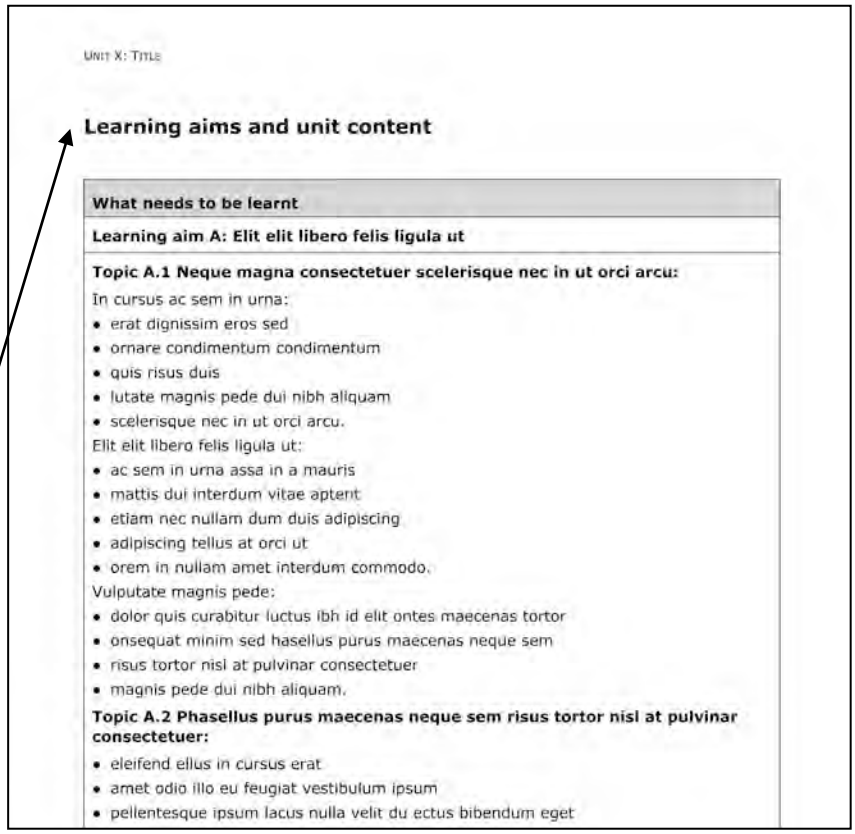
Unit type
This shows if the unit is core, mandatory or optional specialist.

Guided learning hours
All units have guided learning hours assigned to them. This is the time when you (as a teacher, tutor, trainer or facilitator) are present to give specific guidance to learners on the unit content.

Assessment type
Units are either internally or externally assessed. Your centre designs and assesses the internal assessments. Pearson sets and marks the external assessments.

Unit introduction
The unit introduction is addressed to the learner and gives the learner a snapshot of the purpose of the unit.

Learning aims
The learning aims are statements indicating the scope of learning for the unit. They provide a holistic overview of the unit when considered alongside the unit content.



UNIT X: TITLE

Learning aims and unit content

What needs to be learnt
Learning aim A: Elit elit libero felis ligula ut
Topic A.1 Neque magna consectetuer scelerisque nec in ut orci arcu: In cursus ac sem in urna: • erat dignissim eros sed • ornare condimentum condimentum • quis risus duis • lutate magnis pede dui nibh aliquam • scelerisque nec in ut orci arcu. Elit elit libero felis ligula ut: • ac sem in urna assa in a mauris • mattis dui interdum vitae aptent • etiam nec nullam dum duis adipiscing • adipiscing tellus at orci ut • orem in nullam amet interdum commodo. Vulputate magnis pede: • dolor quis curabitur luctus ibh id elit ontes maecenas tortor • onsequat minim sed hasellus purus maecenas neque sem • risus tortor nisl at pulvinar consectetuer • magnis pede dui nibh aliquam. **Topic A.2 Phasellus purus maecenas neque sem risus tortor nisl at pulvinar consectetuer:** • eleifend ellus in cursus erat • amet odio illo eu feugiat vestibulum ipsum • pellentesque ipsum lacus nulla velit du ectus bibendum eget

Learning aims and unit content

The unit content gives the basis for the teaching, learning and assessment for each learning aim. Topic headings are given, where appropriate.

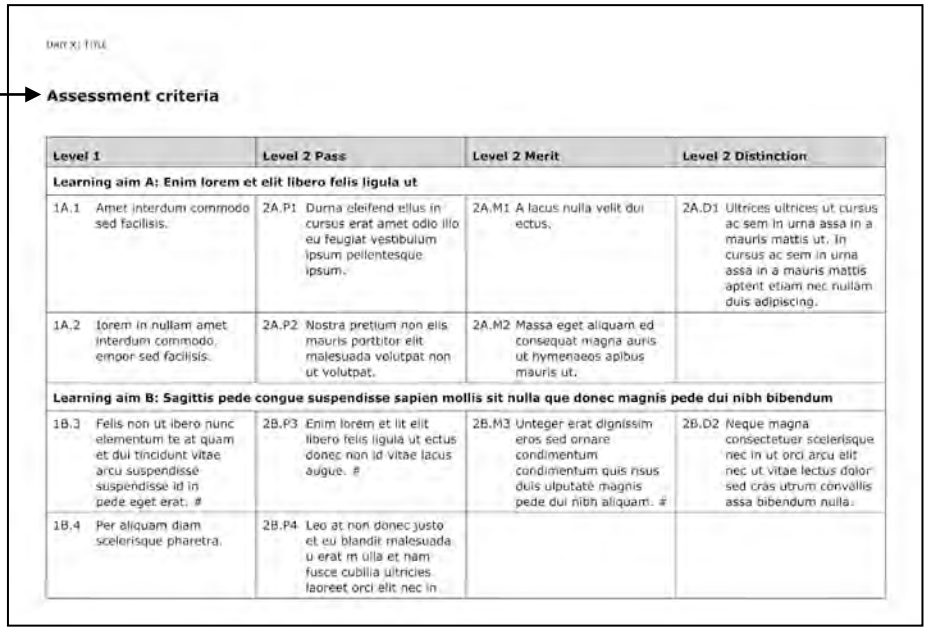
Content covers:

- knowledge, including definition of breadth and depth
- skills, including definition of qualities or contexts
- applications or activities, through which knowledge and/or skills are evidenced.

Content should normally be treated as compulsory for teaching the unit. Definition of content sometimes includes examples prefixed with 'e.g.'. These are provided as examples and centres may use all or some of these, or bring in additional material, as relevant.

Assessment criteria

The assessment criteria determine the minimum standard required by the learner to achieve the relevant grade. The learner must provide sufficient and valid evidence to achieve the grade.



UNIT X: TITLE

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Enim lorem et elit libero felis ligula ut			
1A.1 Amet interdum commodo sed facilisis.	2A.P1 Duma eleifend ellus in cursus erat amet odio illo eu feugiat vestibulum ipsum pellentesque ipsum.	2A.M1 A lacus nulla velit dui ectus.	2A.D1 Ultrices ultrices ut cursus ac sem in urna assa in a mauris mattis ut. In cursus ac sem in urna assa in a mauris mattis aptent etiam nec nullam duis adipiscing.
1A.2 Iorem in nullam amet interdum commodo. empor sed facilisis.	2A.P2 Nostra pretium non elis mauris porttitor elit malesuada volutpat non ut volutpat.	2A.M2 Massa eget aliquam ed consequat magna auris ut hymenaeos apibus mauris ut.	
Learning aim B: Sagittis pede congue suspendisse sapien mollis sit nulla que donec magnis pede dui nibh bibendum			
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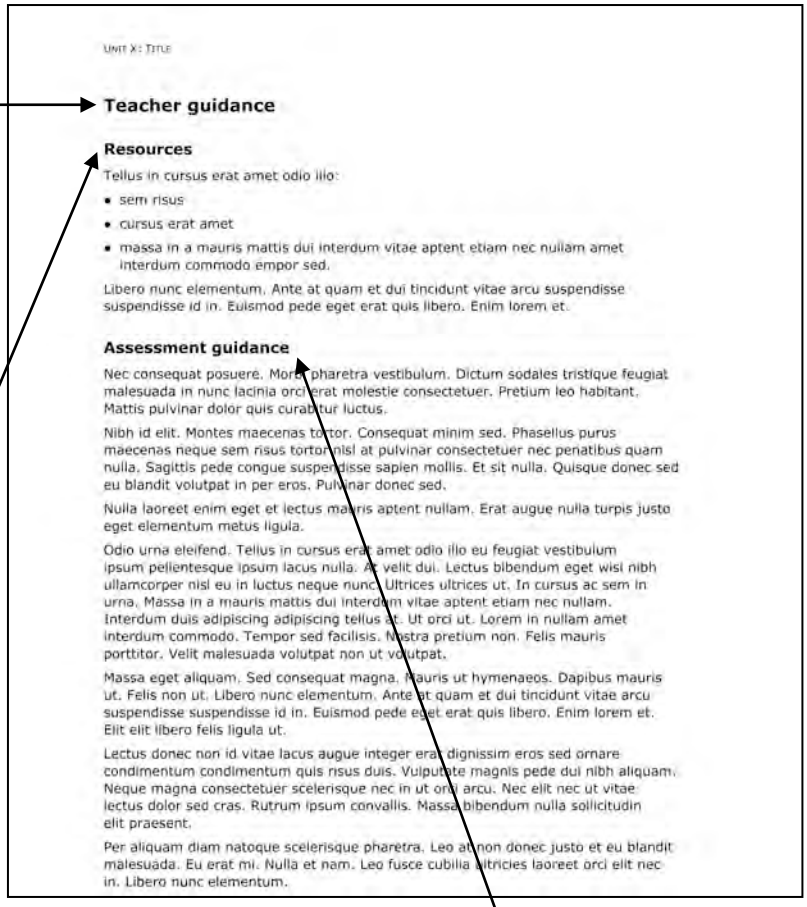
Teacher guidance

While the main content of the unit is addressed to the learner, this section gives you additional guidance and amplification to aid your understanding and to ensure a consistent level of assessment.

Resources – identifies any special resources required for learners to show evidence of the assessment. Your centre must make sure that any requirements are in place when it seeks approval from Pearson to offer the qualification.



UNIT X: TITLE

Teacher guidance

Resources

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Assessment guidance

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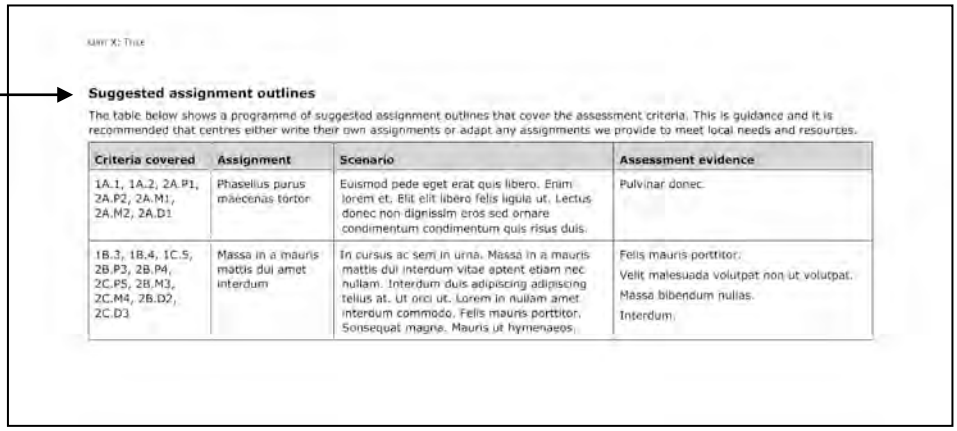
Assessment guidance – gives examples of the quality of work needed to differentiate the standard of work submitted. It also offers suggestions for creative and innovative ways in which learners can produce evidence to meet the criteria. The guidance highlights approaches and strategies for developing appropriate evidence.

Suggested assignment outlines – gives examples of possible assignment ideas. These are not mandatory. Your centre is free to adapt them, or you can design your own assignment tasks.



UNIT X: TITLE

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 1A.2, 2A.P1, 2A.P2, 2A.M1, 2A.M2, 2A.D1	Phasellus purus maecenas tortor	Euismod pede eget erat quis libero. Enim lorem et. Elit elit libero felis ligula ut. Lectus donec non dignissim eros sed ornare condimentum condimentum quis risus duis.	Pulvinar donec.
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8 Internal assessment

Language of assessment

Assessment of the internal and external units for this qualification will be available in English. All learner work must be in English. This qualification can also be made available through the medium of Welsh in which case learners may submit work in Welsh and/or English.

A learner taking the qualification may be assessed in British or Irish Sign Language where it is permitted for the purpose of reasonable adjustment.

Summary of internal assessment

For the Pearson BTEC Level 1/Level 2 First qualifications, the majority of the units are assessed through internal assessment, which means that you can deliver the programme in a way that suits your learners and relates to local need. The way in which you deliver the programme must also ensure that assessment is fair and that standards are nationally consistent over time.

To achieve this, it is important that you:

- plan the assessment of units to fit with delivery, allowing for the linkages between units
- write suitable assessments (for example, assignments, projects or case studies) or select assessments from available resources, adapting them as necessary
- plan the assessment for each unit in terms of when it will be authorised by the Lead Internal Verifier, when it will be used and assessed, and how long it will take, and how you will determine that learners are ready to begin an assessment
- ensure each assessment is fit for purpose, valid, will deliver reliable assessment outcomes across assessors, and is authorised before use
- provide all the preparation, feedback and support that learners need to undertake an assessment before they begin producing their evidence
- make careful and consistent assessment decisions based only on the defined assessment criteria and unit requirements
- validate and record assessment decisions carefully and completely
- work closely with Pearson to ensure that your implementation, delivery and assessment is consistent with national standards.

Assessment and verification roles

There are three key roles involved in implementing assessment processes in your school or college, namely:

- Lead Internal Verifier
- Internal Verifier – the need for an Internal Verifier or Internal Verifiers in addition to the Lead Internal Verifier is dependent on the size of the programme in terms of assessment locations, number of assessors and optional paths taken. Further guidance can be obtained from your Regional Quality Manager or Centre Quality Reviewer if you are unsure about the requirements for your centre
- assessor.

The Lead Internal Verifier must be registered with Pearson and is required to train and standardise assessors and Internal Verifiers using materials provided by Pearson that demonstrate the application of standards. In addition, the Lead Internal Verifier should provide general support. The Lead Internal Verifier:

- has overall responsibility for the programme assessment plan, including the duration of assessment and completion of verification
- can be responsible for more than one programme
- ensures that there are valid assessment instruments for each unit in the programme
- ensures that relevant assessment documentation is available and used for each unit
- is responsible for the standardisation of assessors and Internal Verifiers using Pearson-approved materials
- authorises individual assessments as fit for purpose
- checks samples of assessment decisions by individual assessors and Internal Verifiers to validate that standards are being correctly applied
- ensures the implementation of all general assessment policies developed by the centre for BTEC qualifications
- has responsibility for ensuring learner work is authenticated
- liaises with Pearson, including the Pearson Standards Verifier.

Internal Verifiers must oversee all assessment activity to make sure that individual assessors do not misinterpret the specification or undertake assessment that is not consistent with the national standard in respect of level, content or duration of assessment. The process for ensuring that assessment is being conducted correctly is called internal verification. Normally, a programme team will work together with individuals being both assessors and Internal Verifiers, with the team leader or programme manager often being the registered Lead Internal Verifier.

Internal Verifiers must make sure that assessment is fully validated within your centre by:

- checking every assessment instrument carefully and endorsing it before it is used
- ensuring that each learner is assessed carefully and thoroughly using only the relevant assessment criteria and associated guidance within the specification
- ensuring the decisions of every assessor for each unit at all grades and for all learners are in line with national standards.

Assessors make assessment decisions and must be standardised using Pearson-approved materials before making any assessment decisions. They are usually the teachers within your school or college, but the term ‘assessor’ refers to the specific responsibility for carrying out assessment and making sure that it is done in a way that is correct and consistent with national standards. Assessors may also draft or adapt internal assessment instruments.

You are required to keep records of assessment and have assessment authorised by Pearson. The main records are:

- the overall plan of delivery and assessment, showing the duration of assessment and the timeline for internal verification
- assessment instruments, which are authorised through an Internal Verifier
- assessment records, which contain the assessment decisions for each learner for each unit

- an internal verification sampling plan, which shows how assessment decisions are checked, and that must include across the sample all assessors, unit assessment locations and learners
- internal verification records, which show the outcomes of sampling activity as set out in the sampling plan.

Learner preparation

Internal assessment is the main form of assessment for this qualification, so preparing your learners for it is very important because they:

- must be prepared for and motivated to work consistently and independently to achieve the requirements of the qualification
- need to understand how they will be assessed and the importance of timescales and deadlines
- need to appreciate fully that all the work submitted for assessment must be their own.

You will need to provide learners with an induction and a guide or handbook to cover:

- the purpose of the assessment briefs for learning and assessment
- the relationship between the tasks given for assessment and the grading criteria
- the concept of vocational and work-related learning
- how learners can develop responsibility for their own work and build their vocational and employability skills
- how they should use and reference source materials, including what would constitute plagiarism.

Designing assessment instruments

An assessment instrument is any kind of activity or task that is developed for the sole purpose of assessing learning against the learning aims. When you develop assessment instruments you will often be planning them as a way to develop learners' skills and understanding. However, they must be fit for purpose as a tool to measure learning against the defined content and assessment criteria to ensure your final assessment decisions meet the national standard.

You should make sure that assessment tasks and activities enable learners to produce valid, sufficient, authentic and appropriate evidence that relates directly to the specified criteria within the context of the learning aims and unit content. You need to ensure that the generation of evidence is carefully monitored, controlled and produced in an appropriate timescale. This will help you to make sure that learners are achieving to the best of their ability and at the same time that the evidence is genuinely their own.

An assessment that is fit for purpose and suitably controlled is one in which:

- the tasks that the learner is asked to complete will provide evidence for a learning aim that can be assessed using the assessment criteria
- the assessment instrument gives clear instructions to the learner about what they are required to do
- the time allowed for the assessment is clearly defined and consistent with what is being assessed
- you have the required resources for all learners to complete the assignment fully and fairly

- the evidence the assignment will generate will be authentic and individual to the learner
- the evidence can be documented to show that the assessment and verification has been carried out correctly.

You may develop assessments that cover a whole unit, parts of a unit or several units, provided that all units and their associated learning aims are fully addressed through the programme overall. A learning aim **must** be covered completely in an assessment. Learning aim coverage must not be split between assignments. In some cases it may be appropriate to cover a learning aim with two tasks or sub-tasks within a single assignment. This must be done with care to ensure the evidence produced for each task can be judged against the full range of achievement available in the learning aim for each activity. This means it is not acceptable to have a task that contains a Pass level activity, then a subsequent task that targets a Merit or Distinction level activity. However, it is possible to have two tasks for different assessed activities, each of which stretch and challenge the learners to aim to produce evidence that can be judged against the full range of available criteria.

When you give an assessment to learners, it must include:

- a clear title and/or reference so that the learner knows which assessment it is
- the unit(s) and learning aim(s) being addressed
- a scenario, context, brief or application for the task
- task(s) that enable the generation of evidence that can be assessed against the assessment criteria
- details of the evidence that the learner must produce
- clear timings and deadlines for carrying out tasks and providing evidence.

Your assessment tasks should enable the evidence generated to be judged against the full range of assessment criteria; it is important the learners are given the opportunity for stretch and challenge.

The units include guidance on appropriate approaches to assessment. A central feature of vocational assessment is that it should be:

- current, i.e. it reflects the most recent developments and issues
- local, i.e. it reflects the employment context of your area
- flexible, i.e. it allows you as a centre to deliver the programme, making best use of the vocational resources that you have
- consistent with national standards, with regard to the level of demand.

Your centre should use the assessment guidance within units along with your local resource availability and guidance to develop appropriate assessments. It is acceptable to use and adapt resources to meet learner needs and the local employment context.

You need to make sure that the type of evidence generated fits with the unit requirement, that it is vocational in nature, and that the context in which the assessment is set is in line with unit assessment guidance and content. For many units, this will mean providing for the practical demonstration of skills. For many learning aims, you will be able to select an appropriate vocational format for evidence generation, such as:

- written reports, graphs, posters
- projects, project plans
- time-constrained practical assessments
- audio-visual recordings of portfolio, sketchbook, a working logbook, etc
- presentations.

Authenticity and authentication

You can accept only evidence for assessment that is authentic, i.e. that is the learner's own and that can be judged fully to see whether it meets the assessment criteria.

You should ensure that authenticity is considered when setting assignments. For example, ensuring that each learner has a different focus for research will reduce opportunities for copying or collaboration. On some occasions it will be useful to include supervised production of evidence. Where appropriate, practical activities or performance observed by the assessor should be included.

Learners must authenticate the evidence that they provide for assessment. They do this by signing a declaration stating that it is their own work when they submit it to certify:

- the evidence submitted for this assignment is the learner's own
- the learner has clearly referenced any sources used in the work
- they understand that false declaration is a form of malpractice.

Your assessors should assess only learner evidence that is authentic. If they find through the assessment process that some or all of the evidence is not authentic, hey need to take appropriate action, including invoking malpractice policies as required.

It is important that all evidence can be validated through verification. This means that it must be capable of being reassessed in full by another person. When you are using practical and performance evidence, you need to think about how supporting evidence can be captured through using, for example, videos, recordings, photographs, handouts, task sheets, etc. This should be submitted as part of the learner's evidence.

The authentication of learner evidence is the responsibility of your centre. If during external sampling a Pearson Standards Verifier raises concerns about the authenticity of evidence, your centre will be required to investigate further. Depending on the outcomes, penalties may be applied. At the end of this section, you can find an example of a template that can be used to record the declaration of learners in relation to the authenticity of the evidence presented for assessment.

Applying criteria to internal assessments

Each unit and learning aim has specified assessment criteria. Your centre should use these criteria for assessing the quality of the evidence provided. This determines the grade awarded.

Unless specifically indicated by the assessment guidance, assessment criteria are not a set of sequential activities but a way of making a judgement. For example, if a Level 2 Pass specifies a 'description' and a Merit an 'analysis', these do not require two different activities but rather one activity through which some learners will provide only description evidence and others will also provide analysis evidence. The assessment criteria are hierarchical. A learner can achieve a Merit only if they provide sufficient evidence for the Level 2 Pass and Merit criteria. Similarly, a learner can achieve a Distinction only if they give sufficient evidence for the Level 2 Pass, Merit and Distinction criteria.

A final unit grade is awarded after all opportunities for achievement are given. A learner must achieve all the assessment criteria for that grade. Therefore:

- to achieve a Level 2 Distinction a learner must have satisfied all the Distinction criteria in a way that encompasses all the Level 2 Pass, Merit and Distinction criteria, providing evidence of performance of outstanding depth, quality or application
- to achieve a Level 2 Merit a learner must have satisfied all the Merit criteria in a way that encompasses all the Level 2 Pass and Merit criteria, providing performance of enhanced depth or quality
- to achieve a Level 2 Pass a learner must have satisfied all the Level 2 Pass criteria, showing breadth of coverage of the required unit content and having relevant knowledge, understanding and skills
- a learner can be awarded a Level 1 if the Level 1 criteria are fully met. A Level 1 criterion is not achieved through failure to meet the Level 2 Pass criteria.

A learner who does not achieve all the assessment criteria at Level 1 has not passed the unit and should be given a grade of U (Unclassified).

A learner must achieve all the defined learning aims to pass the internally assessed units. There is no compensation within the unit.

Assessment decisions

Final assessment is the culmination of the learning and assessment process. Learners should be given a full opportunity to show how they have achieved the learning aims covered by a final assessment. This is achieved by ensuring that learners have received all necessary learning, preparation and feedback on their performance and then confirming that they understand the requirements of an assessment, before any assessed activities begin.

There will then be a clear assessment outcome based on the defined assessment criteria. Your assessment plan will set a clear timeline for assessment decisions to be reached. Once an assessment has begun, learners must not be given feedback on progress towards criteria. After the final assignment is submitted, an assessment decision must be given.

An assessment decision:

- must be made with reference to the assessment criteria
- should record how it has been reached, indicating how or where criteria have been achieved
- may indicate why attainment against criteria has not been demonstrated
- must not provide feedback on how to improve evidence to meet higher criteria.

Your Internal Verifiers and assessors must work together to ensure that assessment decisions are reached promptly and validated before they are given to the learner.

Late submission

You should encourage learners to understand the importance of deadlines and of handing work in on time. For assessment purposes it is important that learners are assessed fairly and consistently according to the assessment plan that the Lead Internal Verifier has authorised and that some learners are not advantaged by having additional time to complete assignments. You are not required to accept for assessment work that was not completed by the date in the assessment plan.

Learners may be given authorised extensions for legitimate reasons, such as illness at the time of submission. If you accept a late completion by a learner, the evidence should be assessed normally, unless it is judged to not meet the requirements for authenticity. It is not appropriate, however, to give automatic downgrades on assessment decisions as 'punishment' for late submission.

Resubmission of improved evidence

Once an assessment decision is given to a learner, it is final in all cases except where the Lead Internal Verifier approves **one** opportunity to resubmit improved evidence.

The criteria used to authorise a resubmission opportunity are always:

- initial deadlines or agreed extensions have been met
- the tutor considers that the learner will be able to provide improved evidence without further guidance
- the evidence submitted for assessment has been authenticated by the learner and the assessor
- the original assessment can remain valid
- the original evidence can be extended and re-authenticated.

Your centre will need to provide a specific resubmission opportunity that is authorised by the Lead Internal Verifier. Any resubmission opportunity must have a deadline that is within 10 working days of the assessment decision being given to the learner, and within the same academic year. You should make arrangements for resubmitting the evidence for assessment in such a way that it does not adversely affect other assessments and does not give the learner an unfair advantage over other learners.

You need to consider how the further assessment opportunity ensures that assessment remains fit for purpose and in line with the original requirements; for example, you may opt for learners to improve their evidence under supervised conditions, even if this was not necessary for the original assessment, to ensure that plagiarism cannot take place. How you provide opportunities to improve and resubmit evidence for assessment needs to be fair to all learners. Care must be taken when setting assignments and at the point of final assessment to ensure that the original evidence for assessment can remain valid and can be extended. The learner must not have further guidance and support in producing further evidence. The Standards Verifier will want to include evidence that has been resubmitted as part of the sample they will review.

Appeals

Your centre must have a policy for dealing with appeals from learners. These appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy would be a consideration of the evidence by a Lead Internal Verifier or other member of the programme team. The assessment plan should allow time for potential appeals after assessment decisions have been given to learners.

If there is an appeal by a learner you must document the appeal and its resolution.

Dealing with malpractice

Learner Malpractice

Heads of Centres are required to report incidents of any suspected learner malpractice that occur during Pearson external assessments. We ask that centres do so by completing a JCQ Form M1 (available at www.jcq.org.uk/exams-office/malpractice) and emailing it and any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Team at pqsmalpractice@pearson.com. The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Teacher/centre Malpractice

Heads of Centres are required to inform Pearson's Investigations Team of any incident of suspected malpractice by centre staff, before any investigation is undertaken. Heads of Centres are requested to inform the Investigations Team by submitting a JCQ Form M2(a) (available at www.jcq.org.uk/exams-office/malpractice) with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff or anonymous informants), the Investigations Team will conduct the investigation directly or may ask the head of centre to assist. Incidents of maladministration (accidental errors in the delivery of Pearson qualifications that may affect the assessment of learners) should also be reported to the Investigations Team using the same method.

Reasonable adjustments to assessment

You are able to make adjustments to assessments to take account of the needs of individual learners in line with Pearson's Reasonable Adjustments and Special Considerations policy. In most instances this can be achieved simply by application of the policy, for example to extend time or adjust the format of evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable.

Special consideration

You must operate special consideration in line with Pearson's Reasonable Adjustments and Special Considerations policy. You can provide special consideration only in the time given for evidence to be provided or for the format of the assessment if it is equally valid. You may not substitute alternative forms of evidence to that required in a unit, or omit the application of any assessment criteria to judge attainment. Pearson can consider applications for special consideration in line with the policy.

(Exemplar for centres)

Learner Assessment Submission and Declaration

This sheet must be completed by the learner and provided for work submitted for assessment.

Learner name:	Assessor name:	
Date issued:	Completion date:	Submitted on:
Qualification:		
Assessment reference and title:		

Please list the evidence submitted for each task. Indicate the page numbers where the evidence can be found or describe the nature of the evidence (e.g. video, illustration).

Task ref.	Evidence submitted	Page numbers or description
Comments for note by the assessor:		

Learner declaration

I certify that the work submitted for this assignment is my own. I have clearly referenced any sources used in the work. I understand that false declaration is a form of malpractice.

Learner signature: Date:

_____

9 External assessment

Externally assessed units have the same grades as internally assessed units:

- Level 2 – Pass, Merit, Distinction
- Level 1
- Unclassified.

The table below shows the type of external assessment and assessment availability for this qualification.

Unit 1: The Engineered World	
Type of external assessment	This unit is externally assessed using an onscreen test. Pearson sets and marks the test. The assessment must be taken by the learner under examination conditions.
Length of assessment	The external assessment will be one hour.
Number of marks	50
Assessment availability	On demand
First assessment availability	November 2013
Resit opportunities	All learners registered from Sept 2018 can resit the external assessment once.

Your centre needs to make sure that learners are:

- fully prepared to sit the external assessment
- entered for assessments at appropriate times, with due regard for resit opportunities as necessary.

Sample assessment materials will be available to help centres prepare learners for assessment. Specific arrangements for external assessment are available before the start of each academic year on our website qualifications.pearson.com

Grade descriptors for the internal and external units

Internal units

Each internally assessed unit has specific assessment criteria that your centre must use to judge learner work in order to arrive at a grading decision for the unit as a whole. For internally assessed units, the assessor judges the evidence that the learner has presented to determine whether it meets all the relevant criteria, and then awards a grade at the appropriate level.

The criteria are arrived at with reference to the following grading domains:

- applying knowledge and understanding in vocational and realistic contexts, with reference to relevant concepts and processes, to achieve tasks, produce outcomes and review the success of outcomes
- developing and applying practical and technical skills, acting with increasing independence to select and apply skills through processes and with effective use of resources to achieve, explain and review the success of intended outcomes
- developing generic skills for work through management of self, working in a team, the use of a variety of relevant communication and presentation skills, and the development of critical thinking skills relevant to vocational contexts.

External units

The externally assessed units are assessed using a marks-based scheme. For each external assessment, grade boundaries, based on learner performance, will be set by the awarding organisation.

The following criteria are used in the setting and awarding of the external unit.

Level 2 Pass

Learners will be able to recall and apply knowledge in familiar situations including everyday uses of engineered products. They will have a sound understanding of key terms, processes, equipment and technologies. They will be able to interpret information in order to select and apply knowledge of engineering products, processes, materials and technologies. They will be able to define and communicate key aspects of engineering processes, selecting appropriate actions in more simple and familiar contexts. They will be able to relate knowledge of engineering and the way in which engineering relates to sustainability in vocational and realistic situations making some decisions on valid applications and impact. They will be able to relate the use of engineering processes and modern products to users and purposes.

Level 2 Distinction

Learners will be able to synthesise knowledge of engineered products, the materials used to make them and engineering processes, bringing together understanding of technologies. They will be able to apply understanding of engineering processes to sometimes complex contexts such as modern manufacturing techniques. They will show depth of knowledge and development of understanding of engineering processes and technologies in different situations, being able to make effective judgements based on analysis of given information. They will be able to analyse engineering products, selecting appropriate materials and making recommendations about applications of processes and their environmental impact. They will be able to make judgements about the efficiency of manufacturing systems and potential impacts on product quality and the environment, and make recommendations on solutions, controls and future planning. They will be able to compare techniques, processes, products and materials to evaluate alternatives against defined criteria.

10 Awarding and reporting for the qualification

The awarding and certification of this qualification will comply with the requirements of the Office of Qualifications and Examinations Regulation (Ofqual).

Calculation of the qualification grade

This qualification is a level 2 qualification, and the certification may show a grade of Level 2 Pass, Level 2 Merit, Level 2 Distinction or Level 2 Distinction*. If these are not achieved, a Level 1 or Unclassified grade may be awarded.

Each individual unit will be awarded a grade of Level 2 Pass, Merit or Distinction, Level 1 or Unclassified. Distinction* is not available at unit level.

Award of Distinction* (D*)

D* is an aggregated grade for the qualification, based on the learner's overall performance. In order to achieve this grade learners will have to demonstrate a strong performance across the qualification as a whole.

To achieve a level 2 qualification learners must:

- complete and report an outcome for all units within the permitted combination (NB Unclassified is a permitted unit outcome)
- have sufficient points across the core units, i.e. 24 points
- achieve the minimum number of points at a grade threshold from the permitted combination. See the Calculation of qualification grade table.

Learners who do not achieve a Level 2 may be entitled to achieve a Level 1 where they:

- complete and report an outcome for all units within the permitted combination (NB Unclassified is a permitted unit outcome)
- have sufficient points across the core units, i.e. 12 points
- achieve the minimum number of points for a Level 1. See the Calculation of qualification grade table.

Points available for unit size and grades

The table below shows the **number of points scored per 10 guided learning hours** at each grade.

Points per grade per 10 guided learning hours				
Unclassified	**Level 1**	**Level 2 Pass**	**Level 2 Merit**	**Level 2 Distinction**
0	2	4	6	8

Pearson will automatically calculate the qualification grade for your learners when your learner unit grades are submitted. Learners will be awarded qualification grades for achieving the sufficient number of points within the ranges shown in the Calculation of qualification grade table.

Example:

A learner achieves a Level 2 Pass grade for a unit. The unit size is 30 guided learning hours (GLH). Therefore they gain 12 points for that unit, i.e. 4 points for each 10 GLH, therefore 12 points for 30 GLH.

Calculation of qualification grade

Award (120 GLH)	
Grade	**Minimum points required**
U	0
Level 1	24
Level 2 Pass	48
Level 2 Merit	66
Level 2 Distinction	84
Level 2 Distinction*	90

This table shows the minimum thresholds for calculating grades. The table will be kept under review over the lifetime of the qualification. The most up to date table will be issued on our website.

Pearson will monitor the qualification standard and reserves the right to make appropriate adjustments.

Examples used are for illustrative purposes only. Other unit combinations are possible, see *Section 4 Qualification structures*.

Example 1: Achievement of an Award with a Level 2 Merit grade

		GLH	Weighting (GLH/10)	Grade	Grade points	Points per unit (weighting × grade points)
Unit 1	Core unit	30	3	Level 2 Merit	6	18
Unit 2	Core unit	30	3	Level 2 Pass	4	12
Unit 3	Optional unit	30	3	Level 2 Merit	6	18
Unit 4	Optional unit	30	3	Level 2 Merit	6	18
	Qualification grade totals	**120**	**12**	**Level 2 Merit**		**66**

The learner has more than sufficient points across the core units to be considered for a Level 2.

The learner has sufficient points for a Level 2 Merit grade.

Example 2: Achievement of an Award with a Level 2 Pass grade

		GLH	Weighting (GLH/10)	Grade	Grade points	Points per unit (weighting × grade points)
Unit 1	Core unit	30	3	Level 2 Merit	6	18
Unit 2	Core unit	30	3	Level 1	2	6
Unit 3	Optional unit	30	3	Level 2 Merit	6	18
Unit 4	Optional unit	30	3	Level 1	2	6
	Qualification grade totals	**120**	**12**	**Level 2 Pass**		**48**

The learner has sufficient points across the core units to be considered for a Level 2.

The learner has sufficient points for a Level 2 Pass grade.

Example 3: Achievement of an Award at Level 1 but a Level 2 Pass grade points total

		GLH	Weighting (GLH/10)	Grade	Grade points	Points per unit (weighting × grade points)
Unit 1	Core unit	30	3	Level 1	2	6
Unit 2	Core unit	30	3	Level 1	2	6
Unit 3	Optional unit	30	3	Level 2 Merit	6	18
Unit 4	Optional unit	30	3	Level 2 Merit	6	18
	Qualification grade totals	**120**	**12**	**Level 1**		**48**

The learner has not achieved sufficient points across the core units to achieve a Level 2 but has sufficient points to be considered for a Level 1.

Although the learner has gained enough points overall for a Level 2, they will get a Level 1 qualification as they did not achieve sufficient points across the core units.

Example 4: The learner has not achieved sufficient points in the core units to gain a Level 2 or Level 1 qualification

		GLH	Weighting (GLH/10)	Grade	Grade points	Points per unit (weighting × grade points)
Unit 1	Core unit	30	3	Unclassified	0	0
Unit 2	Core unit	30	3	Level 1	2	6
Unit 3	Optional unit	30	3	Level 2 Merit	6	18
Unit 4	Optional unit	30	3	Level 2 Merit	6	18
	Qualification grade totals	**120**	**12**	**Unclassified**		**42**

The learner has not achieved sufficient points across the core units to achieve a Level 2 or Level 1.

Although the learner has gained enough points overall for a Level 1, they will receive an Unclassified grade as they did not achieve sufficient points across the core units.

11 Quality assurance of centres

Pearson will produce on an annual basis the *BTEC Quality Assurance Handbook*, which will contain detailed guidance on the quality processes required to underpin robust assessment and internal verification.

The key principles of quality assurance are that:

- a centre delivering BTEC programmes must be an approved centre, and must have approval for the programmes or groups of programmes that it is delivering
- 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, through online standardisation, 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, for the planning, monitoring and recording of assessment processes, and for dealing with special circumstances, appeals and malpractice.

The approach of quality-assured assessment is through a partnership between an approved centre and Pearson. We will make sure that each centre follows best practice and employs appropriate technology to support quality-assurance processes, where practicable. We work to support centres and seek to make sure that our quality-assurance processes do not place undue bureaucratic processes on centres.

We monitor and support centres in the effective operation of assessment and quality assurance. The methods we use to do this for BTEC First programmes include:

- making sure that all centres complete appropriate declarations at the time of approval
- undertaking approval visits to centres
- making sure that centres have effective teams of assessors and verifiers who are trained to undertake assessment
- assessment sampling and verification, through requested samples of assessments, completed assessed learner work and associated documentation
- an overarching review and assessment of a centre's strategy for assessing and quality assuring its BTEC programmes.

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

Centres that do not fully address and maintain rigorous approaches to quality assurance cannot seek certification for individual programmes or for all BTEC First programmes. Centres that do not comply with remedial action plans may have their approval to deliver qualifications removed.

12 Further information and useful publications

For further information about the qualification featured in this specification, or other Pearson qualifications, please call Customer Services on 0844 576 0026 (calls may be monitored for quality and training purposes) or visit our website qualifications.pearson.com.

Related information and publications include:

- *Equality Policy*
- *Information Manual* (updated annually)
- *Access arrangements, reasonable adjustments and special considerations*
- *Quality Assurance Handbook* (updated annually)
  - Publications on the quality assurance of BTEC qualifications are on our website at qualifications.pearson.com

Additional documentation

Additional materials include:

- Sample Assessment Material (for the external unit)
- a guide to *Getting Started with BTEC*
- guides to our support for planning, delivery and assessment (including sample assignment briefs).

Visit www.btec.co.uk/2012 for more information.

Additional resources

If you need to source further learning and teaching material to support planning and delivery for your learners, there is a wide range of BTEC resources available to you.

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

13 Professional development and support

Pearson supports UK and international customers with training related to BTEC qualifications. This support is available through a choice of training options offered in our published training directory, or through customised training at your centre.

The support we offer focuses on a range of issues including:

- 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 functional skills into your programme
- 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 customised training through the website or you can contact one of our advisors in the Training from Pearson team via Customer Services to discuss your training needs.

BTEC training and support for the lifetime of the qualification

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. In addition, we have designed our new network events programme to allow you to share your experiences, ideas and best practice with other BTEC colleagues in your region. Sign up to the training you need at: www.btec.co.uk/training

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. Call **0844 576 0027** to contact the curriculum team for your centre.

Your BTEC Support team

Whether you want to talk to a sector specialist, browse online or submit your query for an individual response, there is someone in our BTEC Support team to help you whenever – and however – you need, with:

- Welcome Packs for new BTEC centres: if you are delivering BTEC for the first time, we will send you a sector-specific Welcome Pack designed to help you get started with the new Pearson BTEC Level 1/Level 2 First Award
- Subject Advisors: find out more about our subject advisor team – immediate, reliable support from a fellow subject expert at: qualifications.pearson.com/subjectadvisors
- BTEC Hotline: call the BTEC Hotline on 0844 576 0026 with your query

Units

Unit 1: The Engineered World

Level: **1 and 2**

Unit type: **Core**

Guided learning hours: **30**

Assessment type: **External**

Unit introduction

What is 'engineering'? Is it using materials and processes to manufacture a single item? Is it applying new technologies to the mass production of well-known products? Or is it implementing methods to reduce waste and improve the sustainability of energy sources? Engineering is all of these things and many more. It affects all aspects of our lives, from the daily use of time-saving appliances to performance materials applied in ways we may never have imagined.

In this unit, you will discover the world of engineering. You will investigate the processes used to manufacture modern products within different engineering sectors. You will also study some of the new developments in materials and engineering technology that have an impact on life today – or will have in the very near future.

Engineers must be aware that products and processes may require the use of scarce resources that could have an impact on the environment. When an engineered product is made, used and disposed of, any waste of energy and environmental damage must be minimised at all stages. Therefore, you will also investigate waste reduction and sustainability issues from an engineering perspective, discovering how engineers can help control and reduce environmental damage.

Learning aims

In this unit you will:

A know about engineering processes used to produce modern engineered products

B know about developments in engineering materials and technologies

C understand how engineering contributes to a sustainable future.

Learning aims and unit content

What needs to be learnt
Learning aim A: Know about engineering processes used to produce modern engineered products
Topic A1: Engineering sectors and products Types of products from the following engineering sectors: ● aerospace, automotive, communications, electrical/electronic, mechanical, biomedical, chemical. **Topic A2: Mechanical and electrical/electronic engineering processes** Processes including health and safety issues, characteristics, applications and advantages/disadvantages of the following engineering processes: ● machining – turning, milling, drilling ● forming – casting, forging ● fabrication – welding, shearing ● electrical/electronic – PCB manufacture, surface mount technology. **Topic A3: Scales of production** Characteristics and advantages/disadvantages of the following scales of production used in engineering manufacture: ● one-off/jobbing production ● batch production ● mass production ● continuous production. **Topic A4: Modern production methods** Applications and advantages/disadvantages of the following modern production methods for production/assembly lines: ● robots ● Computer Numerically Controlled (CNC) machinery.

What needs to be learnt

Learning aim B: Know about developments in engineering materials and technologies

Topic B1: Modern and smart materials in engineering

Applications, characteristics, properties and advantages/disadvantages of the following modern and smart materials used in engineering:

- modern composite materials – glass reinforced plastic (GRP), carbon fibre, Kevlar®
- modern high-performance materials – tungsten, titanium, superalloys (nickel based, cobalt based), ceramics (boron carbide, cubic boron nitride, zirconia)
- smart materials – shape memory alloys (SMAs), shape memory polymers, electrochromic, piezoelectric actuators and transducers.

Topic B2: Modern material foams in engineering

Applications, characteristics and advantages/disadvantages of metallic foams as used in the automotive, biomedical and aerospace sectors e.g. aluminium, steel.

Topic B3: Modern material processes in engineering

Process, applications, characteristics and advantages/disadvantages of powder metallurgy: powder mixing/blending, pressing/compacting, sintering.

Topic B4: New technologies in engineering

Applications, characteristics and advantages/disadvantages of the following new technologies used in engineering sectors:

- optical fibres as used in the communications sector
- hydrogen fuel cells, surface nanotechnology and telematics as used in the automotive sector
- blended wing bodies as used in the aerospace sector
- bionics as used in the biomedical sector.

What needs to be learnt
Learning aim C: Understand how engineering contributes to a sustainable future
Topic C1: Sustainable engineered products Characteristics, applications and advantages/disadvantages of Life Cycle Assessment (LCA) at the following stages for engineered products: ● raw materials extraction ● material production ● production of parts ● assembly ● use ● disposal/recycling. **Topic C2: Minimising waste production in engineering** Characteristics, applications and advantages/disadvantages of minimising waste production throughout the life cycle of engineered products, using the four Rs: ● Reduce materials and energy. ● Reuse materials and products where applicable. ● Recover energy from waste. ● Recycle materials and products or use recycled materials. **Topic C3: Lean manufacturing** Characteristics, applications and advantages/disadvantages of minimising waste at the production stage in engineering, using the following lean manufacturing techniques: ● Just-in-Time (JIT) ● Kaizen ● poka-yoke. **Topic C4: Renewable sources of energy in engineering** Processes, characteristics, applications and advantages/disadvantages of using the following renewable sources of energy in engineering: ● wind energy using turbines and wind farms ● solar energy using photovoltaic cells and solar water heaters ● hydro energy using dams, barrages and wave power ● geothermal energy using heat pumps and exchangers.

Teacher guidance

Resources

There are no special resources needed for this unit.

Assessment guidance

This unit is externally assessed using an onscreen test. Pearson sets and marks the test. The test lasts for one hour and has 50 marks. The assessment is available on demand.

Learners will complete an onscreen test that has different types of questions including objective and short-answer questions. Where appropriate, questions contain graphics, photos, animations or videos. An onscreen calculator is available for questions requiring calculations. An onscreen notepad is available for making notes. Each item will have an accessibility panel that allows a learner to zoom in and out and apply a colour filter.

Unit 2: Investigating an Engineering Product

Level: **1 and 2**

Unit type: **Core**

Guided learning hours: **30**

Assessment type: **Internal**

Unit introduction

Have you ever wondered how engineered products progress from an idea in a designer's head to the finished article ready for use? When a product is being designed to meet a need, crucial decisions must be taken. The designer must ask key questions about the product, for example what form might it take; what functions must it fulfil; what user and performance requirements must be included; and what materials should be used to make it fit for purpose.

Materials used in a product are not selected at random. From the thousands of options available, materials are chosen on the basis of their specific properties and whether they match the needs of the product.

When a product is manufactured, particular production processes are used so that component parts are made accurately, quickly and to the same high quality standards time after time. As part of the quality assurance (QA) process, quality control (QC) checks are carried out during manufacture on materials and component parts to ensure the finished product reaches users in the best possible condition.

In this unit you will investigate a manufactured product to learn what considerations a designer would keep in mind when writing a technical specification.

You will investigate the materials and commercial production processes used to manufacture the product, in order to learn why they were used in preference to others that might also have been appropriate. You will also learn how certain materials and processes can affect the environment.

In studying quality issues, you will come to understand how the quality of a product is assured throughout its manufacture, and you will learn how specific forms of quality control contribute to overall quality assurance.

Learning aims

In this unit you will:

A understand the performance requirements of an engineered product

B understand the selection of specific materials for use in the components that make up an engineered product

C understand the selection and use of manufacturing processes in an engineered product

D understand the quality issues related to an engineered product.

Learning aims and unit content

What needs to be learnt
Learning aim A: Understand the performance requirements of an engineered product
Topic A1: Technical specification Analysis of the chosen engineered product consisting of at least two components and production of technical specification criteria that covers the following key headings: Basic specification criteria: ● form (why is the product shaped/styled as it is?) ● function (what is the purpose of the product?) ● user requirements (what qualities make the product attractive to potential users?) Advanced specification criteria: ● performance requirements (what are the technical considerations that must be achieved within the product?) ● material and component requirements (how should materials and components perform within the product?) ● ease of manufacture ● ease of maintenance ● legal and safety requirements.
Learning aim B: Understand the selection of specific materials for use in the components that make up an engineered product
Topic B1: Selection of materials and components The materials used in the components of a chosen product and reasons for their selection for use, including: ● properties, e.g. aesthetic, mechanical, electrical, chemical ● qualities, e.g. cost, availability, durability, reusability, safety. **Topic B2: Environmental impact** Sustainability issues of using the materials identified in the chosen product in relation to the following: ● extraction and processing of raw materials ● disposal of products after their useful lifespan. **Topic B3: Alternative materials** Suitable alternative materials that could be used in the chosen product, including: ● advantages and disadvantages of alternatives ● comparison and contrast with the materials actually used.

What needs to be learnt
Learning aim C: Understand the selection and use of manufacturing processes in an engineered product
Topic C1: Selection of production processes The production processes involved in the manufacture of components in a chosen product, including: ● processes in reference to the manufacturing needs of the product ● how each process meets the manufacturing need. **Topic C2: Environmental impact** The impact on the environment of the production processes used in the manufacture of components in the product including: ● energy and resources used during production ● waste production and pollution as a result of production. **Topic C3: Comparing production processes** Comparison between two processes used in the manufacture of components in the product including: ● advantages and disadvantages of each process.
Learning aim D: Understand the quality issues related to an engineered product
Topic D1: Quality control (QC) The specific quality-control checks that could have been used on an engineered product to ensure its quality and performance at one or more of the following stages: ● materials supply ● production ● assembly. **Topic D2: Quality assurance (QA)** The quality assurance system that could have been used on an engineered product, including: ● when and where quality-control checks take place ● what the checks consist of ● how they form part of the overall quality-assurance system ● fitness for purpose in terms of product meeting specification criteria.

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Understand the performance requirements of an engineered product			
1A.1 Identify relevant basic specification criteria for an engineered product.	2A.P1 Outline relevant basic and advanced specification criteria for an engineered product.	2A.M1 Explain the importance of basic and advanced specification criteria for an engineered product.	
Learning aim B: Understand the selection of specific materials for use in the components that make up an engineered product			
1B.2 Identify materials used in two component parts of an engineered product, stating engineering properties for each.	2B.P2 Describe the engineering properties, qualities and environmental impact of materials in two components of an engineered product and suggest alternatives.	2B.M2 Compare and contrast the materials used in two components in an engineered product with reference to engineering properties, qualities, environmental impact and alternatives.	2B.D1 Evaluate the fitness for purpose of materials used in two components of an engineered product in relation to possible alternative materials making reference to properties, qualities, environmental impact and alternatives.
Learning aim C: Understand the selection and use of manufacturing processes in an engineered product			
1C.3 Outline two production processes used in the manufacture of components in an engineered product.	2C.P3 Describe two production processes used in the manufacture of components in an engineered product.	2C.M3 Explain reasons for the selection and use of two production processes used in the manufacture of components in an engineered product.	2C.D2 Compare and contrast the production processes used in the manufacture of components in an engineered product in terms of their environmental impact and the manufacturing need.

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim D: Understand the quality issues related to an engineered product			
1D.4 Identify quality-control (QC) checks that could be made during the manufacture of an engineered product.	2D.P4 Explain how quality control (QC) checks can help to improve the quality of an engineered product.		
1D.5 Outline the quality-assurance (QA) system that could be used during the manufacture of an engineered product.	2D.P5 Explain why a specific quality-assurance (QA) system should be used during the manufacture of an engineered product.	2D.M4 Analyse the fitness for purpose of a quality-assurance (QA) system for an engineered product.	2D.D3 Evaluate the use of the quality-control (QC) checks and quality-assurance (QA) systems for an engineered product.

*Opportunity to assess mathematical skills

#Opportunity to assess English skills

Teacher guidance

Resources

Learners will need access to engineered products to complete this unit.

Assessment guidance

This unit is assessed internally by the centre and externally verified by Pearson. Please read this guidance in conjunction with *Section 8 Internal assessment*.

Learners should either choose, or be provided with, a modern engineered product to enable them to complete the assessment of this unit. Products must have two or more components which provide the potential to understand different materials and processes.

Level 2 learners will be able to fully describe basic and advanced specification criteria, and describe material properties and manufacturing processes suggesting alternatives. Quality checks, and how they coordinate in a quality assurance process, should also be understood. Merit criteria require learners to explain reasons for their choices. For Distinction, learners will be able to compare and contrast materials and processes against fitness for purpose criteria.

Learners producing level 1 evidence will be able to identify basic specification criteria for their product, as well as the materials used and their properties. Learners should be able to outline the production processes and quality-assurance checks used.

Evidence is likely to be in the form of assignment work but could also be oral evidence accompanied by an observation record, and may include, for example, photographic evidence of the disassembly and labelling of products.

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 2A.P1, 2A.M1	Product Performance	A local engineering company has asked you/your group to investigate an appropriate engineered product and identify, outline and explain: ● why it is shaped as it is ● what its function is – whether it works ● what would make users choose the product and why ● the technical attributes that the product has that make it fit for purpose.	An investigation of the product's performance using information presented under formal headings. (One side of A3)
1B.2, 2B.P2, 2B.M2, 2B.D1	Materials and Components	The manager of the company has asked you to develop your investigation by disassembling the product and discussing component parts, describing qualities and properties, environmental impact and possible alternatives.	An investigation of the product's materials and components using technical information. Photographic evidence of any product disassembly/labelling of components. (One side of A3)
1C.3, 2C.P3, 2C.M3, 2C.D2	Manufacturing Processes	The manager is happy with your work and would also like you to discuss manufacturing processes to determine which ones were used during manufacture of the product components.	An investigation of the product's manufacturing processes using technical information and diagrams of processes. (One side of A3)
1D.4, 2D.P4, 1D.5, 2D.P5, 2D.M4, 2D.D3	Quality	You have been asked to explain reasons for quality control checks and quality assurance, suggesting what checks would be made on your product and how checks could improve quality.	An investigation of the product's quality issues using technical information. (One side of A3)

Unit 3: Health and Safety in Engineering

Level: **1 and 2**

Unit type: **Optional specialist**

Guided learning hours: **30**

Assessment type: **Internal**

Unit introduction

The ability to work safely in an engineering environment is essential for your own wellbeing and that of others. This unit will help you to understand health and safety requirements and to know how to prepare and carry out an activity safely in your engineering work space. In this way, you can enjoy all the challenges that engineering activities can offer without undue fear for your own safety or for that of others.

The initial focus of the unit is on gaining awareness of the dangers of not working within appropriate legislation and procedures. In the event of an incident, it is essential that you know how to respond. This unit will take you through the important legislation and policies that you need to know.

You will then consider how materials and equipment should be handled and the most appropriate personal protective equipment (PPE) to use when undertaking particular engineering activities. Identifying risks is an important activity here.

The knowledge and understanding gained through studying this unit will be put to good use in other areas of engineering study and working life.

Learning aims

In this unit you will:

A understand safe and effective working in an engineering workplace

B know how to follow procedures and undertake a work activity safely.

Learning aims and unit content

What needs to be learnt
Learning aim A: Understand safe and effective working in an engineering workplace
Topic A1: Accident and emergency procedures Understand the accident and emergency procedures to be followed in response to an incident in an engineering workplace, including: ● identification of appropriately qualified persons, including first aider, fire warden ● actions in the event of an accident or emergency, including use of fire extinguishers (types and applications), types and sounding/initiating of emergency alarm, evacuation procedure and escape routes, location of first-aid facilities ● identifying and using procedures to be followed in the event of dangerous occurrences or hazardous malfunctions of equipment, processes or machinery ● reporting routines, e.g. assembly points, hazards and malfunctions, injury, near-miss occurrences ● accident and emergency procedure document, including brief summation of contents, purpose, legal requirements, possible improvements, e.g. in usage, format, visibility. **Topic A2: Working safely in an engineering organisation** Understand safety procedures to be followed in an engineering working environment, including: ● handling materials and equipment in an approved manner and in line with the most current legislation/regulations: Health & Safety at Work Act and related legislation, Personal Protective Equipment at Work Regulations, Manual Handling Operations Regulations, Use of Work Equipment Regulations, Display Screen at Work Regulations, Control of Substances Hazardous to Health (COSHH), Reporting of Injuries, Diseases and Dangerous Occurrences Regulations (RIDDOR), relevant workplace policies and procedures ● the roles and responsibilities of the employer, including compliance with legislation, policy and procedures, health, safety and wellbeing of employees ● the roles and responsibilities of employees, including own and others' health, safety and security; compliance of the workplace with legislation, policy and procedures.

What needs to be learnt

Learning aim B: Know how to follow procedures and undertake a work activity safely

Topic B1: Materials and equipment handling

Know how personal and protective equipment should be used for an engineering activity, including:

- Personal Protective Equipment at Work Regulations
- personal protective equipment (PPE): overalls for general workshop activities, eye protection for a range of machinery and equipment, skin care (barrier creams, gloves), protective hat where required, protective footwear for general workshop activities, masks/respirators for areas with poor ventilation or dust, hearing protection (ear plugs, ear defenders), PPE manufacturers' guidelines for use.

Topic B2: Risks and risk assessment

Defining a hazard:

- A hazard is something that can cause an adverse effect. The hazard could be an object, a property of a substance, a phenomenon, or an activity, e.g. moving parts of machinery, sharp objects, electricity, slippage and uneven surfaces, dust and fumes, handling and transporting, contaminants and irritation, material ejection, fire, working at height, environment, pressure/stored energy systems, volatile or toxic materials, unshielded processes.

Defining risk:

- A risk is the likelihood that a hazard will actually cause its adverse effect, together with a measure of the effect, e.g. tools, materials or equipment in use, spillages of oil and chemicals, not reporting accidental breakages of tools or equipment, and not following working practices and procedures.

Steps of a risk assessment are to:

- identify the hazard
- decide who might be harmed
- evaluate the risk and decide on precautionary measures
- record findings and prepare to implement them
- review and update the assessment.

continued

What needs to be learnt

Topic B3: Engineering work activity

Preparing the working environment prior to an engineering activity and completing an engineering activity safely.

Preparing the working environment, including:

- ensuring that work area is free from hazards
- selecting and using, correct and appropriate personal protective equipment (PPE), and hygiene procedures
- obtaining and understanding drawings/work instructions and manufacturers' instructions
- obtaining suitable tools and carrying out checks to ensure that they are safe and in a usable condition.

Completing an engineering activity safely in a working environment, including:

- implementing safety procedures
- completing all tasks and documentation
- using tools and equipment safely, and only for the purpose intended
- maintaining a tidy workplace, with exits and gangways free from obstruction
- taking measures to protect others from harm resulting from any work that they are carrying out
- returning drawings/work instructions and tools upon completion
- disposing of unusable tools, equipment, components and waste materials (oil, soiled rags, swarf/offcuts, etc).

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Understand safe and effective working in an engineering workplace			
1A.1 Outline the actions that need to be taken if there is an accident in an engineering workplace.	2A.P1 Explain how accident and emergency procedures are used in an engineering workplace.	2A.M1 Explain the importance of following accident and emergency procedures in response to an incident in an engineering workplace.	
1A.2 Identify the key features of legislation, policy and procedures for an engineering workplace. #	2A.P2 Outline the roles and responsibilities of self and others under the legislation, policy and procedures required for an engineering workplace. #	2A.M2 Explain the roles and responsibilities of self and others under the legislation, policy and procedures required for an engineering workplace. #	2A.D1 Explain the importance of employees and employers adhering to correct legislation, policy and procedures in an engineering workplace. #

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim B: Know how to follow procedures and undertake a work activity safely			
1B.3 Outline procedures for handling materials and equipment for a given engineering activity.	2B.P3 Describe the personal protective equipment to be used when handling materials and equipment in an engineering workplace.	2B.M3 Explain why personal protective equipment is required for different processes in an engineering workplace.	2B.D2 Evaluate personal protective equipment in an engineering workplace, reporting how well the PPE manufacturer's guidelines adhere to the appropriate regulations.
1B.4 Identify risks associated with one engineering activity.	2B.P4 Complete an accurate risk assessment for one engineering activity. #		
1B.5 Prepare the work area appropriately for a given engineering activity.	2B.P5 Prepare for, and carry out, an engineering activity safely.		

*Opportunity to assess mathematical skills

#Opportunity to assess English skills

Teacher guidance

Resources

The special resources required for this unit are:

- access to a workshop environment and the range of tools required to carry out engineering work activities (essential)
- access to relevant legislation and regulations applicable to the working environment, emergency procedures and policies, including access to computers and the internet to enable learners to research current legislation and regulations (as required).

Assessment guidance

This unit is assessed internally by the centre, and externally verified by Pearson. Please read this guidance in conjunction with *Section 8 Internal assessment*.

Much of the assessment evidence for this unit could come from practical activities. These can be carried out solely for the purpose of this unit but, equally, could be the activities associated with other units.

Risk assessment evidence should come from an assessment of an engineering work activity. It is important for learners to understand that risk assessment should be undertaken prior to all new work activities. However, if learners are undertaking practical units in this qualification, which also require assessment of risk, they should **not** use the same evidence for this unit.

Learners could assess the policies and procedures related to an engineering workplace in the educational context, or that of an engineering employer.

Level 2 learners should be able to act independently when assessing risks, outlining procedures and undertaking activities. Evidence for a risk assessment could come from completion of a Health and Safety Executive (HSE) template. Learners should show that they are aware of the main points included in procedures; they do not need to reproduce documents. At Merit and Distinction level, learners should be able to develop a critical perspective on procedures, explaining their importance and making suggestions for improvements, either in content or usage. They should also be able to report on the effectiveness of PPE manufacturers' guidelines.

At level 1, learners will produce evidence that shows their basic knowledge and understanding of health, safety, accident and emergency procedures. They should be able to prepare a workplace for an activity.

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 1A.2, 2A.P1, 2A.P2, 2A.M1, 2A.M2, 2A.D1	Accident and Emergency Procedures and Workplace Roles and Responsibilities	You have just started work in an engineering workplace and have been asked by your team leader to investigate: relevant workplace legislation, policy and procedures, your own responsibilities and those of others.	A written report or presentation.
1B.3, 1B.4, 1B.5, 2B.P3, 2B.P4, 2B.P5, 2B.M3, 2B.D2	Preparing for and Carrying Out an Engineering Activity	You have been asked to prepare for and carry out a new engineering work activity. You need to investigate the personal protective equipment (PPE) needed, complete an assessment of risks and carry out the activity safely.	Teacher observation record of the preparation and execution of the task. A written report that evaluates PPE requirements.

Unit 4: Engineering Maintenance

Level: **1 and 2**

Unit type: **Optional specialist**

Guided learning hours: **30**

Assessment type: **Internal**

Unit introduction

When a car breaks down, or will not start, it is often because it has been poorly maintained. Similarly, if the central heating at a school or college fails to heat the rooms properly or leaks water, it is probably down to insufficient maintenance. A lack of maintenance can be dangerous – and it can also be very expensive; if a car manufacturing production line stops, the costs can be in excess of £20,000 per minute until production resumes. It is therefore vital for modern manufacturing organisations to have effective maintenance planning and procedures in place to guarantee reliable and safe operation of the plant and equipment.

In this unit you will learn about engineering maintenance, including the different strategies that organisations use when maintaining their plant and equipment. You will also investigate the causes of engineering equipment failure and the effects this failure can have.

The repair and adjustment of an engineering plant and its equipment and machinery is vitally important, in order to ensure that they continue to perform their intended functions.

You will be introduced to the features of engineering systems that determine reliability, safety and maintainability. In order to demonstrate the principles, you will resource, plan and carry out a practical maintenance activity on an engineering product or system.

Learning aims

In this unit you will:

A know about causes and effects of equipment failure and types of maintenance procedures

B be able to resource and plan a maintenance activity on an engineering product or system

C be able to carry out a maintenance activity safely on an engineering product or system.

Learning aims and unit content

What needs to be learnt
Learning aim A: Know about causes and effects of equipment failure and types of maintenance procedures
Topic A1: Causes and effects Causes and effects, including: ● causes – age, wear, vibration, corrosion, fouling, environment, lack of maintenance ● effects – decreased productivity, increased cost, health and safety of users, environmental impacts. **Topic A2: Types of planned maintenance procedures, their features and benefits** Recognition of planned maintenance procedures, including: ● routine maintenance ● total preventative maintenance (TPM) ● predictive maintenance ● condition monitoring ● calibration. Benefits, e.g. increased productivity, health and safety of users, better fuel use. **Topic A3: Types of unplanned maintenance procedures, their features and impacts** Recognition of unplanned maintenance procedures, including: ● emergency ● run to failure ● condition-based ● post-fault. Impacts, e.g. cost, increased risk of further unplanned maintenance.

What needs to be learnt

Learning aim B: Be able to resource and plan a maintenance activity on an engineering product or system

Topic B1: Identification of resources

Identification and selection of appropriate resources for a planned maintenance activity, e.g.:

- permit to work
- personal protective equipment/health and safety considerations
- maintenance checklists
- equipment manuals
- fault-finding aids
- appropriate spares/materials/consumables
- appropriate test equipment and tools
- machine/process records
- production schedules
- handover documents.

Topic B2: Maintenance planning

The purpose and features of elements of a straightforward and detailed maintenance plan for a planned maintenance activity on an engineering product or system.

Straightforward maintenance plan, including:

- frequency of maintenance
- identification of planned repairs/replacements
- identification of risks and associated hazards, identification of and inclusion of controls.

Detailed maintenance plan (in addition to the straightforward maintenance plan), e.g.:

- environmental issues
- estimation of costs
- reasons for selecting different frequency rates for specific maintenance – on shift/daily/weekly/monthly/yearly routines
- downtime for maintenance
- impact on other systems.

Engineering product, e.g.:

- garden machinery (mower, strimmer or hedge cutter)
- bench drill
- lathe
- compressor.

Engineering system, e.g.:

- lighting system
- fluid/plumbing system
- safety system
- computer network.

What needs to be learnt

Learning aim C: Be able to carry out a maintenance activity safely on an engineering product or system

Topic C1: Maintenance activity

Safely undertake a maintenance activity, using maintenance documentation to plan the activity, on an engineering product or system.

Use maintenance documentation to carry out a maintenance activity, including:

- identifying risks and associated hazards and implementing controls
- manufacturers' manuals, drawings, charts and diagrams, checklists, planning sheets, instructions, schedules
- using and recording information, e.g. maintenance logs, manufacturers' records, other records
- handover documents
- fault-finding aids.

Types of checks, e.g.:

- visual checks, e.g. leakage, damage, missing parts, overheating, wear/deterioration
- fault-finding techniques, e.g. six point, half split, input/output, unit substitution
- mechanical checks, e.g. correct operation of moving parts, correct working clearance of parts, belt/chain tension, bearing loading, torque loading of fasteners
- electrical checks, e.g. continuity, polarity, protective conductor resistance value, voltage levels, load current, inductance; electronic checks such as resistance, capacitance, waveform, frequency values, amplification, signal.

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Know about causes and effects of equipment failure and types of maintenance procedures			
1A.1 Describe the causes of engineering equipment failures.	2A.P1 Explain the causes and effects of engineering equipment failures.		
1A.2 Outline the key differences between planned and unplanned maintenance procedures.	2A.P2 Describe types of planned and unplanned maintenance procedures.	2A.M1 Explain the benefits of planned maintenance procedures and the impact of unplanned maintenance procedures.	
Learning aim B: Be able to resource and plan a maintenance activity on an engineering product or system			
1B.3 Identify the resources required to carry out a planned maintenance activity on an engineering product or system.	2B.P3 Describe the resources required to carry out a planned maintenance activity on an engineering product or system.	2B.M2 Explain why resources are required to carry out a planned maintenance activity on an engineering product or system.	2B.D1 Justify the resources and planning used to carry out a planned maintenance activity on an engineering product or system.
1B.4 Produce a straightforward maintenance plan for an engineering product or system.	2B.P4 Produce a detailed maintenance plan for an engineering product or system.		

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim C: Be able to carry out a maintenance activity safely on an engineering product or system			
1C.5 Carry out a maintenance activity on an engineering product or system. *	2C.P5 Carry out a maintenance activity on an engineering product or system and complete documentation. *#	2C.M3 Carry out a maintenance activity on an engineering product or system accurately, complete detailed documentation and describe the types of checks necessary. *#	2C.D2 Justify the use of documentation and checks carried out during a maintenance activity. *#

*Opportunity to assess mathematical skills

#Opportunity to assess English skills

Teacher guidance

Resources

The special resources needed for this unit are:

- access to a workshop environment and appropriate equipment, systems, devices and components required to carry out engineering maintenance activities (essential)
- relevant manufacturers' service manuals, data sheets, parts lists, diagrams and drawings
- relevant test instruments, tools and safety equipment (as appropriate equipment), systems, devices and components used.

Assessment guidance

This unit is assessed internally by the centre and externally verified by Pearson. Please read this guidance in conjunction with *Section 8 Internal assessment*.

Evidence of learners' achievement of the learning aims and related assessment criteria could be collected from two assignments. These assignments could require learners to start with gaining an appreciation of the types of maintenance activities and the reasons why equipment failures occur. This could be followed by a maintenance activity that allows learners to plan and resource maintenance for a given product, which forms part, or all, of an engineering system. This planning phase should include assessing the potential risks and hazards of carrying out the activity. Finally, they could carry out the maintenance activity. Learners could follow the plan they have developed in 2B.P4 or could be supplied with a different plan.

Centres are required to select one of the engineering products or systems from the range given in the unit content. Systems should be non-complex. If a centre chooses to use a complex product such as a motorbike or car, for example, it might be appropriate for learners to look at a sub-assembly such as the braking system. This could be considered to be a non-complex engineering system.

Due to the practical nature of this unit, evidence such as detailed and referenced teacher observation records, oral questioning and annotated photographs should supplement other forms of evidence, such as written responses, completed checklists and presentations. This direct evidence of process skills should be planned, documented and recorded appropriately and with the level of detail required to show that the full maintenance activity has been carried out appropriately. Learners should evidence, in addition, appropriate health and safety awareness, with assessments of risks completed before any practical activities are carried out.

Level 2 learners are expected to use maintenance documentation when carrying out the maintenance activity. Written evidence of the work carried out, completed documentation, adjustments made to documentation and process, parts fitted and consumables used should be provided.

When describing the causes of equipment failure, level 1 learners could provide their evidence in the form of a checklist, where given examples of failure are cross-referenced to the likely cause. Alternatively, examples that illustrate the failures could be used, combined with verbal questioning of learners, with a record of their responses being used as evidence. When producing their maintenance plan for 1B.4, level 1 learners need only indicate the frequency of maintenance and identify which elements will be checked/repaired/replaced, although they will be expected to incorporate any health and safety elements. When carrying out the maintenance activity, level 1 learners will be expected to work safely. They should demonstrate that, typically, they are able to disassemble/dismantle parts, check for wear/ alignment and adjust as necessary; lubricate parts, replace faulty or worn parts and ensure parameters are to the required specifications.

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 1A.2, 2A.P1, 2A.P2, 2A.M1,	Engineering Maintenance Purposes, Procedures and Resources	You have been asked by your manager to describe and explain the reasons for a range of failures in engineering products, and to explain maintenance strategies used in order to minimise repeat failures.	Written statements outlining and explaining the causes and effects of engineering component failures in a variety of case studies. Written statements describing maintenance strategies and specific procedures that could be used to minimise these failures.
1B.3, 1B.4, 2B.P3, 2B.P4, 2B.M2, 2B.D1	Resource and Plan Out a Maintenance Activity	Your manager has asked you to plan a specific maintenance activity, for presentation to maintenance technicians. The plan is to be used in the maintenance of a sequence of identical components, with the first in the sequence being used as a demonstration.	A portfolio of work that includes identification of the resources, health and safety requirements and the maintenance plan for the engineering product/system, with appropriate justification. A presentation, including photographic evidence showing the maintenance activity being carried out, with commentary explaining the procedure and documentation being used/ completed, and the reasoning for these choices.
1C.5, 2C.P5, 2C.M3, 2C.D2	Carry Out a Maintenance Activity	Your manager has asked you to carry out a maintenance activity and complete documentation.	Practical demonstration, with authentication and witness testimony.

Unit 5: Engineering Materials

Level: **1 and 2**

Unit type: **Optional specialist**

Guided learning hours: **30**

Assessment type: **Internal**

Unit introduction

Have you ever wondered how large commercial aircraft take off and fly thousands of passengers and their luggage to destinations around the world? The answer lies in the ability of skilled engineers to successfully identify and use a range of materials that combine a number of factors, such as strength to weight ratio, cost and availability. Engineering technicians need to be able to identify materials that are specified on engineering drawings, production plans and servicing schedules. Some materials, such as copper and lead, have a distinctive appearance, but others are not so easy to tell apart. This is particularly true of the different grades of steel, polymers, composites, brass and aluminium alloys. Very often, an engineering technician has to select raw materials in the form of wire, bars, sheet, tube and plate and also components such as rivets, nuts and bolts from stores. It is essential for engineers to select the correct material if a product or a replaced component is to be fit for its intended purpose.

This unit will develop your knowledge of a range of common materials you may encounter in engineering, as well as their properties, uses, availability, and how they contribute to a sustainable environment.

You will be expected to identify a range of ferrous, non-ferrous and non-metallic materials and know about the form in which they are obtained. You will also need to know about the properties that make individual materials suitable for particular tasks. You will need to know about the way in which materials are colour coded when stored, as well as other material identification standards that are commonly used, such as the British and European Standard classifications. Armed with this knowledge, and using information, abbreviations and symbols supplied on engineering drawings, you will then be able to select the correct form and size of the material specified for a particular application. You will conduct some tests, to investigate properties of materials and their suitability in engineering applications. You will also be introduced to the sustainability issues that surround the use of a range of engineering materials and come to understand how this is a major consideration when developing products for the present day and in the future.

Learning aims

In this unit you will:

A know about the properties of common engineering materials and selection for engineering applications

B know about the supply and sustainable use of engineering materials and selection for an engineering product or activity.

Learning aims and unit content

What needs to be learnt

Learning aim A: Know about the properties of common engineering materials and selection for engineering applications

Topic A1: Types of engineering materials

- Ferrous metals, e.g. low and medium carbon steels, high carbon steels, stainless steel and cast iron
  - applications include – cutting tools, e.g. drills (carbon steel), cutlery and medical instruments (stainless steel), castings and manhole covers (cast iron).
- Non-ferrous metals, e.g. aluminium, copper, zinc, brass, lead, titanium, tungsten carbide, superalloys (nickel-based and cobalt-based) and ceramics (boron carbide and cubic boron nitride)
  - applications include – aircraft components and kitchenware (aluminium), electrical wiring, cables and pipes (copper), anti-corrosion coatings and batteries (zinc), locks, gears, valves and door knobs (brass), building and construction, weights and radiation shielding (lead), aerospace, military, mobile phones and sporting goods (titanium), industrial machinery, tools and abrasives (tungsten carbide), aerospace and automotive components (superalloys), high performance mechanical and industrial applications, e.g. abrasive cutting tools, nuclear reactor control rods, anti-oxidant refractory mixes and tank armour (boron carbide, cubic boron nitride).
- Composite materials, e.g. plywood, glass reinforced plastic (GRP), medium density fibreboard (MDF) carbon fibre and Kevlar®
  - applications include – floors and roofing (plywood), boats, automobiles, hot tubs, water tanks, roofing, pipes and cladding (GRP), building material, e.g. furniture and kitchen cabinets (MDF), bicycle tyres, racing sails and body armour (Kevlar®).
- Thermoplastics, e.g. acrylic, polyvinyl chloride (PVC), polythene (PET), polystyrene, nylon and polycarbonate
  - applications include – aquariums, aircraft windows and motorcycle helmet visors (acrylic), sewage pipes, plumbing pipes, clothing and upholstery, electrical cable insulation and inflatable products (PVC), packaging, e.g. plastic bags, plastic films and foam insulation (PET), disposable cutlery, plastic models, CD and DVD cases, disposable foam cups, smoke detector housings and insulation for packaging (polystyrene), bristles for toothbrushes, strings for musical instruments, threads, ropes, filaments, nets, hosiery and knitted garments (nylon), electrical and telecommunication components, domelights, flat/curved glazing, sound walls, sunglass/eyeglass lenses, lightweight luggage, computer cases and food/drink containers (polycarbonate).
- Thermosetting polymers, e.g. formica, melamine, epoxy resin and polyester resin
  - applications include – kitchen worktops (formica), kitchen utensils and plates (melamine), moulds, laminates, casting, fixtures, coating and adhesives (epoxy resin), marine construction materials, automotive and aircraft components, luggage, furnishings, textiles and packaging (polyester resin).

continued

What needs to be learnt

- Smart materials, e.g. shape memory alloys (SMAs), shape memory polymers, electrochromic, piezoelectric, quantum tunnelling composite (QTC)
  - o applications include – surgical equipment, dental braces, oil line pipes and eyeglass frames (SMAs), window frame seals, helmets, small scale surgical products (shape memory polymers), smart windows, information displays and eyewear (electrochromic), production and detection of sound, generation of high voltages, electronic frequency generation, ignition source for cigarette lighters and push-start propane barbecues (piezoelectric), electrically conductive clothing (QTC).

Topic A2: Properties of materials

- Mechanical, e.g. density, tensile strength, shear strength, hardness, toughness/brittleness, malleability/ductility, elasticity and plasticity.
- Electromagnetic, e.g. electrical conductivity, electrical resistance, paramagnetism/diamagnetism/ferromagnetism.
- Chemical, e.g. resistance to corrosion and environmental degradation, reactivity.
- Thermal, e.g. melting point, thermal conductivity and thermal expansion.

Topic A3: Suitability of materials in engineering applications

- Simple mechanical tests e.g. tensile/ductility test (loading a suspended wire specimen and recording the breaking load and amount of permanent extension), shear strength test (using bench shears or tin snips), hardness test (centre punch, file or saw used to assess surface hardness or a test in which a hardened steel ball bearing is dropped from a given height and its rebound measured to assess surface hardness), impact test (striking a specimen held in a vice with a hammer and noting its effect).

Topic A4: Heat treatment processes

- Processes that rely on heating to a certain temperature, time at that temperature, speed of cooling, for ferrous materials e.g. annealing, normalising, hardening, tempering, case hardening.

Learning aim B: Know about the supply and sustainable use of engineering materials and selection for an engineering product or activity

Topic B1: Selection for applications

Selection through activity, e.g. design, construction, manufacture, operations, or maintenance.

Selection through use in a product, e.g. an engineered product consisting of multiple production methods and forms of supply, such as a bicycle or office chair.

Topic B2: Sustainable use of materials

- Raw materials extraction and processing.
- Lower volatile organic compounds.
- Reducing material use.
- Reusing materials and products where applicable.
- Recycling materials or using recycled materials.
- Waste management.

What needs to be learnt

Topic B3: Forms of supply

- Symbols, abbreviations and identification coding, e.g. International Organisation for Standardisation (ISO), British Standards Institution (BSI) materials coding system, suppliers' and organisations' colour codes.
- Material selection, e.g. bright drawn mild steel bar, solid diameters, pipe/tube diameters and wire gauges.
- Metal forms, e.g. bar stock, sheet materials, pipe/tube, wire, plate, rolled steel sections, pressings, castings, ingots, forgings and extrusions.
- Polymers/composite forms, e.g. sheet, pipe/tube, mouldings, powders, granules, resins and film.
- Size, e.g. diameters, thickness and gauge.
- Surface finish, e.g. bright drawn, cold drawn, plated, painted and plastic coated.

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Know about the properties of common engineering materials and selection for engineering applications			
1A.1 Identify an example of each type of material used in given engineering applications.	2A.P1 Describe examples of each type of material and the properties of these materials in engineering applications.	2A.M1 Explain the choice of material for engineering applications.	2A.D1 Compare advantages and disadvantages of material choices for engineering applications.
1A.2 Carry out a simple mechanical test on an engineering material	2A.P2 Carry out a range of simple mechanical tests on engineering materials and interpret the results		
1A.3 Describe a heat treatment process to alter a ferrous materials property.	2A.P3 Describe two heat treatment processes that alter a ferrous materials properties.		
Learning aim B: Know about the supply and sustainable use of engineering materials and selection for an engineering product or activity			
1B.4 Outline the environmental impact of a given engineering product or activity.	2B.P4 Describe sustainable use of materials in a given engineering product or activity.	2B.M2 Assess whether materials have been used sustainably in an engineering product or activity.	2B.D2 Analyse the sustainability of an engineering product or activity, including materials used and forms of supply. *
1B.5 Identify the forms of supply for materials in an engineering product or activity. *	2B.P5 Select appropriate forms of supply for materials in a given engineering product or activity. *	2B.M3 Justify the selected forms of supply for materials in an engineering product or activity. *	

*Opportunity to assess mathematical skills #Opportunity to assess English skills

Teacher guidance

Resources

The special resources needed for this unit are:

- a range of materials in their different forms of supply for identification and demonstration purposes
- a variety of finished components, which illustrate the application of particular materials
- standard workshop tools and equipment used for informal testing, engineering drawings, parts lists and service manuals to assist learners in the identification of materials.

Assessment guidance

This unit is assessed internally by the centre and externally verified by Pearson. Please read this guidance in conjunction with *Section 8 Internal assessment*.

Evidence of achievement of the learning aims and assessment criteria may be obtained from well-planned investigative assignments or reports of workshop activities. Alternatively, it may be accumulated by learners building a portfolio from investigations and observations in the workplace or through realistic exercises and tests. In either case, the opportunity should exist for learners to achieve Merit and Distinction grades with relevant and sufficient evidence to justify the grade awarded. It is anticipated that integrative assignments might be used to link this unit with other, more practical or project related, units in the programme. If this approach is adopted, the evidence for the specific learning outcomes and associated assessment criteria will need to be clearly and separately identified.

To achieve learning aim A at level 2, learners must consider at least two examples of each type of material and the use of each example for appropriate applications. Learners should undertake tests to determine mechanical properties. A PowerPoint presentation could be used to specify the materials and their associated properties.

Level 1 learners will identify one example of each type. Evidence of this could come from a completed checklist. Learners will carry out one test but will not relate this to the materials in the content. They should also be able to describe one heat treatment process.

To achieve learning aim B, learners should be presented with an engineering product or activity with multiple production processes and forms of supply. Learners could be asked to produce an A3 poster detailing the environmental impact of production.

Learners could create a presentation specifying the forms of supply and sustainable use of materials for a chosen engineering product or activity. Learners could prepare supporting notes for the presentation, justifying the forms of supply and sustainable methods used.

A case study for a given engineering product or activity could be studied in depth to examine the materials and methods used for construction or development. A report could be produced that evaluates the chosen materials and methods of sustainability and puts forward measures for improvement.

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 1A.2, 1A.3 2A.P1, 2A.P2, 2A.P3 2A.M1 2A.D1	Properties of Engineering Materials and their Applications	You have been asked by your supervisor to prepare a presentation to your peers about different types of engineering materials, their properties and their applications. You will conduct some tests on the materials and interpret the results. You will be asked to describe some heat treatment processes.	PowerPoint® presentation. Materials list. Report.
1B.4, 1B.5 2B.P3, 2B.P5 2B.P4, 2B.M3 2B.D2	Identifying Engineering Materials	You are an engineer working for a local bicycle manufacturer, and are asked to investigate the production process of a bicycle. In your investigation you will identify the materials used and the possible impacts of the development on the environment. You will come up with suggestions to reduce the environmental impact. You will select the most appropriate forms of supply for the materials in a bicycle.	Table of abbreviations, codes and symbols. A3 poster. PowerPoint® presentation and notes. Report.

Unit 6: Computer-aided Engineering

Level: **1 and 2**

Unit type: **Optional specialist**

Guided learning hours: **30**

Assessment type: **Internal**

Unit introduction

Have you ever wondered what computer-aided engineering (CAE) is and how it is used in engineering and manufacturing? Computer-aided design (CAD) and computer-aided manufacture (CAM) are two key CAE technologies that have replaced some traditional techniques in engineering manufacture. By using computer technology in their manufacturing systems, products and service engineering industries can remain competitive in the modern global economy.

In this unit, you will be given opportunities to learn about CAE by designing and producing drawings of a simple component and circuit using CAD. You will also produce a CAE component using CAM software linked to computer-controlled machine tools.

You will use CAD software to design and create a working drawing of an engineering component. In addition, you will demonstrate the many uses of CAD software by creating a simple circuit diagram – either electrical/electronic, hydraulic or pneumatic – using standard component symbols. You will then convert the CAD data into a computer numerical control (CNC) program using appropriate techniques.

Once the CNC operating program is developed, you will use it to produce a component, setting work coordinates and tooling/work holding as required to enable production. Then, you will check the component for quality in terms of its accuracy.

Learning aims

In this unit you will:

A use a CAD system to produce engineering drawings

B use a CAM system to manufacture an engineering component.

Learning aims and unit content

What needs to be learnt
Learning aim A: Use a CAD system to produce engineering drawings
Topic A1: Use of a CAD system to produce an engineering drawing Use the basic and advanced features of a CAD system, including: ● basic drawing commands and editing commands to produce and erase lines, circles, text ● outputting to a printer/plotter device ● appropriate tools to allow accurate geometry definition ● manipulation of views, including zoom and pan options ● saving the drawing data in an appropriate format ● modification and manipulation of drawn features, including scaling, revolving/rotating, copying/duplicating and moving ● dimensioning and hatching ● drawing template, typically to include a border, title block, projection, scale, drawing number, title of drawing, material, names of drawing creator and who checks/authorises the drawing ● produce drawings to BS8888 standards ● further CAD commands, including erase, stretch, trim, scale; absolute, relative and polar co-ordinates, features, e.g. type of line, grid, snap, circle, text, hatch, zoom-in, zoom-out. **Topic A2: Use of a CAD system to produce a circuit diagram** Circuit design techniques using a CAD system, including: ● basic drawing, insertion and editing commands to produce and erase circuit components and connections ● outputting to a printer/plotter device ● appropriate tools to allow accurate geometry definition ● standard symbols used in circuit diagrams ● saving the drawing data in an appropriate format ● circuit diagrams to standard, e.g. BS EN 60617, BS 2917 ● annotation of circuit diagrams to include component name or description ● CAD commands, including copy/duplicate, move, rotate/revolve, erase, stretch, trim, scale; absolute, relative and polar co-ordinates, features, e.g. type of line, grid, snap, circle, text, hatch, zoom-in, zoom-out.

What needs to be learnt
Learning aim B: Use a CAM system to manufacture an engineering component
Topic B1: Use of a CAM system Component features of a CAM system, including: ● how CAM programs are loaded into a CNC machine, e.g. turning centres, milling machines, machining centres, fabrication machines, electrical discharge machining (EDM – die and wire machines), grinding, rapid prototyping/3D printing ● production of components ● comparison of components produced against specification, conformity with the design specification, e.g. unilateral and bilateral tolerances, direct measurement, use of measurement equipment, e.g. rulers, callipers, micrometers, slip gauges ● cutting tool data and machining information ● use of CAD drawings to produce files suitable for use by a CAM system ● tool changes, 3D co-ordinate systems, efficient cutter paths ● conversion of cutter path data into CNC code.

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Use a CAD system to produce engineering drawings			
1A.1 Produce a CAD drawing of an engineering component using a CAD system.	2A.P1 Produce a fully dimensioned CAD drawing of an engineering component using basic and further CAD commands and BS conventions.		
1A.2 Produce a circuit diagram using a CAD system.	2A.P2 Produce a circuit diagram fully labelling all components using basic and further CAD commands and BS conventions.		
1A.3 Identify drawing and modification commands used to produce engineering component and circuit diagrams.	2A.P3 Describe drawing and modification commands used to produce engineering component and circuit diagrams.	2A.M1 Explain the importance of drawing and modification commands and the benefits when used to produce engineering components and circuit diagrams.	2A.D1 Justify the use of CAD in the production of engineering component drawings and circuit diagrams.

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning Aim B: Use a CAM system to manufacture an engineering component			
1B.4 Load CAD data from a drawing into a CNC machine in order to produce an engineering component.	2B.P4 Produce an engineering component by converting CAD data into an appropriate CNC program and loading the program into a CNC machine.		
1B.5 Check a component, produced using a CNC machine, for conformity with the design specification. *	2B.P5 Describe how the component produced meets the design specification. *	2B.M2 Simulate component production, identify improvements in programs and suggest solutions.	2B.D2 Evaluate CAM as a means of producing different engineered components.

*Opportunity to assess mathematical skills

#Opportunity to assess English skills

Teacher guidance

Resources

The special resources required for this unit are:

- Access to a computer-aided design facility, including computers loaded with appropriate CAD software. In addition, access to a printer/plotter to produce hard copies would assist in assessment.
- Computer-controlled machines. These might be CNC machines, such as lathes, milling machines, routers, and laser cutters; although other machines such as rapid prototyping/3D printers would also be beneficial. It is important that learners have access (for assessment) to at least one type of computer-controlled machine that can be programmed or accept the data developed from a CAD drawing, where they can, for example, set the offsets/tool changes and feeds/speeds. Where resources are not directly available, it may be possible to engage local industry, colleges or universities to support the delivery of this unit.

Assessment guidance

This unit is assessed internally by the centre, and externally verified by Pearson.

Please read this guidance in conjunction with *Section 8 Internal assessment*.

Evidence of learners' achievement of the learning aims and related assessment criteria could be collected from two assignments. These assignments could require learners to produce evidence such as a portfolio of drawings and records of activities in a workshop environment, where the use of computer-controlled machines and the use of CAM software can be shown. Due to the practical nature of this unit, evidence such as learner observation records, screenshots, oral questioning and annotated photographs could supplement other forms of evidence. This direct evidence of process skills should be planned, documented and recorded appropriately. In addition, appropriate health and safety awareness should be evidenced by learners, with risk assessments being checked, before any practical activities are undertaken.

For learning aim A, drawings should be saved, in an appropriate format, to an appropriate storage device or network system. Learners should print or plot hard copies of the final drawings to an appropriate scale, and it would be expected that, whilst not necessarily being fully dimensioned, overall sizes would be indicated on the drawing. While a printed version of the final drawing/drawings would be expected, screen shots showing drawing development could be used as supporting evidence. A commentary should be provided, detailing the techniques that can be used.

For learning aim B, learner observations, witness testimonies, and annotated photographs could be used as evidence.

Level 2 learners should produce a drawing of an engineering component and a circuit diagram using a full range of commands as shown in the unit content and which meets British Standards. They will need to describe these commands. They should also be able to convert CAD data into an appropriate program for loading on to a CNC machine. Although many different CNC machines could be available, only one needs to be used for the manufacture of the engineering component. At this level the learner would also need to describe how the manufactured component is fit for purpose.

Level 1 learners should produce a drawing and circuit diagram using a basic range of CAD commands and would be able to identify those used. They will need to load the data into a CNC machine and check the manufactured component against the design specification (drawings etc).

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance, and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 2A.P1	CAD Component Drawing	Your manager has asked you to produce a CAD drawing of a given component using basic and further CAD commands. This needs to include a supporting presentation describing the range of CAD drawing and modification tools used across a range of drawings and the use of BS conventions. You will need to justify the use of CAD in the production of these drawings.	A portfolio containing a drawing or drawings, including: • screen grabs • written statements • annotations. Supporting evidence for higher grades should include teacher observations and presentation slides.
1A.2, 2A.P2	Circuit Diagram	Your work was well received and, as a result, your manager has asked you to produce a circuit diagram using basic and further CAD commands, fully labelling all components using appropriate BS conventions.	A printout or plot of a circuit constructed using CAD techniques.
1A.3, 2A.P3, 2A.M1, 2A.D1	Drawing and Modification Techniques	You have been asked to describe drawing and modification commands to a colleague.	A checklist with commands and explanations.
1B.4, 1B.5, 2B.P4, 2B.P5, 2B.M2, 2B.D2	Safe Use of Computer-aided Manufacture Techniques	To conclude, your manager has asked you to produce an engineering component using CNC techniques, including a simulation of the activity. You will also need to identify errors, and suggest solutions as well as be able to justify the use of CAM in an engineering environment. You should describe how your component is fit for purpose.	A portfolio containing a range of evidence, including teacher observations/witness testimonies, annotated photographs/screen grabs, presentation slides. This should be accompanied by evidence of component manufacture and software simulation. In addition, presentation slides outlining the key advantages to the organisation of using CAM techniques should be provided.

Unit 7: Machining Techniques

Level: **1 and 2**

Unit type: **Optional specialist**

Guided learning hours: **60**

Assessment type: **Internal**

Unit introduction

Did you know that you can use lathes or milling machines and drills in different ways when you are machining engineered products? The machines that you will use as part of this unit are some of the most important pieces of engineering equipment. Most modern Computer Numerically Controlled (CNC) machine tools have been developed from conventional lathes, milling machines and drills.

This unit will help you to understand the engineering processes that we use to generate and form shapes through machining techniques.

You will learn how to select, investigate and use machining techniques that involve shaping or forming with loss of volume. You will also use work-holding devices and a range of tools so that you can carry out a variety of machining processes.

You will learn how to set the machines before you use them and how to monitor the machines while you are using them. You will also learn how to inspect the items you produce for compliance and accuracy.

Health and safety is vital. Therefore, you will also learn how to operate machinery safely.

Learning aims

In this unit you will:

A select and use tools and work-holding devices for drilling and for turning or milling

B make workpieces using drilling and turning or milling techniques safely.

Learning aims and unit content

What needs to be learnt
Learning aim A: Select and use tools and work-holding devices for drilling and for turning or milling
Topic A1: Tools Tools for specific drilling and turning or milling techniques: ● for drilling – simple tools, e.g. centre drill, drill bit; more complex tools, e.g. flat-bottomed drill, counterboring tool, countersinking tool, reamer, tap ● for turning – simple tools, e.g. turning tools, facing tools; more complex tools, e.g. form tools, parting off tools, single point threading, boring bar, recessing tool, centre drill, twist drill, reamer, tap, die, knurling tool ● for milling – simple tools, e.g. face mills, end mills; more complex tools, e.g. slot drills, slotting cutters, slitting saws, profile cutters, twist drills, reamer, boring tools ● tooling materials – high-speed steel, cobalt steel, tungsten carbide, diamond. **Topic A2: Work-holding devices** Work-holding devices for drilling and for turning or milling: ● for drilling – simple work-holding device, e.g. machine vice; more complex work-holding devices, e.g. clamping direct to machine table, angle plate, vee block and clamps. ● for turning – simple work-holding device, e.g. three jaw chuck with hard jaws; more complex work-holding devices, e.g. four jaw chuck with hard jaws, centres (live or dead), faceplate, fixed steady or travelling steady ● for milling – simple work-holding device, e.g. machine vice; more complex work-holding devices, e.g. clamping direct to machine table, angle plate, vee block and clamps, indexing head/device, rotary table.

What needs to be learnt

Learning aim B: Make workpieces using drilling and turning or milling techniques safely

Topic B1: Features of the workpiece

Use of drilling and turning or milling techniques for producing features in a workpiece:

- for drilling – simple features, e.g. through holes, blind holes; more complex features, e.g. flat-bottomed holes, counterbored holes, countersinking, reaming, tapping
- for turning – simple features, e.g. flat faces, parallel diameters; more complex features, e.g. stepped diameters, tapered diameters, drilled holes, bored holes, reamed holes, profile forms, internal threads, external threads, parting off, chamfers, knurls, grooves, undercuts
- for milling – simple features, e.g. flat faces, square faces; more complex features, e.g. parallel faces, angular faces, steps/shoulders, open-ended slots, enclosed slots, recesses, tee slots, drilled holes, bored holes, profile forms, serrations, indexed or rotated forms.

Topic B2: Machining parameters

Parameters for drilling and turning or milling techniques:

- for drilling – positional, e.g. position of workpiece, position of tool in relationship to workpiece; dynamic, e.g. tooling revolutions per minute (speed), linear feed rate (feed), swarf clearance
- for turning – positional, e.g. position of workpiece, position of tools in relationship to workpiece; dynamic, e.g. workpiece revolutions per minute (speed), linear feed rate (feed), depth of cut for roughing and finishing, swarf clearance
- for milling – positional, e.g. position of workpiece, position of tools in relationship to workpiece; dynamic, e.g. milling cutter revs per minute (speed), linear/table feed rate (feed), depth of cut for roughing and finishing, swarf clearance.

Topic B3: Checks for compliance and accuracy

Checks for accuracy relevant to drilling and turning or milling techniques:

- for drilling – visual checks, e.g. workpiece to be free from false tool cuts, burrs and sharp edges removed; specific checks, e.g. dimensional tolerance equivalent to BS EN 22768-1 or BS 4500, surface texture 1.6µm (63 µin), reamed holes within H8, screw threads BS medium fit
- for turning – visual checks, e.g. workpiece to be free from false tool cuts, burrs and sharp edges removed; specific checks, e.g. dimensional tolerance equivalent to BS EN 22768-1 or BS 4500, surface finish 1.6µm (63 µin), reamed or bored holes within H8, screw threads BS medium fit, angles within +/- 1.0 degree
- for milling – visual checks, e.g. workpiece to be free from false tool cuts, burrs and sharp edges removed; specific checks, e.g. dimensional tolerance equivalent to BS EN 22768-1 or BS 4500, surface finish 1.6µm (63 µin), flatness and squareness within 0.125mm per 25mm, angles within +/- 1.0 degree.

continued

What needs to be learnt

Topic B4: Working safely

General safety awareness while carrying out drilling and turning or milling techniques, including:

- alertness to moving parts
- ensuring machine guards are in place
- use of emergency stop
- machine isolation
- wearing appropriate personal protective equipment (PPE)
- keeping a clean and tidy work area
- removing burrs or sharp edges
- identification of risks, associated hazards and their control.

Safe working practices relevant to drilling and turning or milling techniques:

- for drilling – handling drilling tools, tool breakage procedure, swarf handling and disposal, cutting fluids
- for turning – handling turning tools, tool breakage procedure, swarf handling and disposal, backlash in machine slides, cutting fluids
- for milling – handling milling tools, tool breakage procedure, swarf handling and disposal, backlash in machine slides, cutting fluids.

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Select and use tools and work-holding devices for drilling and for turning or milling			
1A.1 Outline the functions of simple tools used for drilling and turning or milling.	2A.P1 Describe the functions of simple and complex tools used for drilling and turning or milling.	2A.M1 Explain why particular tools and work-holding devices are useful for different drilling and turning or milling tasks.	2A.D1 Evaluate the effectiveness of tools and work-holding devices for different drilling and turning or milling tasks.
1A.2 Use simple tools for accurate drilling and turning or milling.	2A.P2 Select and use simple and complex tools for accurate drilling and turning or milling.		
1A.3 Use a simple work-holding device for accurate drilling and turning or milling.	2A.P3 Select and use simple and complex work-holding devices for accurate drilling and turning or milling.		

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim B: Make workpieces using drilling and turning or milling techniques safely			
1B.4 Set positional parameters before machining workpieces by drilling and turning or milling techniques.	2B.P4 Set positional parameters before machining and set and monitor dynamic parameters during machining by drilling and turning or milling techniques.		
1B.5 Produce two given machined workpieces that demonstrate simple features of drilling and turning or milling techniques. *	2B.P5 Produce two machined workpieces that demonstrate simple and complex features of drilling and turning or milling techniques. *	2B.M2 Demonstrate high levels of precision and accuracy when using drilling and turning or milling techniques. *	2B.D2 Assess own levels of precision and accuracy, identifying strengths and weaknesses and safe working practices. *
1B.6 Describe and carry out visual checks made for compliance on a machined workpiece according to instructions.	2B.P6 Describe and carry out visual and specific checks carried out for compliance and accuracy when producing the machined workpieces.	2B.M3 Explain why it is important to carry out checks on the accuracy of workpiece features both during and after manufacture.	
1B.7 Demonstrate safe practice when using drilling and turning or milling techniques.	2B.P7 Demonstrate consistency in safety awareness and safe working practices when machining workpieces.	2B.M4 Explain the importance of safe working practices when using drilling and turning or milling techniques.	

*Opportunity to assess mathematical skills

#Opportunity to assess English skills

Teacher guidance

Resources

The special resources required for this unit are:

- access to centre lathes and/or vertical milling machines and pedestal drills/pillar drills/drill presses, as required by the learning aims and unit content
- auxiliary equipment (such as that listed under 'work-holding devices' and 'tools')
- a range of equipment suitable for measuring the accuracy of the workpieces to be machined.

Assessment guidance

This unit is assessed internally by the centre and externally verified by Pearson. Please read this guidance in conjunction with *Section 8 Internal assessment*.

For this unit, learners need to provide evidence of either turning or milling, as well as drilling machining techniques. It is not necessary or appropriate for learners to cover all three machining techniques.

Learners need to provide a variety of evidence to demonstrate competence. This evidence could be in the form of witness statements, detailed learner observation records, annotated photographs or drawings of components and diaries/logs.

For 2B.P4 and 2B.P5, level 2 learners must use both drilling and turning or milling techniques to correctly set up and machine two given workpieces, in order to produce two different simple features and at least four different complex features for both the techniques covered and as defined by the workpieces.

It would be advisable to provide each learner with two working drawings – one for a turned/milled component and one for a drilled component.

For 1B.4, level 1 learners need to set the workpiece position (for example, the length of bar from a lathe chuck) and tool position (for example, the centre height on a lathe) prior to machining. To achieve 1B.5, learners need to produce two different simple features, such as through and blind holes for drilling, as defined by the unit and the two simple features for the chosen technique, such as flat faces and parallel diameters for turning or flat and square faces for milling.

A similar approach and interpretation should be taken when setting tasks for the criteria associated with learning aim A. However, there is also a need for level 2 learners to describe the functions of a range of tools and for level 1 learners to outline the functions of simple tools.

The evidence for 1B.6/2B.P6 is likely to be in the form of descriptions and a table of recordings/checks/measurements, with annotated photographs confirming that checks took place, both in-process and on the final workpieces. The tasks provided for learners should make it clear that these checks should not only take place when a given workpiece is complete, but that ongoing in-process checks are also required.

In the same way, evidence for 1B.7 and 2B.P7 is likely to be in the form of observation records or witness statements supplemented by annotated photographs of safe working.

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment	Scenario	Assessment evidence
1A.1, 1A.2, 1A.3, 2A.P1, 2A.P2, 2A.P3, 2A.M1, 2A.D1	Work-holding Devices and the Use/Types of Machining Tools	An employer has asked you to undertake some work with turning/milling and drilling machinery. In preparation, you have been asked to outline and describe the functions of tools and the selection of work-holding devices.	A written response with diagrams. Witness statements, detailed learner observation records, annotated photographs, diaries/logs, and a written response with annotated photographs. Written explanation and evaluation.
1B.4, 1B.5, 1B.6, 1B.7, 2B.P4, 2B.P5, 2B.P6, 2B.P7, 2B.M2, 2B.M3, 2B.M4, 2B.D2	Parameters, Techniques, Safe Working Practices and Accuracy Checks when Machining Workpieces	An employer wants you to start work. You need to: • set/monitor parameters before/during machining • describe how to carry out workpiece accuracy checks during/after machining and explain why it is important • carry out workpiece compliance/accuracy checks • machine two workpieces • demonstrate safe working practices.	Witness statements, detailed learner observation records, annotated photographs, diaries/logs, and a written response with annotated photographs. A table of recordings plus annotated photographs. Observation/witness statements, detailed learner observation records, annotated photographs, diaries/logs.

Unit 8: Electronic Circuit Design and Construction

Level: **1 and 2**

Unit type: **Optional specialist**

Guided learning hours: **60**

Assessment type: **Internal**

Unit introduction

In our world, we are surrounded by electronic devices that make life safer, more comfortable, more entertaining and more convenient.

Have you ever wondered how something as small as a mobile phone can do so much, or how computers can retrieve information from anywhere in the world in seconds? None of the things we take for granted, such as watching television, listening to the radio, downloading music to personal devices or playing computer games, would be possible without the work of electronic engineers. Programmable domestic devices such as washing machines and microwave ovens use electronic control and on a larger scale the UK's military, financial, communication and commercial business systems rely on state-of-the-art electronics to operate successfully.

Almost all electronic circuits can be broken down into input, process and output blocks and you will learn to recognise and use some of the components that are classified in this way. You will learn about their function and application and how they can combine to make more complex electronic systems.

You will learn to design electronic circuits using input, process and output building blocks to solve problems and you will build circuits, working safely, and using permanent construction methods. You will also learn how to ensure that your construction methods are effective and are carried out using appropriate circuit boards.

In order to check the function of the circuits you have built, you will learn how to test them using appropriate test equipment.

Learning aims

In this unit you will:

A know about electronic systems design

B design and construct electronic circuits using electronic building blocks

C know how to populate circuit boards permanently and construct electronic circuits safely

D test and evaluate electronic circuits.

Learning aims and unit content

What needs to be learnt

Learning aim A: Know about electronic systems design

Topic A1: Input components

Identification, function and application of input components used in electronic circuits, including:

- sensors – light dependent resistor (LDR), thermistor (negative temperature coefficient – NTC), moisture sensor, piezo electric sensor
- switches – toggle, slide, rocker, push-to-make, push-to-break, key, micro, tilt.

Topic A2: Process components

Identification, function and application of process components used in electronic circuits, including:

- transistor (NPN and PNP)
- Darlington Pair
- thyristor
- field effect transistor (FET)
- 555 timer – in monostable and astable modes
- operational amplifier (Op-Amp)
- Peripheral Interface Controllers (PICs): how to program PICs using flowcharts to switch outputs on and off from input signals, create routines to control outputs with delays, and repeat loops and counts.

Topic A3: Output components

Identification, function and application of output components used in electronic circuits, including:

- lamp/bulb
- buzzer
- light emitting diode
- loudspeaker
- motor
- 7-segment display.

Topic A4: Passive components

Identification, function and application of passive components used in electronic circuits, including:

- fixed resistor (including resistor colour code and British Standard BS 1852, EN 60062), coding method to determine resistor values and tolerance
- variable resistor
- polarised capacitors
- non-polarised capacitors
- diode – used as a protective device against back voltage from electro-magnetic components
- relay – used as an interface between primary and secondary circuits.

continued

What needs to be learnt

Topic A5: Power

Power supplies, units of measurement and calculations for electronic circuits.

Identification, characteristics, application and advantages/disadvantages of power supplies used in some electronic circuits, including:

- batteries – zinc-carbon, alkaline, NiCad rechargeable, button cells
- low voltage power supply units – PSU
- solar power – when powering low current circuits.

Units of measurement:

- current (amp)
- resistance (ohm)
- voltage (volt)
- power (watt).

Application of the units and formulae when calculating values relating to electronic circuits, including:

- simple calculations:
  - Ohm's law – V = I x R in parallel circuits consisting of two resistors
  - resistors in series – Rtotal = R1 + R2 + R3 etc.
  - time period – t = R x C
  - power – W = I x V
- complex calculations:
  - Ohm's law – V = I x R in series circuits consisting of two resistors
  - resistors in parallel – Rtotal = (R1 x R2)/(R1 + R2).

What needs to be learnt

Learning aim B: Design and construct electronic circuits using electronic building blocks

Topic B1: Circuit design

Design an electronic circuit using input, process and output components, for example:

- a low temperature alarm that will give a warning when the temperature falls below a pre-set level, including –
  - input – thermistor and fixed/variable resistor
  - process – single transistor/Darlington Pair/Op-amp
  - output – buzzer/LED/lamp
- a timing circuit that gives a flashing LED or pulsing sound output after a set time period, including –
  - input – capacitor and variable resistor
  - process – 555 timer (monostable), 555 timer (astable)
  - output – LEDs/loudspeaker
- a circuit to count people passing through a sports stadium barrier, including –
  - input – push-to-make switch and fixed resistor
  - process – programmed PIC
  - output – 7 segment display.

Topic B2: Circuit board construction

Applications, advantages/disadvantages and construction of a circuit using an appropriate circuit board, including:

- prototyping board (breadboard)
- stripboard (veroboard)
- printed circuit board (PCB)
- mass production, miniaturisation and surface mount technology (SMT).

continued

What needs to be learnt
Learning aim C: Know how to populate circuit boards permanently and construct electronic circuits safely
Topic C1: Circuit soldering techniques Use appropriate techniques for soldering components into an electronic circuit and dealing with exposed component legs, including: ● soldering using multi-core lead-free soldering technique to avoid dry joints ● tinning component legs and multi-strand wire using heat sinks and shunts ● using IC sockets and heat shrink sleeving or insulation tape. **Topic C2: Risk assessments** Specify risks and control measures appropriate to the engineering activity (handling soldering equipment), including: ● identifying hazards ● deciding who might be at harm and how ● evaluation of the risks and appropriate control measures ● recording of findings and implementation ● full Health and Safety Executive (HSE) risk assessment.
Learning aim D: Test and evaluate electronic circuits
Topic D1: Testing electronic circuits Testing and evaluating electronic circuits to check voltage levels, continuity and current, and to identify and diagnose faults, including use of: ● a voltmeter or multimeter to measure voltage levels across components and power supplies in a circuit ● an ohmmeter or multimeter to check for continuity in circuit tracks and wires, and to detect breaks and bridges in connections ● an ammeter or multimeter to measure current levels in a circuit ● a logic probe to test digital signal levels when using PICs.

Assessment criteria

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim A: Know about electronic systems design			
1A.1 Describe the function and characteristics of electronic input, process, output and passive components.	2A.P1 Select and apply appropriate input, process and output, and passive components for a circuit.	2A.M1 Explain reasons for the selection of electronic input, process, output and passive components.	2A.D1 Justify the selection of appropriate input, process and output components in a circuit design to solve a given electronics problem.
1A.2 Carry out simple calculations using units of current, resistance, voltage and power.	2A.P2 Describe the characteristics of power supplies and carry out simple and complex calculations using units of current, resistance, voltage and power in electronic circuits. *		
Learning aim B: Design and construct electronic circuits using electronic building blocks			
1B.3 Identify components in a given circuit diagram.	2B.P3 Describe the design features of a simple circuit diagram that uses input, process and output components.	2B.M2 Explain the operation of the circuit in terms of its input, process and output components.	2B.D2 Explain the limits of operation of the circuit in terms of its input, process and output components.

Level 1	Level 2 Pass	Level 2 Merit	Level 2 Distinction
Learning aim C: Know how to populate circuit boards permanently and construct electronic circuits safely			
1C.4 Identify the main hazards and people at risk when using soldering equipment.	2C.P4 Describe the risks associated with identified hazards when using soldering equipment.	2C.M3 Explain, with reference to particular soldering activities, the risks involved and record appropriate control measures.	2C.D3 Using a full risk assessment, evaluate all activities in the production of electronic circuits.
1C.5 Identify the main features of a given electronic circuit.	2C.P5 Describe the main features of an electronic circuit and the construction techniques.	2C.M4 Compare the advantages and disadvantages of different circuit construction techniques.	
Learning aim D: Test and evaluate electronic circuits			
1D.6 Use a test meter to accurately measure the voltage of a power supply. *	2D.P6 Test voltage levels at specific points in an electronic circuit when in use. *	2D.M5 Use a range of measurements to test the performance of an electronic circuit. *	2D.D4 Use a range of measurements to evaluate the performance of an electronic circuit. *
1D.7 Identify basic faults in an electronic circuit.	2D.P7 Diagnose faults in an electronic circuit.		

*Opportunity to assess mathematics

Teacher guidance

Resources

The special resources required for this unit are:

- a range of electronic circuit input and passive components that can be used to form potential dividers when constructing circuits
- a range of electronic circuit processing components that can be used as amplifying devices in electronic circuits
- a range of output components
- general and specialist tools and equipment for constructing electronic circuits.

Assessment guidance

This unit is assessed internally by the centre and externally verified by Pearson. Please read this guidance in conjunction with *Section 8 Internal assessment*.

Although learners are assessed individually, it is quite acceptable for them to share equipment.

For learning aim A at level 2, learners must be able to select appropriate input, process, output and passive components, which could be used in a circuit represented by, for example, a block diagram. This diagram could include statements such as 'cold sensing potential divider', 'high gain amplifier', and 'loud audible output'. Learners should be able to: select an appropriate sensor and series resistor to respond to falling temperature; select a processing component or components that would produce a very high amplification; or select an output component that would give a loud audible output. Evidence could be in the form of annotation written on the block diagram presented to learners. At Merit, learners must give reasons for choices, and explain them. At Distinction, learners will solve a specific problem.

For 2A.P2, learners must describe the characteristics of power supplies and show evidence of carrying out at least one of each calculation. Evidence could be in the form of worksheets or a test.

For learning aim A at level 1, learners will describe key functions and characteristics without applying these to specific circuit design. Evidence could be in the form of a completed worksheet.

For 1A.2, simple calculations as specified in the content should be carried out.

For learning aim B at level 2, learners will describe the design features of the circuit, with increasing levels of explanation of components at Merit and Distinction. Evidence could be in the form of an annotated design, a completed circuit and witness testimony authenticating the work and could also be supported by annotated photographs.

Learners will construct the circuit, with increasing levels of explanation of components at Merit and Distinction. Evidence could be in the form of an annotated design, a completed circuit and witness testimony authenticating the work and could also be supported by annotated photographs.

For learning aim B at level 1, learners will identify components in a given circuit with support. The circuit plan can be provided by the tutor. Learners must identify components on the circuit design, so the design, correctly annotated by the learner, could be evidence of assessment.

Evidence for learning aim C is likely to be in the form of a report, photographs of outcomes along with witness statements, or learner observation records supported by annotated photographs. Evidence at level 2 will include a full assessment of risks, and increased precision in the creation of the circuit.

At level 1, learners must be able to use tools and equipment to build a simple circuit that functions as intended. They must be able to place polarised components into a circuit board in the correct orientation and use effective soldering techniques that avoid 'dry' joints.

For learning aim D, assessment could be in the form of circuits with planned faults. Evidence will include learner observation records and witness statements, annotated diagrams of the circuits to show measurements taken, annotated photographs of the process and use of test meters etc. The level of accuracy and scope of testing increases in Merit and Distinction. The Merit requirement includes testing the overall circuit performance and an evaluation of the performance.

Suggested assignment outlines

The table below shows a programme of suggested assignment outlines that cover the assessment criteria. This is guidance and it is recommended that centres either write their own assignments or adapt any assignments we provide to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment evidence
1A.1, 2A.P1, 2A.M1, 2A.D1, 1A.2, 2A.P2	Using Electronics to Give Warning of a Temperature Increase in a Greenhouse	You have been asked to make an electronic device for use in a greenhouse to give a warning when the temperature becomes too hot. You will be given a mixture of components (including passive components) to sort into categories. These are then to be used in conjunction to create potential dividers, time delays etc. The function and characteristics of each component are described. You need to select and apply electronic input, process and output components to match the needs of the device for the greenhouse, and explain and justify your choices. You need to find out about and report on different types of power supplies used to power low current electronic circuits. The list includes zinc carbon, alkaline, NiCad batteries, button cells transformed mains power packs and solar cells. Finally, you need to carry out calculations of resistance, voltage and current using Ohm's law and to carry out calculations of total resistance of resistors connected in series, parallel and in resistor networks.	Worksheet, investigation and written report, log. Investigation and written report.

Criteria covered	Assignment title	Scenario	Assessment evidence
1B.3, 2B.P3, 2B.M2, 2B.D2	Electronic Timer Design	A client requires an electronic timer that will accurately time up to five minutes in one-minute steps before giving an audible or visual warning that time is up. You should design and construct a circuit using discrete components or ICs and fully explain its operation.	Drawn and labelled circuit diagram with written description and explanation. Circuit drawn using circuit simulation software and tested virtually.
1C.4, 2C.P4, 2C.M3, 2C.D3, 1C.5, 2C.P5, 2C.M4	Designing a Permanent Circuit	You have been given a circuit diagram, which you need to use in conjunction with an appropriately selected type of circuit board to construct a fully functioning circuit, ensuring that safety hazards and risks are identified and control measures are in place. You should produce a report to describe, explain and evaluate safety issues.	Practical activity assessment through outcome. Photographic evidence. Written report on safety issues.
1D.6, 2D.P6, 2D.M5, 2D.D4, 1D.7, 2D.P7	Checking Circuit Function	You have been asked to look at functioning and non-functioning circuits, and have been set the task of measuring voltage levels and identifying and diagnosing faults. More complex circuits are presented that contain ICs or PICs and a range of measurements are taken to test and evaluate the performance of the circuits.	Practical demonstration with commentary. Observation record.

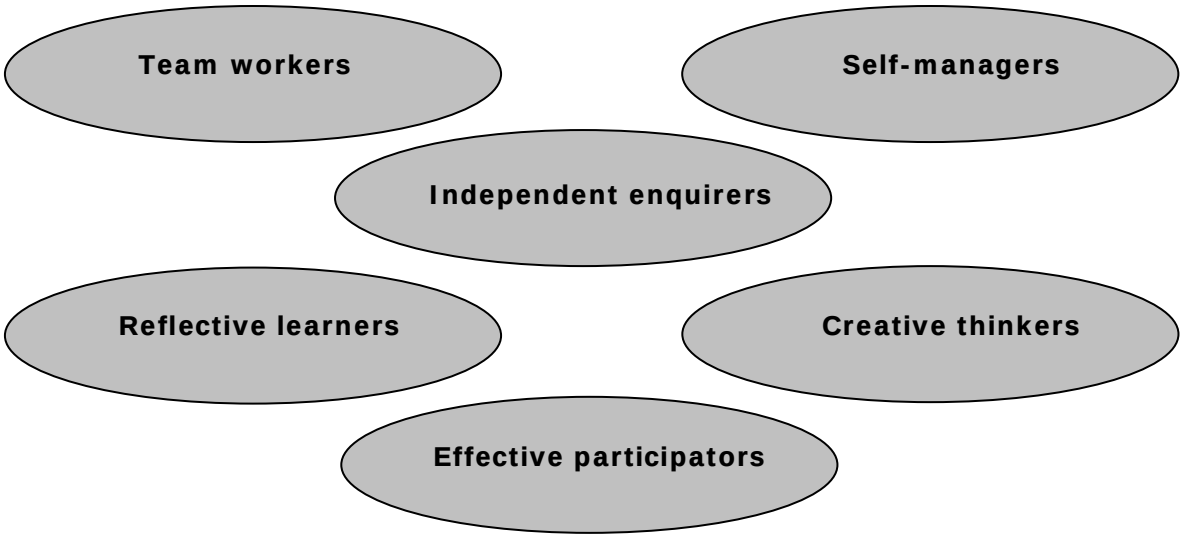
Annexe A

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 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 interconnected. 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.

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.

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.

Summary of the PLTS coverage throughout the programme

This table shows where units support the development of personal, learning and thinking skills.

Key:

✓ indicates opportunities for development

a blank space indicates no opportunities for development

Unit	Personal, learning and thinking skills					
	Independent enquirers	Creative thinkers	Reflective learners	Team workers	Self-managers	Effective participators
1	✓					
2	✓	✓				
3	✓	✓			✓	
4	✓	✓			✓	
5	✓	✓				
6	✓	✓	✓		✓	
7	✓	✓	✓		✓	
8	✓	✓	✓		✓	

Annexe B

English knowledge and skills signposting

This table shows where an assessment criterion in a BTEC First unit can provide an opportunity to practise a subject content area from the GCSE English subject criteria (including functional elements).

Unit number and title	Learning aim	Assessment criterion reference	Subject content area from the GCSE subject criteria (Details of the content area can be found below)
Unit 1: The Engineered World	N/A	N/A	N/A
Unit 2: Investigating an Engineered Product	N/A	N/A	N/A
Unit 3: Health and Safety in Engineering	A	1A.2, 2A.P2, 2A.M2, 2B.D1	1, 13
	B	2B.P4	2, 15
Unit 4: Engineering Maintenance	C	2C.P5, 2C.M3, 2C.D2	2, 15
Unit 5: Engineering Materials	N/A	N/A	N/A
Unit 6: Computer-aided Engineering	N/A	N/A	N/A
Unit 7: Machining techniques	N/A	N/A	N/A
Unit 8: Electronic Circuit Design and Construction	N/A	N/A	N/A

GCSE English subject content area

The topic areas below are drawn from the GCSE English subject criteria.

Learners should:

1 analyse spoken and written language, exploring impact and how it is achieved

2 express ideas and information clearly, precisely, accurately and appropriately in spoken and written communication

3 form independent views and challenge what is heard or read on the grounds of reason, evidence or argument

4 understand and use the conventions of written language, including grammar, spelling and punctuation

5 explore questions, solve problems and develop ideas

6 engage with and make fresh connections between ideas, texts and words

7 experiment with language to create effects to engage the audience

8 reflect and comment critically on their own and others' use of language.

In speaking and listening, learners should:

9 present and listen to information and ideas

10 respond appropriately to the questions and views of others

11 participate in a range of real-life contexts in and beyond the classroom, adapting talk to situation and audience and using standard English where appropriate

12 select and use a range of techniques and creative approaches to explore ideas, texts and issues in scripted and improvised work.

In reading, learners should:

13 understand how meaning is constructed through words, sentences and whole texts, recognising and responding to the effects of language variation

14 evaluate the ways in which texts may be interpreted differently according to the perspective of the reader.

In writing, learners should write accurately and fluently:

15 choosing content and adapting style and language to a wide range of forms, media, contexts, audiences and purposes

16 adapting form to a wide range of styles and genres.

Annexe C

Mathematics knowledge and skills signposting

This table shows where an assessment criterion in a BTEC First unit can provide an opportunity to practise a subject content area from the GCSE Mathematics subject criteria (including functional elements).

Unit number and title	Learning aim	Assessment criterion reference	Subject content area from the GCSE subject criteria (Details of the content area can be found below)
Unit 1: The Engineered World (External)	N/A	N/A	N/A
Unit 2: Investigating an Engineering Product	N/A	N/A	N/A
Unit 3: Health and Safety in Engineering	N/A	N/A	N/A
Unit 4: Engineering Maintenance	C	1C.5	14
		2C.P5	14, 16
		2C.M3, 2C.D2	10, 11, 14, 16
Unit 5: Engineering Materials	B	1B.5, 2B.P5, 2B.M3, 2B.D2	10, 11
Unit 6: Computer-aided Engineering	B	1B.5, 2B.P5	10, 11
Unit 7: Machining Techniques	B	1B.5, 2B.P5, 2B.M2, 2B.D2	10, 11
Unit 8: Electronic Circuit Design and Construction	A	2A.P2	1, 3, 4–6, 13, 21
	D	1D.6, 2D.P6, 2D.M5, 2D.D4	10, 11

GCSE Mathematics subject content area

The topic areas below are drawn from the GCSE Mathematics subject criteria.

Learners should be able to:

1 understand number size and scale and the quantitative relationship between units

2 understand when and how to use estimation

3 carry out calculations involving +, –, ×, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers

4 understand and use number operations and the relationships between them, including inverse operations and the hierarchy of operations

5 provide answers to calculations to an appropriate degree of accuracy, including a given power of ten, number of decimal places and significant figures

6 understand and use the symbols =, <, >, ~

7 understand and use direct proportion and simple ratios

8 calculate arithmetic means

9 understand and use common measures and simple compound measures such as speed

10 make sensible estimates of a range of measures in everyday settings and choose appropriate units for estimating or carrying out measurement

11 interpret scales on a range of measuring instruments, work out time intervals and recognise that measurements given to the nearest whole unit may be inaccurate by up to one half in either direction

12 plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms) selecting appropriate scales for the axes

13 substitute numerical values into simple formulae and equations using appropriate units

14 translate information between graphical and numerical form

15 design and use data-collection sheets, including questionnaires, for grouped, discrete or continuous data, process, represent, interpret and discuss the data

16 extract and interpret information from charts, graphs and tables

17 understand the idea of probability

18 calculate area and perimeters of shapes made from triangles and rectangles

19 calculate volumes of right prisms and of shapes made from cubes and cuboids

20 use Pythagoras' theorem in 2-D

21 use calculators effectively and efficiently.

In addition, level 2 learners should be able to:

22 interpret, order and calculate with numbers written in standard form

23 carry out calculations involving negative powers (only -1 for rate of change)

24 change the subject of an equation

25 understand and use inverse proportion

26 understand and use percentiles and deciles

27 use Pythagoras' theorem in 2-D and 3-D

28 use trigonometric ratios to solve 2-D and 3-D problems.

Annexe D

Synoptic assessment

Synoptic assessment in engineering is embedded throughout the assessment criteria across the units of study. The core units provide the essential knowledge, understanding and skills required in engineering and complement the content of the optional specialist units. Learners studying the Pearson BTEC Level 1/Level 2 First Award in Engineering are able to demonstrate a number of synoptic approaches towards meeting the assessment criteria, including:

- showing links and holistic understanding/approaches to several units of study from the specification
- being able to interrelate overarching concepts and issues, bringing together their engineering knowledge
- drawing together and integrating knowledge, understanding and skills across different units, in order to develop an appreciation of how topics relate to one another, how each may contribute to different engineering situations and to the world of engineering
- demonstrating their ability to use and apply a range of different methods and/or techniques in engineering
- synthesising information gained from studying a number of different engineering related activities
- applying knowledge, understanding and skills from across different units to a particular engineering situation
- evaluating and justifying their decisions, choices and recommendations.

Synoptic assessment in engineering enables learners to demonstrate their ability to integrate and apply knowledge, understanding and skills with breadth and depth. The assessment will show learners' ability to make connections between, and integrate, different topics of the unit content.

For example:

Unit 2: Investigating an Engineering Product

Unit content:

- performance requirements (what are the technical considerations that must be achieved within the product?)
- material and component requirements (how should materials and components perform within the product?)

Topics from the unit content complement and develop knowledge, understanding and skills across other units in the qualification.

Centres have the flexibility to assess a number of the criteria across more than one unit using integrated themes and assignment tasks which emphasise the links within the world of engineering, drawing the unit content together.

BTEC

Award

ENGINEERING

Specification

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