OCR
RECOGNISING ACHIEVEMENT

Principal Learning

Engineering

OCR Level 2 Principal Learning in Engineering H810

Extract from OCR Centre Handbook
Section 3 - Accredited units

The OCR centre handbook for Level 2 Principal Learning in Engineering is available to download, free of charge, from the OCR website (www.ocr.org.uk).

The centre handbook comprises 12 sections and each section can be down loaded separately. Sections may be updated at any time by OCR and centres should refer to the OCR website for the latest version.

The centre handbook sections are:

1 Introduction

2 Principal Learning in Engineering – an overview

3 Units

4 General information

5 External assessment

6 Internal assessment

7 Mapping and signposting

8 Administration arrangements

9 Supporting documentation

10 Further support and information

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12 The Diploma – components and features

Unit F548: The engineered world

Unit level	**Unit size**
Level 2	60 Guided Learning Hours

Unit overview

This unit provides learners with the opportunity to understand in detail the contribution that engineering makes to the social and economic development of the world and the social, economic and political factors that influenced engineering achievements, through the study of significant engineering achievements. Learners will also consider the way in which engineering impacts on their everyday lives.

Sustainability, environmental and human use issues are significant and learners will extend their appreciation of this area by applying statistical methods to the analysis of data, trends in environmental change, their effects and the conservation of materials.

Learners will be introduced to the engineering sectors, their diversity, products and services, the responsibilities and duties of employers and employees, career pathways, engineering professional bodies and skills councils.

At this level it is anticipated that the learning activity will involve a degree of autonomy. Learners will be asked to make comparisons, demonstrate skills and interpret available information in the completion of the assessment task.

Learning outcomes	Assessment criteria	Exemplification
1 The learner will understand the contribution of great engineering achievements to social and economic development since the19th Century	1.1 Identify and assess engineering achievements from **two** engineering sectors that have/have had demonstrable social and economic effects 1.2 Identify the engineers associated with the development of the engineering achievements 1.3 Identify and assess the social, human, economic and political effects of a particular engineering achievement 1.4 Identify and assess the social, human, economic and political issues that drove the achievement 1.5 Identify and assess the technical issues faced by the developing engineer and any technical advances that the engineer relied/acted on (IE5, IE6) (Eng, ICT)	• The learner should understand the contribution made by **two** of the following engineering sectors to social and economic development • It is anticipated the presenter will select contributors to match the needs of the learner • **Transport** – railways, roads and bridges, steam ships: Brunel, Stephenson, Telford, Macadam, – motorways, Channel Tunnel, Millau viaduct • **Power and Utilities** – electricity generation: Faraday, power stations and high tension transmission, S Ferranti, steam turbine, Charles Parsons, nuclear power, E Fermi, The National Grid – gas: North Sea gas – water and sewerage treatment: J Bazalgette, D Cameron • **Civil Engineering and Building** – steel: Henry Bessemer, B Huntsman – concrete: J Aspdin – reinforcing: J Monier – steel frame buildings: J Paxton, W L Jenney – elevators: eg Otis – environmental building controls: James Harrison – commercial refrigeration: John Gorrie – concept of air-conditioning: Franz Sangalli – modern central heating

Learning outcomes	Assessment criteria	Exemplification
		Automotive • automobiles: Daimler, F Lanchester, H Ford, A Issigonis, F Porsche, Mary Anderson – windscreen wipers **Aircraft** • Frank Whittle, gas turbine, Barnes Wallis, geodetic airframe, John Stringfellow, Wright Brothers, heavier than air flight, Concorde, Airbus **Biomedical** • Charles Dotter, cardiac stent, Willem Kollf, kidney dialysis, patient-controlled pacemaker, Leon Abrams and Ray Lightwood • portable defibrilator, Frank Pantridge • MRI Paul Lauterbur and Peter Mansfield **Chemical and process** • Carl von Linde, liquefaction of air (related to refrigeration) • William Perkin, Aniline Dyes • fractional distillation, B. Silliman • oil refining, plastics moulding: Edith Flanigen • Stephanie Kwolek: 'Kevlar' • Patsy Sherman: 'scotchgard'

Learning outcomes	Assessment criteria	Exemplification
		Machine tools • Whitworth, precision measuring machine • Maudslay, centre lathe • Ramsden, screw cutting lathe • J Nasmyth, steam hammer and milling machine • Jacquard, automated loom • robots, CNC, CAD/CAM **Lifestyle and household** • automatic washing machines, vacuum cleaner, Hoover, Dyson, Kenwood • Braun, Remington, electric toothbrush, Gillette, razor **Electronics** • thermionic valve, Edison and De Forrest • radio, Tesla and Marconi, T Baylis (sustainable) • RADAR, cavity magnetron, H Boot and J Randall, microwave heating • transistor, Brattain, Shockley and Bardeen • microchip, W Dummer and J Kilby • Ruby Laser, Theodore Maiman, Robert Dennard, memory chip • optical fibre, John Tyndall and Narinder S Kapany

Learning outcomes	Assessment criteria	Exemplification
2 The learner will know about the sectors of engineering, their products, services and the role of professional bodies and sector skills councils	**As part of a team and individually:** 2.1 Identify the industries represented by each of the sector skills councils 2.2 Identify the products and services provided by each of the engineering sectors 2.3 Identify the main engineering professional bodies and assess the nature of the work they do 2.4 Identify and assess the merits of the registration schemes associated with different engineering trades (IE4, TW1, TW2, TW6) (Eng, ICT)	• The learner should understand the purpose and contribution made by the following engineering sectors: – energy and utility – automotive – built environment – petrochemical – manufacturing and scientific – transport • Associated sub-sectors: – engineering professional bodies and Skills Councils • Learners should also appreciate that some aspects of engineering do not sit conveniently within the above sectors; they may fall outside or relate to more than one sector

Learning outcomes	Assessment criteria	Exemplification
3 The learner will know about job roles in engineering, career and training opportunities and the rights and responsibilities of employers and employees	**As part of a team and individually:** 3.1 Assess the different craft roles, their basic duties and responsibilities 3.2 Assess the different technician roles, their basic duties and responsibilities 3.3 Assess the different professional roles, their basic duties and responsibilities 3.4 Identify and assess the basic rights of individuals in paid employment 3.5 Identify and assess the responsibilities of individuals in paid employment 3.6 Identify and assess the rights and duties of employers (IE4, TW1, TW2, TW6, EP2) (Eng, ICT)	• The learner should understand and recognise the importance and purpose of: – craft, technical and professional roles training and careers – basic rights and responsibilities of employees – rights and duties of employers – terms of employment ◊ pay ◊ holiday entitlement ◊ benefits ◊ health & safety
4 The learner will be able to identify the environmental effects of engineering industries and explain ways in which resources can be conserved	4.1 Identify and assess at least one environmental effect and its cause. Express views from the perspective of each of the **two** chosen engineering sectors 4.2 Identify and assess ways in which engineering protects the environment 4.3 Discriminate between renewable and non-renewable resources 4.4 Identify and assess methods of recycling materials 4.5 Identify and assess methods of conserving materials 4.6 Interpret numerical and graphical information to derive information on environmental effects and conservation of resources (IE3, IE5, IE6) (Eng, Maths, ICT)	• The learner should understand the environmental effects of different industries: – gas emissions, chemical use in processes and agriculture, building, mining, quarrying and landfill operations – waste treatment and disposal, natural resources and petroleum dependence, renewable resources • Statistical and mathematical derivation of information from a scenario or graphical situation is an important aspect of this unit

Form of assessment

This unit will be externally assessed. The assessment will take the following format:

A 10-minute digitally recorded viva-voce. Learners are required to give verbal responses to a set of questions, cues and allowable prompts provided to the presenter by OCR for each examination session. The questions will be based on the assessment criteria and will require learners to provide specific information based on investigations as well as analysis and reflection. During the viva-voce learners will also be required to respond to an employee and employer scenario, correctly identifying basic rights and responsibilities for a given situation. It is anticipated at this level that learners may require some prompting and that the learning activity will be under direct supervision.

The centre is required to provide a digital camera and mount that can record up to 15 minutes (to allow for candidates with special requirements) of video of the viva-voce spoken exchange between the learner and presenter, whose profile should be clearly visible on camera. The presenter must complete an Examination Recording sheet for each learner. The form must include details of key responses made by the learner and be signed by the learner, presenter and witnessed by an independent invigilator who must also be present but off screen.

The use of a viva-voce has several advantages:

- it provides, within the context of an externally assessed test, learners with the opportunity to respond to questions linked specifically to their experiences and as such enables learners to relate to real events in a 'sector' context
- the questions provided attempt to elicit the full depth of a learner's understanding in relation to each learning outcome, however, the ability for the interviewer to probe understanding using approved cues and prompts will ensure that the full extent of a learner's abilities are considered by the external OCR assessor
- a viva-voce provides scope for the presenter to paraphrase questions to ensure that all learners can understand what is required by the question
- all learners, including those with certain learning difficulties, will clearly benefit from this style of assessment
- viva-voce clearly assists the learner demonstrate functional skills in English
- viva-voce is often the type of strategy used by an employer to test understanding and so presents a real opportunity for learners to demonstrate employability skills.
- it, by its very nature, uniquely identifies the learner and inhibits recourse to unfair methods or excessive guidance.

Centre support materials provide;

- guidance on the nature of the digital evidence
- learner briefing sheet
- the conduct for setting up, running and recording the viva-voce
- examples of differentiated responses for each mark band.

Marking criteria

The total number of marks for this unit is 60.

The working criteria are provided in the Specimen Assessment Materials (SAMs) supporting this Engineering unit.

Approaches to applied learning and assessment

This unit is intended to be delivered using a variety of strategies.
Learning outcome 1 may be pursued through a learner centred mini research task on great achievements and engineers that have contributed to the development of local or national industries. The focus of the research should extend beyond fact finding. Learners should be encouraged to conduct a piece of research into an area of engineering that interests them, research the subject and examine and assess the social, economic and political issues that;

- inspired or drove the achievement
- resulted from the achievement
- as well as the technical problems that were faced by the developing engineer during implementation.

Learning outcomes 2 and 3 **must** be pursued using a team approach to research into the activities of sector skills councils, engineering professional bodies and the industries they represent. Learners should learn about the different industries which make up the engineering sectors, use electronic communication (internet and email) to find out about training and career opportunities and relevant employer and employee responsibilities. Delivery should include visits to companies and talks from training managers and personnel officers.

Learners should develop thinking skills by deriving factual information from employer and employee scenarios, job contracts, employment, Health and Safety law. They should be given the opportunity to assess situations and make informed decisions.

Learning outcome 4 may be pursued by field and desk research into local industries, the way they treat, handle or dispose of process waste, scrap and rework materials, visits to engineering company's process and manufacturing plant, municipal waste disposal plant and companies developing clean technologies and environmental monitoring equipment. Learners are expected to collect and use data and statistical methods to derive and assess information, draw conclusions on recycling, production, scrap and rework, environmental effects and energy consumption audits.

Learners should record all their research in a workbook. The sections of the workbook match the assessment criteria and are designed to prompt appropriate research as well as accommodate the learners' findings. Teachers/tutors/presenters should note, however, that the assessment criteria for this unit do not provide for any assessment of the workbook, the assessment is based solely on the learners' responses to the specific set questions presented to the learners. The set of questions will change each examination session and, as with any other form of external test, will not be known to the presenter or learners before the viva-voce takes place. Over a three-year period all the assessment criteria will be covered at least once.

Learners may need assistance when considering the issues of sustainability; help and advice can be obtained from Practical Action SDA Website: www.sda-uk.org.

Support material for the teaching of Mathematics can be obtained from teacher and trainer resources prepared by the Quality Improvement Agency (QIA); National Teaching and Learning Change Programme 'Engineering' and 'Improving learning in mathematics'.

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply mathematics in a number of ways. Specifically, learners will;

- read, listen and interpret information from books (1, 2, 3, 4) – read, discuss and understand published information on engineers, achievements, sectors, job roles, environment and sustainability
- make relevant contributions to discussions, respond appropriately to others (1, 2, 3) – viva-voce
- use formal and technical language (1, 2, 3, 4) – viva-voce
- use English to record research undertaken (1, 2, 3, 4) – about achievements, sectors, job roles, environment and sustainability
- select and use appropriate ICT to investigate information (1, 2, 3, 4) – achievements, sectors, job roles, environment and sustainability
- select and use appropriate ICT to analyse information (4) – use software to create and analyse data and graphs
- use mathematics to interpret numerical values, assess impact (4) – statistics relating to environmental effects, recycling statistics

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criteria 1.5, 2.4, 3.6 & 4.6
Creative thinkers:	There are no opportunities in this unit
Reflective learners:	There are no opportunities in this unit
Team workers:	Assessment criteria 2.4 & 3.6
Self managers:	There are no opportunities in this unit
Effective participators:	Assessment criterion 3.6

Unit F549: Engineering design

Unit level	**Unit size**
Level 2	60 Guided Learning Hours

Unit overview

This unit provides learners with the opportunity to understand the importance of engineering design through the study of engineering products and components. An engineered product should be selected and identified by the learners and its performance and function analysed in depth. The product should be disassembled and key criteria for its function identified and recorded. Comparative products should then be disassembled and their strengths and weaknesses identified and recorded.

Learners will then produce a product design brief and specification, which clearly identifies an improvement to the original selected product.

From the design brief and specification of the improved product, learners will produce and present a design solution using appropriate presentation and modelling methods.

A series of tests should then be undertaken in order to prove the design and to establish the material(s) that could be used for the manufacture of the improved product.

It is possible to link this unit with Unit F551: Producing engineering solutions. If the learner chooses to do this it will provide an opportunity to realise a solution that they have developed and designed. Guidance for the selection of suitable content for the unit will be produced in OCR support materials.

Learning outcomes	Assessment criteria	Exemplification
The learner will: 1 Develop a knowledge and understanding of the importance of the performance and functions of an engineered product	The learner can: 1.1 Select and dismantle an engineered product and identify the key functional criteria used in its design (IE4) 1.2 Establish the strengths and weaknesses of comparative products including the needs of the user and manufacturer (IE4) (Eng)	• Use suitable tools and equipment safely and correctly to dismantle engineered products, and record evidence of their use • Research and investigate similar products • Use existing products to establish strengths and weaknesses • Record investigations in real time
2 Develop a knowledge and understanding of the implications of standards, legislation	2.1 Investigate and research legislation relevant to the selected product. Apply this knowledge when designing (IE2) (Eng)	• Research relevant standards and draw conclusions on implications
3 Be able to develop knowledge and understanding of the key requirements of design briefs and the key considerations influencing product design specifications	3.1 Identify possible alternatives and improvements to the selected product and produce a design brief for these improvements (CT5) 3.2 Develop a fully justified design specification for the improved product	• Use previous research on strengths and weaknesses of similar products to identify a possible improvement for the selected product • Ensure that all specification points are justified, ie explain the reason for the point being made

Learning outcomes	Assessment criteria	Exemplification
4 Develop knowledge and understanding of a range of techniques used in producing and presenting design ideas and solutions	4.1 Explore, select and use appropriate presentation techniques for producing design ideas and solutions (ICT)	• Integrate presentation techniques using 2D and 3D modelling • Orthographic, exploded, pictorial drawings • Paper, ICT and digital evidence
5 Develop a knowledge and understanding of proving (testing the design in the environment in which the design will function) a design involving an appreciation of scientific, mathematical and materials issues that underpin designing	5.1 Set success criteria, devise suitable tests to prove the developed design. Organise time and resources, analyse and evaluate information (IE4, IE6) (Maths, ICT)	• Evaluate models and seek the views of others. Test ideas to show they work • Carry out tests on a possible material for the product to establish its properties

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order to provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the model assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the model assignment.

This form of assessment has been adopted as a large proportion of the learning outcomes relate to practical abilities. The context of the work requires the learner to experience real events and work alongside people in a 'sector' context, for example, work in the workplace. Learners will also need access to specialist equipment to demonstrate their skills and extended periods of time to apply their knowledge.

The assignment involves learners analysing a real product, comparing it with other similar products and then searching out possible improvements to the product. The evidence for assessment should be presented in the form of a design portfolio.

The assignment should aim to motivate the learners and make best use of local resources and differentiate effectively across the full range of ability. It is vital that the assignment is related to a real purpose, has clear goals and these goals are fully communicated to the learners. From the start and throughout the assignment, the learners should be supervised in controlled conditions as outlined in OCR guidance and these conditions should be agreed and accepted by the learners. Wherever possible, learners will complete all work under the direct supervision of a teacher/tutor/presenter. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor presenter to confidently authenticate the work.

Learners are required to produce a portfolio of design development, research and 'proving' test evidence presented as either a paper-based portfolio of approximately 20 sheets of A3 or in the current OCR electronic format. (English, ICT)

In this unit it is recommended that learners spend 30glh on the acquisition of knowledge, skills and understanding. The remaining 30glh will take the form of controlled assessment where the learners produce the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the assignment will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR 2 Principal Learning in Engineering Centre handbook.

Marking criteria

The total number of marks for this unit is 60.

AC	Band 1	Band 2	Band 3
1	Gives a description of the function of the engineered product, how it is used and manufactured **[0 1 2 3]**	Gives a description of the function of the engineered product, presents an analysis of the strengths and weaknesses of the product and similar products Has considered the needs of the user and how the product is manufactured **[4 5 6]**	Gives a detailed description of the function of the engineered product, presents an analysis of the strengths and weaknesses of the product in comparison to a range of similar products and identifies key criteria used in its design Has considered the needs of the user and how the product is manufactured **[7 8 9]**
2	Demonstrates a basic understanding of legislation relevant to the selected product **[0 1 2]**	Demonstrates limited understanding of standards and legislation relevant to the selected product **[3 4]**	Demonstrates detailed understanding of the implications of standards and legislation relevant to the selected product **[5 6]**
3	Presents a basic brief with little reference to possible improvements **[0 1 2]**	Identifies a possible improvement and produces a design brief for the improved product **[3 4]**	Clearly identifies an improvement and produces a detailed design brief for the improved product **[5 6]**

AC	Band 1	Band 2	Band 3
3	Produces a basic specification showing little objective analysis of the original product **[0 1 2]**	Produces a limited specification covering a range of issues, justification is based on an objective analysis of the original product **[3 4]**	Produces a detailed and justified specification from the objective analysis of the original product **[5 6]**
4	Uses an appropriate form of communication **[0 1 2]** Uses basic presentation styles and techniques to communicate the improvements **[0 1 2 3]** Communication is clear **[0 1 2 3]**	Selects the most appropriate forms of communication **[3 4]** Uses a limited range of presentation styles and techniques to communicate the design alternatives and improvements **[4 5 6]** Communication is clear and accurate **[4 5 6]**	Independently selects the most appropriate forms of communication **[5 6]** Uses a wide range of presentation styles and techniques to communicate the design alternatives and improvements **[7 8 9]** Communication consistently exhibits clarity and accuracy **[7 8 9]**
5	Gives basic details of tests undertaken to prove the design with little evidence of measurement Little attempt to provide basic conclusions **[0 1 2 3]**	Sets limited success criteria Gives simple details of tests undertaken to prove the design including limited evidence of measurement and mathematical calculation Simple conclusions are drawn **[4 5 6]**	Sets success criteria Gives clear details of tests undertaken to prove the design including evidence of accurate measurement, mathematical calculation and calibration Clear conclusions are drawn **[7 8 9]**

Approaches to applied learning and assessment

The unit content encourages the use of a wide range of teaching approaches to aid learners with a variety of appropriate styles to demonstrate their abilities – supporting the aim of developing those generic skills that enhance a young person's employability. Learners need to be provided with the opportunity to carry out individual research and participate confidently and creatively.

The unit is based on practical experience of analysing a real product and comparing it with other similar products. Identifying a weakness to be improved will enable learners to engage on a realistic engineering design activity to formulate and develop possible solutions. Tests should include a scientific test and mathematical analysis to prove the suitability of a material to be used in the developed design. This test must show clear evidence of material properties supporting the choice of material.

If this unit is linked with Unit F551, it will provide learners with an opportunity to realise an engineering design project from the initial design brief through to final realisation as an engineered solution.

In this unit, advice should be given on presentation techniques and modelling techniques including computer aided design packages (CAD) which produce 2D and 3D models. In the largest section, 24 marks are awarded and design ideas should be integrated with a variety of 2D and 3D modelling techniques and developments recorded as they happen in real time with ongoing evaluation. Digital images (photographic evidence) and dialogue from other team members will support the assessment evidence. Learners will need assistance when considering issues of sustainability; help and advice can be obtained from Practical Action SDA website: (www.sda-uk.org).

It will help learners if their design portfolio is carefully structured to address the assessment criteria. Work should be presented on no more than 20 sheets of A3 securely bound or the current OCR electronic format.

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply, combine and adapt mathematical knowledge in a number of ways. Specifically, the learners will;

- produce and analyse mathematical data (5) – analyse test results, compare data against success criteria
- use mathematics to prove suitability of a particular selection (5) – compare statistical data on materials, dimensions
- use a wide range of ICT to analyse, compare and contrast data in complex and unfamiliar contexts (4, 5) – research legislation, use computer modelling, write up a report
- use English to communicate ideas with others (2) – Investigate legislation and technical information, write up the report, communicate with others
- read, listen and interpret complex information (1-2) – Find out through reading and talking with experts working within the chosen sector

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criteria 1.1, 1.2, 2.1 & 5.1
Creative thinkers:	Assessment criterion 3.1
Reflective learners:	There are no opportunities in this unit
Team workers:	There are no opportunities in this unit
Self managers:	There are no opportunities in this unit
Effective participators:	There are no opportunities in this unit

Unit F550: Engineering applications of computers

Unit level	**Unit size**
Level 2	60 Guided Learning Hours

Unit overview

This unit provides learners with the opportunity to investigate and experience the use of computers in a range of engineering applications, including 'expert systems' for problem solving, diagnostics, maintenance operations, process control and manufacturing. The unit also enables a learner to understand how computers have enabled advances in the way engineering tasks are performed.

An expert system is a computer program that contains some of the subject-specific knowledge of one or more human experts. The most common form of expert systems is a program made up of a set of rules that analyse information (usually supplied by the user of the system) about a specific class of problems, as well as providing mathematical analysis of the problem(s), and, depending upon their design, recommend a course of user action in order to implement corrections. It is a system that utilises what appear to be reasoning capabilities to reach conclusions.

Learners should also understand why embedded systems are used in modern domestic products, how computer systems are used in maintenance operations and have a knowledge and understanding of the way computer-based communication systems are used to exchange data.

Learning outcomes	Assessment criteria	Exemplification
The learner will: 1 Develop knowledge and understanding of the way computers are used in engineering, manufacturing and process control	The learner can: Explain how computers are used: 1.1 To design new products 1.2 In production and process control 1.3 For stock control 1.4 For financial control (IE4) (Eng, Maths, ICT)	• Understand how CAD systems and graphical packages are used to design/model new products • Understand how CAM systems are used in the manufacturing process • Investigate the use of bar code readers and computer program to monitor material levels, resources, components (JIT) inputs, and outputs and order points (JIT) • Investigate the use of computers for workplace financial control and record keeping
2 Develop knowledge and understanding of simple control programmes	2.1 Analyse a problem in systems terminology 2.2 Recognise and use input switches and sensors 2.3 Recognise and use output devices 2.4 Use linear, symbolic or flow-chart programming including conditional sequencing 2.5 Simulate a control system (CT1, CT5) (Eng, Maths, ICT)	• Use of systems diagrams • Use of different types of switched inputs and sensors such as infra-red, temperature, magnetic, light-level • Use of output devices such as motors, solenoids, relays, lights, buzzers • Download control program to PIC chip • Typical control problems are: Air conditioning and central heating systems in buildings • Environmental control in horticulture • Secure and controlled environments for historical artefacts • Security systems and burglar alarms • Manufacturing processes

Learning outcomes	Assessment criteria	Exemplification
3 Develop knowledge and understanding of simple expert systems for problem solving and maintenance operations in engineering	3.1 Understand what is meant by the term 'expert system' 3.2 Understand how to input data into an expert system 3.3 Select suitable parameters for problem solving 3.4 Interpret results and use them to modify engineering features 3.5 Explain how and why computers are used in maintenance operations (Eng, Maths, ICT)	• Use spread sheets to analyse systems data. (This will be more fully developed in Unit F554 Level 2 and Unit F560 Level 3 where computers are used to predict maintenance failure modes and frequency) • Solve problems involving the mass or volume of parts for casting by making adjustments to linear dimensions; check for interference between assembled parts; use automatic placement of similar parts; use parametric systems to generate families of parts • Solve problems involving structural components in bridge trusses
4 Develop knowledge and understanding of computer-based communication systems to communicate data	4.1 Demonstrate understanding of the use of modern consumer products to communicate and exchange data during design, manufacture and maintenance (IE6) (Eng, Maths, ICT)	• Use of laptop computers to access and communicate information • Use of Personal Digital Assistants (PDAs) to record digital images, annotations and dialogue in real time as it happens • Use of third generation mobile phones to record information in real time as it happens • Downloading and transferring information from communications devices in a form that is usable and accessible for engineering reports and portfolios. Bluetooth. SMS multi media messages

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the model assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the model assignment.

This form of assessment has been adopted as a large proportion of the learning outcomes relate to practical abilities. The context of the work requires learners to experience real events and work alongside people in a 'sector' context. Learners will also need access to specialist equipment to demonstrate their skills and extended periods of time to apply their knowledge.

Learners are required to undertake an assignment in which they analyse a modern domestic product (which must contain an embedded computer system) in terms of the use made of computers in its design, process control, manufacturing, diagnostics and maintenance.

The evidence should consist of a research report including screen shots, digital evidence, analysis and comments. The evidence presented must reflect the structure of the marking criteria.

The assignment should aim to motivate learners and make best use of local resources and differentiate effectively across the full range of ability. It is vital that the assignment is related to a real domestic product, has clear goals and these goals are fully communicated to the learners. From the start and throughout the assignment, the learners should be supervised in controlled conditions as outlined in OCR guidance and these conditions should be agreed and accepted by the learners. Wherever possible, learners will complete all work under the direct supervision of a teacher/tutor/presenter. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor/presenter to confidently authenticate the work.

In this unit it is recommended that learners spend 40glh on the acquisition of knowledge, skills and understanding. The remaining 20glh will take the form of controlled assessment where the learners produce the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the assignment will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR Level 2 Principal Learning in Engineering Centre handbook.

Marking criteria

The total number of marks for this unit is 60.

AC	Band 1	Band 2	Band 3
1	Has examined modern domestic product which contains an embedded computer control system. In the context of this product has demonstrated some understanding of how computers are used in a work setting to: Design new parts, for production and stock control Made some reference to the use of digital technologies **[0 1 2 3 4]**	Has investigated and examined a modern domestic product which contains an embedded computer control system. In the context of this product has demonstrated an understanding of how computers are used in a work setting to: Design new parts, for production, process control, stock control, finance control and maintenance Made some reference to the use of digital technologies **[5 6 7 8]**	Has independently investigated and thoroughly examined a modern domestic product which contains an embedded computer control system. In the context of this product has demonstrated a thorough understanding of how computers are used in a work setting to: Design new parts, for production, process control, stock control, finance control and maintenance Made thorough reference to the use of digital technologies **[9 10 11 12]**
2	Has developed basic understanding of simple computer control systems. Has simulated simple control functions of the chosen modern domestic product **[0 1 2 3 4 5 6]**	Has developed limited understanding of simple computer control systems. Has simulated complicated control functions of the chosen modern domestic product **[7 8 9 10 11 12]**	Has developed thorough understanding of simple computer control systems. Has simulated complex control functions of the chosen modern domestic product **[13 14 15 16 17 18]**

AC	Band 1	Band 2	Band 3
3	Has demonstrated basic knowledge and understanding of simple expert systems for problem solving and maintenance operations and has considered these in the context of the chosen domestic product **[0 1 2 3 4 5 6]**	Has demonstrated limited knowledge and some understanding of simple expert systems for problem solving and maintenance operations and has considered these in the context of the chosen domestic product Has detailed methods used to input appropriate data into an expert system. Can record the output and adjust features to match requirements **[7 8 9 10 11 12]**	Has demonstrated thorough knowledge and understanding of simple expert systems for problem solving and maintenance operations and has considered these in the context of the chosen domestic product Has explained in detail the methods used to input appropriate data into an expert system. Can accurately record the output and adjust the correct features to match the requirements **[13 14 15 16 17 18]**
4	Can explain the use of simple computer-based communication systems used to exchange data during the design and manufacturing of the chosen modern domestic product **[0 1 2 3 4]**	Can identify and explain the use of computer-based communication systems used to exchange data during the design and manufacturing and maintenance of the chosen modern domestic product **[5 6 7 8]**	Can independently identify and explain the use of computer-based communication systems used to exchange data during the design and manufacturing and maintenance of the chosen modern domestic product **[9 10 11 12]**

Approaches to applied learning and assessment

The unit content encourages the use of a wide range of teaching approaches to aid learners with a variety of styles to demonstrate their capabilities – supporting the aim of developing those generic skills that support a young person's employability.

Problems involving expert and control systems should be presented in real-life contexts with an emphasis on the application rather than systems theory. Learners should choose a modern domestic product from a prescribed and approved list to analyse. The assessment evidence, in the form of a research reports can be in either paper or electronic format – details of which are contained in documentation supporting this unit.

Suggested supporting software:

CAD

- Pro/DESKTOP
- Pro/ENGINEER Schools Advanced
- Solidworks
- Autodesk Inventor
- ArtCAM Pro
- WestPoint Bridge Designer

Control

- Economatics: Logicator
- Data Harvest: GO, SOLO PIC programming system
- Keep IT Easy: Flowol 3
- Commotion CoCo 3
- Deltronics: Control IT
- Nottingham Trent University: ICON2

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply mathematics in a number of ways. Specifically learners will;

- write short documents (2, 3) – explain how and why computers are used in maintenance operations
- use formal language (1, 2, 3, 4) – explain how and why computers are used in maintenance operations
- select and use appropriate ICT to record, refer to and compare information – (3) use spread sheets to analyse systems data
- use mathematics to interpret numerical values given (1) – financial control and record keeping.

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criteria 1.4 & 4.1
Creative thinkers:	Assessment criterion 2.5
Reflective learners:	There are no opportunities in this unit
Team workers:	There are no opportunities in this unit
Self managers:	There are no opportunities in this unit
Effective participators:	There are no opportunities in this unit

Unit F551: Producing engineering solutions

Unit level	**Unit size**
Level 2	60 Guided Learning Hours

Unit overview

The purpose of this practical topic is to allow learners the opportunity to have the experience of producing solutions to simple engineering problems.

The unit will involve learners producing a comprehensive plan for the manufacture of an engineering solution from a set of engineering drawings and instructions which are provided by the centre. Learners will need to select suitable materials, manufactured parts and components and select tools, equipment and processes.

The learners will then make a quality engineered solution using their own plan in a safe, effective and efficient manner. During production they will review their own progress, adapt to circumstances as they change and undertake appropriate quality checks.

It is likely that the assignment will link directly with the sector in which the learner has most experience and these activities could be carried out in the context of production, maintenance, installation and commissioning.

It is possible to link this unit to follow on from Unit F549: Engineering design. If the learner chooses to do this it will provide an opportunity to realise a solution which they have developed and designed in Unit F549 where they create a brief, specification and working drawings, which can all be used as a basis for the production plan that forms the focus of Unit F551. This is not, however, a prerequisite and learners can work from pre-prepared working drawings.

Learning outcomes	Assessment criteria	Exemplification
The learner will: 1 Be able to interpret and use engineering drawings Be able to select suitable materials and standard components for engineering applications Develop knowledge and understanding of planning Understand the need for health and safety standards	The learner can: 1.1 Produce a detailed plan for making, installing, commissioning and maintaining a selected product from a given engineering drawing/set of instructions which includes details of suitable materials, use of standard components and processes to be adopted (SM3) 1.2 Relate the plan to health and safety issues, including a risk assessment of procedures for processing the materials and components involved (SM4) (Eng, Maths)	• Preparing a suitable sequence of operations • Reading, interpreting and understanding engineering instructions, job instructions, engineering drawings • Dealing with problems concerning planning • Cleaning components, removing burrs and sharp edges • Good housekeeping, eg leaving the work area in a safe condition, cleaning the equipment, disposal of waste
2 Be able to demonstrate that they have used tools, equipment and processes to create a high-quality and accurate outcome	2.1 Produce a high-quality and accurate outcome that demonstrates effective making skills 2.2 Record and review progress during making, adapting ideas as circumstances change, altering the production plan in order to produce a high-quality and accurate outcome 2.3 Check the performance of the risk assessment and make any necessary modifications to process or risk assessment (RL3, CT5, CT6) (Eng, Maths)	• Produce a product which is fit for purpose • Taking remedial action and deciding when to act on your own initiative and adapt the production plan

Learning outcomes	Assessment criteria	Exemplification
3 Be able to perform quality control checks	3.1 Show evidence of the use of well-planned quality control checks in all aspects concerned with making, installation, commissioning and maintenance of the product (Maths)	• Check materials and components at commencement of operations, at critical stages during the activities and on completion of the activities • Checking for visual defects in use • Check the status of the equipment that learners use in making, installation, commissioning and maintenance, eg torque wrenches, pressure vessels, lifting and handling equipment, pressure gauges, micrometers, vernier gauges, digital and analogue test meters

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order to provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the Model Assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the Model Assignment.

This form of assessment has been adopted as a large proportion of the learning outcomes relate to practical abilities. The context of the work requires learners to experience real events and work alongside people in a 'sector' context. Learners will also need access to specialist equipment to demonstrate their skills and extended periods of time to apply their knowledge.

The unit will involve learners producing an engineering solution from a supplied set of engineering drawings and instructions. Learners will need to select suitable materials, manufactured parts and components, develop a plan for the solution, select tools and equipment, work safely and perform appropriate quality checks. It is likely that the assignment will link directly with the sector in which a learner has most experience.

The assignment should aim to motivate learners, make best use of local resources, particularly links with an engineering sector and differentiate effectively across the full range of ability. It is vital that the assignment is related to a real purpose, has clear goals and these goals are fully communicated to the learners. From the start and throughout the assignment, the learners should be supervised in controlled conditions as outlined in OCR guidance and these conditions should be agreed and accepted by the learners. Wherever possible, learners will complete all work under the direct supervision of a teacher/tutor/presenter. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor/presenter to confidently authenticate the work.

In this unit it is recommended that learners spend 30glh on the acquisition of knowledge, skills and understanding. The remaining 30glh will take the form of controlled assessment where the learners produce the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the assignment will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR Level 2 Principal Learning in Engineering Centre handbook.

The assessment evidence will involve the production of a portfolio which records all details of the engineering solution. This report must include:

- A plan, as detailed in assessment criterion 1
- Evidence by the learner of having used tools and equipment and in a safe and efficient manner
- Real time photographic records of production processes being completed with learner annotation
- Photographic records of the solution showing its fitness for purpose
- Details of quality checks used during production, installation and during maintenance
- Learner observations of their own progress during production

Marking criteria

The total number of marks for this unit is 60.

AC	Band 1	Band 2	Band 3
1	From engineering drawings and instructions produce a basic plan for an engineering solution **[0 1 2 3]** Include basic details indicating the selection of suitable materials, standard parts, components and processes to be used **[0 1 2 3]** Show a basic understanding of health and safety issues **[0 1 2]**	From engineering drawings produce a plan for an engineering solution **[4 5 6]** Include limited details of the selection of suitable materials, standard parts, components and processes to be used **[4 5 6]** Show some understanding of risk assessment **[3 4 5]**	From engineering drawings and instructions produce a comprehensive plan for an engineering solution **[7 8 9]** Include full details indicating the selection of suitable materials, standard parts, components and processes to be used **[7 8]** Show a thorough understanding of health and safety issues, including risk assessment of procedures and materials involved **[6 7]**
2	Demonstrates a low level of skill in the production of a solution that only partially functions or is not complete **[0 1 2 3 4 5 6]**	Demonstrates a reasonable level of skill with some accuracy in the production of a solution that functions in most respects **[7 8 9 10 11 12]**	Demonstrates a high level and accurate making skill in the production of a quality solution that is fit for purpose **[13 14 15 16 17 18]**
2 **3**	Review progress during completion of the solution **[0 1 2]** Show basic evidence of the use of quality control checks and the use of processes, tools and equipment **[0 1 2]**	Review progress during completion of the solution **[3 4]** Adapt procedures as circumstances change **[3 4]**	Review progress thoroughly during completion of the solution **[5 6]** Adapt procedures as circumstances change, altering the production plan or the intended outcome if necessary **[5 6]** *Continued next page*

AC	Band 1	Band 2	Band 3
	Work in a safe manner **[0 1 2]**	Show evidence of the use of some quality control checks and the use of processes, tools and equipment in a safe manner **[3 4]**	*Cont.* Show evidence of the use of well-planned and thorough quality control checks and the use of processes, tools and equipment in a safe and efficient manner **[5 6]**

Approaches to applied learning and assessment

The unit content encourages the use of a wide range of teaching approaches to aid learners with a variety of appropriate styles to demonstrate their abilities – supporting the aim of developing those generic skills that enhance a young person's employability. Therefore, learners need to be provided with the opportunity to carry out individual research and participate confidently in the application of the engineering solution.

If this unit is linked with Unit F549: Engineering design, it will give learners an opportunity to realise a product they have designed and developed. This requirement, although encouraged, is not essential, learners could work from alternative working drawings.

In this unit, advice should be given on methods of recording evidence in real time as activities are taking place. Digital photography would be suitable for this. Clear photographic evidence of the quality of the final solution is necessary for assessment purposes and learners should be encouraged to present their finished solution clearly in a suitable form for others to judge its quality. An overall view is required together with close-up details and some idea of scale.

Evidence by the learner of having used tools, equipment, standard components and processes in a safe and efficient manner is required.

The report should be presented in a folder containing all the evidence or in an equivalent OCR electronic format.

Resources relating to Health and Safety issues can be found in the Quality Improvement Agency (QIA) teacher and trainer resources for the National Teaching and Learning Programme: 'Engineering'.

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply mathematics in a number of ways. Specifically, learners will;

- write short documents (1, 2) – reading, interpreting and understanding engineering instructions, job instructions, engineering drawings
- generate results to a given level of accuracy (3) – micrometers, vernier gauges, digital and analogue test meters.

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	There are no opportunities in this unit
Creative thinkers:	Assessment criterion 2.3
Reflective learners:	Assessment criterion 2 .3
Team workers:	There are no opportunities in this unit
Self managers:	Assessment criteria 1.1 & 1.2
Effective participators:	There are no opportunities in this unit

Unit F552: Construct electronic and electrical systems

Unit level	**Unit size**
Level 2	30 Guided Learning Hours

Unit overview

This unit provides learners with the opportunity to learn about the basic principles and techniques used in the construction of electronic and electrical systems. This is a practical-based unit which complements the unit on engineering design (Unit F549 Level 2) and allows learners to develop further understanding of the importance of applied mathematical skills in engineering.

Learners will develop knowledge and understanding of basic electronic and electrical principles, be able to recognise and select components, understand operating principles of circuits and carry out testing and fault finding. Learners will also develop their skills in using circuit diagrams, electronic and electric circuits, safe use of tools and equipment and carrying out simple calculations.

Learners will use their knowledge of electrical/electronic components to develop a prototype system in order to solve the selected design problem. Learners will present the evidence within a 'workbook', using a range of techniques including text, digital photography, screen dumps, freehand sketches and CAD drawing. An electronic template for the workbook will be provided by OCR. The timed and scripted activity is designed to take place within a workshop environment. The activity will be structured through the use of a presenter's script, which will clearly outline instructions to the learners and give appropriate timings to them for each section of the challenge.

Learning outcomes	Assessment criteria	Exemplification
The learner will: 1 Demonstrate knowledge and understanding of basic electronic and electric principles and associated safe working practices	The learner can: 1.1 Describe and apply basic electronic and electrical principles (Eng) 1.2 Describe, apply and justify the need for safe working practices (Eng)	• Understand the principles of current, Electro Motive Force (EMF), potential difference, resistance, power and energy • Recognise electrical hazards to include: - visual inspection of equipment - PAT compliance - selection of test equipment • Demonstrate safe use of manually operated tools to include: - soldering iron - wire cutters - wire strippers - pliers, screwdrivers - de-soldering tools - manual/PCB drills • Work in a safe and appropriate manner that considers the needs of others
2 Demonstrate knowledge and understanding of the operating principles of a range of electronic and electrical components	2.1 Identify and describe the properties of a range of electronic and electrical components (Eng, ICT) 2.2 Use calculations to select component values (Maths) 2.3 Correctly select components to ensure the operation of a circuit	• Demonstrate knowledge and application of: - resistors: types (fixed, variable, thermistor, light dependant), tolerances, colour code - capacitors: types, values, colour code - semi-conductors - diodes, transistors integrated circuits: operational amplifiers, timers, logic gates, counters, PIC's *Continued next page*

Learning outcomes	Assessment criteria	Exemplification
		Cont. - audio/visual Indicators: lamps, LED's, buzzers and their component symbols - cells and batteries, copper wire, plugs and sockets, switches
3 Demonstrate knowledge and understanding of the construction of electronic and electrical circuits	3.1 Identify and be able to select suitable methods of circuit construction (IE4) (Eng, ICT)	• Demonstrate knowledge and application in the construction of circuits to include: - soldering techniques - stripboards - protoboards - breadboards - soldering onto PCB • Construct a range of circuits to include: - audio and optical circuits - transistor circuits (sensors and switches) - alarm circuits - logic and counting circuits

Learning outcomes	Assessment criteria	Exemplification
4 Demonstrate knowledge and understanding of testing and evaluation of the operation of electronic and electrical circuits	4.1 Identify and justify the selection of appropriate testing and fault-finding methods. Test circuits acting on the outcome (IE1, IE4, IE6) (Eng, ICT)	• Select and use appropriate test equipment and test methods to include: - power supplies - multi-meter - logic probe • Undertake appropriate circuit testing to include: - checking construction against circuit diagrams - continuity testing - visual inspection - expected values

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order to provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the model assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the model assignment.

The context for the assessment of this unit is a six-hour 'Technology Challenge'. This form of assessment has been adopted as it assesses a learner's ability to apply knowledge, make on the spot decisions and test the outcome against a challenging brief.

The assignment will take the following format:

A six-hour (three two-hour sessions) 'Design Challenge' Activity linked to one of the engineering sectors. The focus of the activity should be set by the teacher/tutor/presenter in conjunction with the learners and engineering sector. A number of model assignments (eg Landrover TrackNAv Challenge) and centre guidance on assignment setting are published in additional centre support materials supporting this unit. The chosen assignment should aim to motivate the learners and make best use of local resources and differentiate effectively across the full range of ability. From the start and throughout the assignment, the learners should be supervised in controlled conditions as outlined in OCR guidance and these conditions should be agreed and accepted by the learners. Learners will complete all work under the direct supervision of a teacher/tutor/presenter. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor/presenter to confidently authenticate the work.

Learners will use their knowledge of electrical/electronic components to develop a prototype system in order to solve the selected design problem. Learners will present the evidence within a 'workbook', using a range of techniques including text, digital photography, screen dumps, freehand sketches and CAD drawing. An electronic template for the workbook will be available to download from the OCR website. The activity is designed to take place within a workshop environment. The activity will be structured through the use of a presenter's script, which will clearly outline instructions to learners and give appropriate timings to the learner for each section of the challenge.

In this unit it is recommended that learners spend 24glh on the acquisition of knowledge, skills and understanding. The remaining 6glh will take the form of controlled assessment where the learners produce the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the assignment will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR Level 2 Principal Learning in Engineering Centre handbook.

Marking criteria

The total number of marks for this unit is 30.

AC	Band 1	Band 2	Band 3
1	Stated the basic electronic and electrical principles; worked in a safe manner **[0 1 2]**	Described the basic electronic and electrical principles; considered the safety of others **[3 4]**	Accurately applied electronic and electric principles; has demonstrated a good understanding of safe working procedures **[5 6]**
2	Outlined the operating principles of a range of electronic and electrical components **[0 1 2]**	Described the operating principles of a range of electronic and electrical components **[3 4]**	Successfully applied the operating principles of a range of electronic and electrical components **[5 6]**
3	Considered and suggested different electronic and electrical circuit arrangements **[0 1 2 3 4]**	Explained the reasons for selection of electronic and electrical circuit arrangements **[5 6 7 8]**	Designed and successfully prototyped electronic and electric circuits **[9 10 11 12]**

AC	Band 1	Band 2	Band 3
4	Identified appropriate testing method for testing electronic and electric circuits; used simple calculations to predict circuit test data **[0 1 2]**	Carried out testing of electronic and electrical circuits and recorded data findings; used complex calculations to predict circuit test data – voltage current **[3 4]**	Used test results to prove operation or identify circuit modifications to enable correct operation; used and tested complex calculations to prove the use of alternative components or circuit change based on the data findings **[5 6]**

Approaches to applied learning and assessment

Learning outcomes for this unit are best achieved by adopting a primarily practical approach. Learners should be encouraged to freely handle and assess a wide range of electrical/electronic components that are in common use in a range of engineering sectors. Learners should be able to design, construct, test and evaluate circuits using a range of 'sensing components' such as those linked with Temperature, Light, Pressure, Sound, Humidity, Moisture and Position.

Resources for investigating the operation of simple circuits and manipulation of calculations can be found in the Quality Improvement Agency (QIA) teacher and trainer resources for the National Teaching and Learning Programme; 'Engineering'. Further mathematical resources can be found in 'Improving learning in mathematics'.

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply mathematical knowledge in a number of ways. Specifically, learners will;

- select and apply mathematics to find solutions (2) – calculate and select component values
- select and use ICT systems independently (2, 3) – produce PCB's
- use English to communicate ideas with others (1, 2, 3, 4) – Investigate technical information and data, respond in workbook
- read, listen and interpret complex information (1–5) – Find out through reading and talking with experts.

Personal, learning and thinking skills

There are opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criteria 3.1 & 4.1
Creative thinkers:	No opportunities in this unit
Reflective learners:	No opportunities in this unit
Team workers:	No opportunities in this unit
Self managers:	No opportunities in this unit
Effective participators:	No opportunities in this unit

Unit F553: Manufacturing engineering

Unit level	**Unit size**
Level 2	60 Guided Learning Hours

Unit overview

This is essentially a practical unit with most learners needing guidance and support during the practical activities and when testing and undertaking field work. Prior knowledge of how to take readings, record findings and analyse data are essential prerequisites to this unit.

It is essential that the learner's progress is monitored and guidance continually given.

Learners will need to understand the principles behind performing quality checks, be able to use computer controlled machines (CNC), understand and plan for multiple production while understanding the importance of health and safety in an industrial workplace.

This unit requires learners to work initially as part of a team(s) to plan the multiple production of one product from a list of prescribed products detailed by OCR.

They will then individually detail necessary quality control checks and explain the procedures of setting up a complex CNC machining operation, including the associated risks, prior to individually manufacturing **five** identical components of the product using the CNC machine.

The learners will produce a detailed report on the data findings of their chosen quality control checks and suggested improvements, together with details and explanation of their contribution to the team production plan.

Centres can, subject to OCR approval, suggest alternative products. However, no modifications are permitted to OCR-approved or prescribed products.

Learning outcomes	Assessment criteria	Exemplification
As part of a team the learner will demonstrate knowledge and understanding of: 1.1 The importance of planning for manufacture of the prescribed product and the consideration of alternative methods 1.2 The need to co-operate with others and share responsibilities for the success of the manufacture of multiple components	The learner can: 1.1 Contribute to the production of a manufacturing plan. Suggest additional and/or alternative methods of manufacture based on their own knowledge and experience 1.2 Co-operate with others in reaching agreement in order to achieve the desired outcome (IE1, TW1, TW2, TW5) (Eng, Maths)	Specific detail will vary depending on the product selected from those prescribed and detailed by OCR • Completion of relevant section of the workbook showing the learner can produce: – details and justification of the chosen manufacturing processes and produce a production plan for the prescribed product – decide how multiples of the product could be manufactured by a team – agree what is an acceptable manufacturing tolerances
Individually the learner will demonstrate knowledge and understanding of: 2 The types and importance of a variety of quality checks and the use of statistical methods of testing	2.1 Design, describe, select and use quality checks for the manufactured component including details of tolerances (CT1, IE4) (Eng, Maths, ICT)	• Detailed descriptions of six quality checks for the chosen component • Detailed justification of alternative methods using the gathered statistical data
3 Programming and setting up a CNC machining operation The health and safety risks associated with the machining process	3.1 Program and set up a CNC machining operation 3.2 Review the machining process on screen, acting on the outcome 3.3 Record details of the procedure 3.4 Manufacture **five** identical components on a CNC machine 3.5 Plan a safe procedure and confidently employ the procedure (SM4) (Eng, Maths, ICT)	• A detailed set of instructions for a third party to undertake the same operation • A justified, comprehensive risk assessment reflecting industrial practice

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order to provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the model assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the model assignment.

This form of assessment has been adopted as a large proportion of the learning outcomes relate to practical abilities. The context of the work requires the learner to experience real events and work alongside people, other learners in the 'team' and in a 'sector' context. The learner will also need access to specialist equipment (CNC machine tools) to demonstrate their skills and extended periods of time to apply their knowledge.

Learners will record all their evidence for assessment in a workbook consisting of five distinct sections. All sections of the workbook should be completed in order, with learners using text, annotated sketches and annotated digital images as appropriate.

The focus of the activity should be set by the teacher/tutor/presenter in conjunction with the learner. The chosen assignment should aim to motivate the learner and make best use of local resources and differentiate effectively across the full range of ability. From the start and throughout the assignment, learners should be supervised in conditions set out by the teacher/tutor/presenter and agreed and accepted by the learner from the onset of the assignment. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor/presenter to confidently authenticate the work.

At this level it is anticipated that the learners will undertake directed activity with a degree of autonomy, achieve outcomes within time constraints and accept responsibility, in a 'team' context, for the quantity and quality of the outcome.

In this unit it is recommended that learners spend 30glh on the acquisition of knowledge, skills and understanding. The remaining 30glh will take the form of controlled assessment where the learners produce the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the assignment will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR Level 2 Principal Learning in Engineering Centre handbook.

Marking criteria

The total number of marks for this unit is 60.

AC	Band 1	Band 2	Band 3
As part of a team			
1	Has detailed and selected manufacturing methods and processes in order of the prescribed product **[0 1 2]**	Has contributed to the plan of manufacture of the prescribed product identifying alternative methods and processes. Selected correct manufacturing procedures to be adopted **[3 4]**	Has made a significant contribution to a detailed plan of manufacture of the prescribed product identifying alternative methods and processes. Selected and fully justified correct procedures to be adopted **[5 6]**
1	Has made a basic input into the team planning of the operation **[0 1 2 3 4]**	Has made a basic input into the planning of the team operation and has contributed by undertaking a responsible role **[5 6 7 8]**	Has been instrumental in ensuring the success of the team operation by undertaking a significant role **[9 10 11 12]**
Individually			
2	Has listed some basic quality checks **[0 1 2 3]**	Has produced a number of quality control checks and has an awareness of basic statistical testing **[4 5 6]**	Has fully detailed appropriate quality control checks using actual and statistical testing methods **[7 8 9]**

AC	Band 1	Band 2	Band 3
3	Has, under supervision, set up a machining operation **[0 1 2]** Has produced a basic risk assessment for the operation **[0 1 2]** Has, with some guidance, manufactured multiple components **[0 1 2]**	Has set up a complex machining operation **[3 4 5]** Has produced a risk assessment that is limited to some important aspects of the operation **[3 4 5]** Has, with some assistance, manufactured multiple components **[3 4 5]**	Has fully explained the procedures and detailed sequencing of setting up a complex machining operation, has set up the operation **[6 7]** Has anticipated and managed risks **[6 7]** Has independently manufactured multiple components **[6 7]**
2 **3**	Has recorded basic data from the application of the chosen quality tests **[0 1 2 3 4]**	Has produced a limited set of data with analysis from the chosen quality tests **[5 6 7 8]**	Has produced a detailed report on the data findings of the chosen quality tests. Has interpreted the data in order to analyse the performance of the machining operation **[9 10 11 12]**

Approaches to applied learning and assessment

Learners will need to work as part of a team and also individually during the task. On health and safety grounds, presenters should intervene appropriately but details **must** be acknowledged and included in the appropriate section of each learner's workbook.

Learners will initially, as part of a team, consider:

- how multiples of an engineered component or product could be manufactured by a team;

The learner will then individually:

- Design an appropriate set of quality checks and the means by which they would be undertaken
- Set up a CNC machining operation
- Manufacture a batch of **five** products using a CNC machine
- Determine what tolerances would be acceptable for the engineered component or product being produced
- Apply quality control checks
- Analyse and use the statistical data from all of the quality checks
- Suggest modified and improved quality checks in the light of their findings
- Consider health and safety in relation to the practical activity and the industrial equivalent.

Guidance on approximate size of submission of assessable evidence:

- Completion of all sections of the workbook by hand or ICT.
- Supporting digital evidence included in the workbook. This must be annotated by the learner in order to gain rewards against the assessment criteria.

Resources for managing Health and Safety can be found in the Quality Improvement Agency (QIA) teacher and trainer resources for the National Teaching and Learning Programme: 'Engineering'.

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply mathematical knowledge in a number of ways. Specifically, learners will:

- produce and analyse mathematical data (2, 3) – understand and apply the concept of machining tolerances, work out dimensions
- select, interact and use ICT systems independently for a complex task (2, 3) – set up a CNC machine tool and manufactured components
- use English to communicate ideas with others (1, 2, 3) – record procedures, data, detail a risk assessment
- read, listen and interpret complex information (3) – undertake a risk assessment, follow printed instructions

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criteria 1.2 & 2.1
Creative thinkers:	Assessment criterion 2.1
Reflective learners:	There are no opportunities in this unit
Team workers:	Assessment criterion 1.2
Self managers:	Assessment criterion 3.5
Effective participators:	There are no opportunities in this unit

Unit F554: Maintenance

Unit level	**Unit size**
Level 2	30 Guided Learning Hours

Unit overview

This unit provides learners with the opportunity to learn basic principles and techniques of engineering maintenance. While working safely, learners will experience carrying out maintenance and diagnostic procedures using manufacturers' information and data sheets.

Learners will also have the opportunity to learn about the methods used to analyse failure trends and develop knowledge and understanding of the implications if products or equipment are not properly maintained.

Learning outcomes	Assessment criteria	Exemplification
1 The learner will develop knowledge and understanding of the procedures used in maintaining an engineered product or system	The learner can: 1.1 Use manuals, manufacturers' information and data to inform the correct procedure for the routine maintenance of an engineered product or system (Eng, Maths, ICT) 1.2 Carry out routine maintenance operations and/or diagnostic routines on an engineered product or system (SM3) 1.3 Use appropriate tools and equipment safely and effectively (SM4) 1.4 Devise a maintenance procedure for an engineered product or system. Test the procedure, make any necessary modifications and re-test (Eng)	• The learner should know how to perform routine maintenance operations on a range of engineered systems and products using tools and equipment and information as necessary • The learner will know how to reference manufacturers' manuals and product/system information and data. The choice of product or system could be determined by learner interest or available local engineering employer provision, eg: – car engines and transmissions – braking and suspension – power tools – electric motors – domestic white goods – garden machinery – industrial equipment – sports equipment – sewing machines (see approaches to learning and applied assessment) • The learner will develop skills in the use of: – manually operated tools: ◊ sockets ◊ spanners ◊ screwdrivers ◊ clamps ◊ extractors and pullers *Continued next page*

Learning outcomes	Assessment criteria	Exemplification
		Cont. – measuring equipment: ◊ rules ◊ vernier gauges ◊ multi-meters – joining: ◊ crimping and soldering equipment – Personal safety equipment • The learner will develop maintenance procedures detailing processes, tools and safety for an engineering, product or system identified by the learner
2 The learner will develop knowledge and understanding of the implications for the user and the manufacturer if engineered products or systems are not properly maintained	2.1 Research and investigate the implications and impact for both the user and manufacturer if routine maintenance procedures are not followed. Act on any information gained (IE2)	• The learner should develop knowledge and understanding the implications of poor maintenance practice such as: – personal injury – inconvenience – financial impact – user responsibilities – legal issues – loss of production through downtime – damage to reputation – damage to personnel – equipment – property and other possible ramifications

Learning outcomes	Assessment criteria	Exemplification
3 The learner will develop knowledge and understanding about different causes for the failure of engineered products and systems, and the use of statistical methods in measuring and analysing failure trends	3.1 Identify and explain the causes of the various types of system and component failure. Take remedial action as necessary 3.2 Show by means of calculation, Mean time to repair (MTTR), Mean time to failure (MTTF), Mean time between failure (MTBF) and Availability (A) values for components, machines and engineering systems (RL2) 3.3 By interpreting data, evaluate the reliability of components, machines and engineering systems (RL5) (Maths)	• The learner should understand the factors that contribute to the failure of mechanical and electrical systems and know their causes, eg: – maladjustment – mal-operation – run to failure – stress fracture – fatigue – wear – embrittlement – overloading – seizure – anodic and chemical corrosion – lubrication failure – fouling – vibration – poor implementation of the method statement • The learner should understand and recognise the importance and purpose of the following statistical methods in the maintenance of engineered systems: – using data from production and maintenance job cards, calculate mean mode median to determine MTTF and MTTR values – Mean gives MTTF (for non-repairable components) and MTBF (for repairable systems) *Continued next page*

Learning outcomes	Assessment criteria	Exemplification
		Cont. – Mode gives frequency of breakdowns, Median shows accuracy of Mean (widely different values indicate presence of extreme data) • The learner should present results of statistical analysis using suitable methods, eg spreadsheet/graph

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order to provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the model assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the model assignment.

This form of assessment has been adopted as a large proportion of the learning outcomes relate to practical abilities. The context of the work requires learners to experience real events and work alongside people in a 'sector' context. Learners will also need access to specialist equipment to demonstrate their skills and extended periods of time to apply their knowledge.

Individual learners are required to complete two assignments and for each produce a structured report. The style and presentation should address an employer audience:

Assignment 1: A two-part report which contains:

a) Documented evidence of the routine maintenance of an engineered product or system including reference to the tools, information and procedures used. The learner should provide supporting evidence in the form of photographic evidence and supporting learner comments of the procedures undertaken, together with the use of tools and equipment;

b) A learner-produced maintenance plan detailing the procedures for maintaining an engineered product or system identified by the learner. The plan should detail maintenance procedures, tools and equipment required together with appropriate safety considerations.

Assignment 2: A two-part report which contains:

a) An evaluation of the reliability of an engineered component from a different engineered product or system to that which the learner maintained in assignment 1, using statistical methods to analyse the failure trends. Supporting evidence of the method of analysis must be included;

b) Identify an engineering product failure or system failure that can be attributed to poor maintenance and explain the impact and implications for both the user and the manufacturer.

The assignment should aim to motivate the learners and make best use of local resources and differentiate effectively across the full range of ability. It is vital that the assignment is related to a real purpose, has clear goals and these goals are fully communicated to the learners. From the start and throughout the assignment, the learners should be supervised in controlled conditions as outlined in OCR guidance and these conditions should be agreed and accepted by the learners. Wherever possible, learners will complete all work under the direct supervision of a teacher/tutor/presenter. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor/presenter to confidently authenticate the work.

In this unit it is recommended that learners spend 15glh on the acquisition of knowledge, skills and understanding. The remaining 15glh will take the form of controlled assessment where learners produce the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the task will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR Level 2 Principal Learning in Engineering Centre handbook.

Marking criteria

The total number of marks for this unit is 30.

AC	Band 1	Band 2	Band 3
1	With guidance, uses manufacturers' information to undertake simple routine maintenance of an engineered product or system using tools and equipment safely **[0 1 2]** Devise a basic maintenance procedure for an engineered product or system **[0 1 2 3]**	Selects manufacturers' information to undertake routine maintenance of an engineered product or system using tools and equipment safely **[3 4]** Devise and test a simple maintenance procedure for an engineered product or system **[4 5 6]**	Independently selects and uses manufacturers' information, to undertake complex routine maintenance including the use of a diagnostic routine of a engineered product or system using tools and equipment safely **[5 6]** Independently devise and test a maintenance procedure for an engineered product or system **[7 8 9]**
2	Outline the nature of the failure and the aspect of maintenance that caused it. Considers the implications of the failure **[0 1 2 3]**	Gives detailed information relating to the nature of the failure and the aspect of maintenance that caused it. Considers the implications and impact of the failure **[4 5 6]**	Gives detailed information relating to the nature of the failure and the aspect of maintenance that caused it. Considers the implications and impact of the failure for both the user and the manufacturer **[7 8 9]**
3	With guidance, use a statistical method to analyse failure trends. Present findings in a suitable format seeking guidance as necessary **[0 1 2]**	Uses statistical methods to analyse failure trends. Interpret data and present findings in a suitable format **[3 4]**	Independently uses statistical methods to analyse failure trends. Correctly interprets data and present findings to include a planned maintenance schedule for the associated engineered product or system **[5 6]**

Approaches to applied learning and assessment

This unit is intended to be delivered using a variety of strategies.

Learning outcome 1 could be delivered within a work experience environment under close supervision, or workshop. In addition to tools, equipment, manuals and manufacturers information, learners will need access to a range of engineered products and systems on which to carry out the tasks. Centres should endeavour to source real engineered components by contacting local industries. Reports must provide photographic evidence and supporting learner comments of the procedures undertaken together with the use of tools and equipment.

Learning outcome 2 should be based upon a component that did not form part of the activity associated with learning outcome 1.

Learning outcome 3 is intended to use actual industrial data (a scenario or simulation is acceptable).

Functional skills

This unit will provide learners with opportunities to use English, ICT and apply mathematics in a number of ways. Specifically learners will;

- compare, select, read and understand text (1) – reference manufacturers' manuals and product/system information and data
- use appropriate checking procedures and evaluate their effectiveness (1, 3) – calculate mean mode median to determine MTTF and MTTR values
- use ICT to search for and select information (1) – reference manufacturers' manuals and product/system information and data.

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criterion 2.1
Creative thinkers:	There are no opportunities in this unit
Reflective learners:	Assessment criteria 3.2 & 3.3
Team workers:	There are no opportunities in this unit
Self managers:	Assessment criteria 1.2 & 1.3
Effective participators:	There are no opportunities in this unit

Unit F555: Innovation, enterprise and technological advance

Unit level	**Unit size**
Level 2	60 Guided Learning Hours

Unit overview

Innovation and creativity have been at the forefront of engineering developments from the 20th century into the 21st century. Their relative importance is set to increase significantly in the future.

This unit provides learners with the opportunity to understand the importance of the development of new ideas and methods protecting the intellectual property associated with that new idea. They will understand the ways in which businesses benefit and profit from new ideas and the way in which new ideas and developments effect technological change in the home, businesses, the economy and society.

The learners will select from a list of products identified by OCR, which will be updated on a regular basis.

The learners will need to be provided with opportunities to explore a range of products and their associated development as well as their own work, to allow them to demonstrate their knowledge of this area through completion of a workbook.

The unit presents opportunities for learners to develop their research, investigation and evaluation skills together with problem solving and innovative thinking.

Learning outcomes	Assessment criteria	Exemplification
The learner will demonstrate knowledge and understanding of: 1 How innovation and creativity benefit engineering	The learner can: 1.1 Explain how innovation and creativity benefit engineering (IE4) (Eng)	Related to the chosen product, the learner will: • Detail and justify how creativity and innovation benefit engineering
2 How ideas and new developments are protected	2.1 Explain how ideas and developments are protected (Eng)	• Detail how protection of the design idea has been achieved and what this means in real terms, eg intellectual property
3 The roles of research, development and raising finance when developing new products	3.1 Describe the roles of research, development and raising finance when developing new products (Eng)	• Relate specific details of the research, development and raising finance when developing new products
4 The impact of new developments in materials and processes on products The effects of the engineering technologies in the home, workplace and built environment	4.1 Evaluate the impact of new developments in materials and processes on products 4.2 Evaluate the effects of the engineering technologies in the home, workplace and built environment (IE3, IE4, IE5, IE6) (Eng)	• Explain and justify the impact and effects of engineering technological development
5 The environmental and social impact of engineering and sustainability of resources	5.1 Explain the environmental and social impact of engineering and sustainability of resources. (IE3, IE4) (Eng)	• Explain and evidence the environmental and social impact of engineering and sustainability of resources

Form of assessment

OCR will provide model assignments along with guidance and criteria related to using them, centres must adhere to this guidance. The model assignments will consist of tasks that are applied and holistic in approach. Care should be taken to ensure that a single task, or group of inter-related tasks, is capable of generating evidence against the appropriate assessment criteria and across all marking criteria. This unit will be externally moderated.

To assist centres in the teaching and assessment of this unit, OCR has designed an appropriate 'Model Assignment'. This assignment may be used by centres without modification. However, in order to provide appropriate contextualisation, improve access or increase local relevance, centres may 'tailor' the model assignments within set parameters. Details of the scope of adaptation are provided in the 'Notes for Tutors' section that accompanies the model assignment.

This form of assessment has been adopted as a large proportion of the learning outcomes relate to practical abilities. The context of the work requires that learners experience real events and work alongside people in a 'sector' context. Learners will also need access to specialist equipment to demonstrate their skills and extended periods of time to apply their knowledge.

The learners are required to complete a research assignment based on a specific product. The learners should record all their research, findings, observations, analysis and individual conclusions in a workbook.

The learners should have the workbook available throughout their study of the unit and may return to an earlier section in the light of any new discoveries. Should it be necessary to illustrate a particular point, photos, sketches, drawings and other presentation methods may be used.

Teachers/tutors/presenters should note that the assessment criteria are accessed solely by the learner's completion of an individual workbook, the learner's individual responses to the specific set prompts and additional graphical evidence supported by candidate annotations.

The assignment should aim to motivate the learners and make best use of local resources and differentiate effectively across the full range of ability. It is vital that the assignment is related to a real purpose, has clear goals and these goals are fully communicated to the learners. From the start and throughout the assignment, the learners should be supervised in controlled conditions as outlined in OCR guidance and these conditions should be agreed and accepted by the learners. Wherever possible, the learners will complete all work under the direct supervision of a teacher/tutor/presenter. These controls will help to secure the validity and reliability of the assessment, provide good manageability for all involved and allow the teacher/tutor/presenter to confidently authenticate the work.

In this unit it is recommended that learners spend 40glh on the acquisition of knowledge, skills and understanding. The remaining 20glh will take the form of controlled assessment where the learner produces the appropriate evidence.

It is the responsibility of the centre to ensure that the learners' work is marked by a competent person. This person must apply the marking criteria clearly outlined in this unit. Further guidance is available to markers in the additional centre support materials. Once marked by the centre, the assignment will be moderated externally by OCR in accordance with QCA's Code of Practice.

Further guidance on 'controlled assessment' is provided in the OCR Level 2 Principal Learning in Engineering Centre handbook.

Marking criteria

The total number of marks for this unit is 60.

AC	Band 1	Band 2	Band 3
1	Has used a few sources of information to investigate the chosen product with regard to innovation and creativity **[0 1 2 3]**	Has identified a limited range of sources of information to investigate the chosen product with regard to innovation and creativity **[4 5 6]**	Has used a number of sources of information to investigate the chosen product with regard to innovation and creativity and justified their use **[7 8 9]**
2	Can outline the basic protection of the design for the chosen product **[0 1 2 3]**	Can describe how the protection of the design for the chosen product works and what effect it has had on that product **[4 5 6]**	Can explain why the relevant protection(s) was selected for the chosen design and detail how it works and the costs involved **[7 8 9]**

AC	Band 1	Band 2	Band 3
3	Has identified basic details of research activity, developmental work and finance **[0 1 2 3 4 5]**	Has explained the relevance of research activity, developmental work and finance **[6 7 8 9 10]**	Has outlined in detail, research activities and developmental work and justified the financial decisions which have been made **[11 12 13 14 15]**
4	Can give basic details of materials and processes used in the production of the chosen product Can identify, with reference to the chosen product, the effects of the engineering technologies in the home, the workplace and built environment **[0 1 2 3 4 5 6]**	Can explain why the materials and processes were used for the chosen product Can explain, with reference to the chosen product, the cause and effects of engineering technologies in the home, the workplace and the built environment **[7 8 9 10 11 12]**	Can explain and justify the use of the materials and processes used in the chosen product and suggest alternatives together with reasoning of why they were not used Can explain and evaluate, with reference to the chosen product, the cause and effects of engineering technologies in the home, the workplace and the built environment **[13 14 15 16 17 18]**
5	Has identified, with reference to the chosen product, the environmental and social impacts of engineering and sustainability of resources **[0 1 2 3]**	Has explained, with reference to the chosen product, the environmental and social impacts of engineering and sustainability of resources **[4 5 6]**	Has explained and evaluated, with reference to the chosen product, the environmental and social impacts of engineering and sustainability of resources **[7 8 9]**

Approaches to applied learning and assessment

The unit content encourages the use of a wide range of teaching approaches to aid learners with a variety of appropriate styles to demonstrate their abilities – supporting the aim of developing those generic skills that enhance a young person's employability.

The learners need to be provided with the opportunity to carry out independent research, develop investigative and evaluative skills, and employ problem solving while using innovative thinking. Learners will benefit from support and move forward to independently develop and employ these skills.

Learners may work as part of teams for some of the activities but must undertake a significant amount of the investigative activities and make associated conclusions independently and record and report their individual findings and conclusions in their own workbook.

The products identified by OCR will be updated on a two-yearly cycle. This will give continuity over a two-year course and give presenters planning time.

Functional skills

This unit will provide learners with the opportunity to use English in a number of ways. Specifically, learners will;

- write documents to communicate information, ideas and opinions. (1, 2, 3, 4 & 5) – explain and evidence the environmental and social impact of engineering and sustainability of resources.

Personal, learning and thinking skills

There are several opportunities in this unit for learners to develop and apply their personal, learning and thinking skills. The assessment criteria listed below indicate which of the skills can be developed and applied.

Independent enquirers:	Assessment criteria 1.1, 4.2 & 5.1
Creative thinkers:	There are no opportunities in this unit
Reflective learners:	There are no opportunities in this unit
Team workers:	There are no opportunities in this unit
Self managers:	There are no opportunities in this unit
Effective participators:	There are no opportunities in this unit