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Cambridge **NATIONALS** LEVEL 1/2



ENGINEERING MANUFACTURE

Specification

OCR Level 1/2 Cambridge National Award in Engineering Manufacture (60 glh)

OCR Level 1/2 Cambridge National Certificate in Engineering Manufacture (120 glh)

Version 5 - December 2019

Summary of key changes to this specification

Section	Title of section and change	Version and date issued
3.3 Grading and awarding grades	Additional text added to clarify the potential for grade thresholds to change.	Version 5 December 2019
All	New format for the specification, however with the exception of the changes highlighted below, the content remains unchanged.	Version 4 September 2019
Throughout	The term 'model assignment' has been replaced with 'set assignment' throughout.	
4.5 Authentication	Updated information on the use of Centre authentication forms.	
6.2 Accessibility	Updated information on approval requirements and permissible access arrangements.	
7 Administration	Updated information	
8.1 Progression from these qualifications	Updated information	
8 Other information	The following information has been removed: Key Skills Functional Skills	
2.3 Unit R109: Engineering materials, processes and production	At the end of each unit, updated Connections between units for synoptic assessment	
2.4 Unit R110: Preparing and planning for manufacture		
2.5 Unit R111: Computer aided manufacturing		
2.6 Unit R112: Quality control of engineered products		
3.2 Synoptic assessment		Updated section
Appendix B Marking criteria for centre assessment	Updated Guidance on synoptic assessment for each unit	
7.4 Unit and qualification resits	Updated information about resits for the externally assessed unit	Version 2 September 2018

OCR Cambridge Nationals in Engineering Manufacture

Qualification title	Guided Learning Hours (GLH)	Entry Code	Reference
OCR Level 1/2 Cambridge National Award in Engineering Manufacture	60	J832	601/1218/9
OCR Level 1/2 Cambridge National Certificate in Engineering Manufacture	120	J842	601/1219/0

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1 Introduction

1.1 Qualification aims

Engineering manufacture is a discipline of engineering dealing with different manufacturing practices and processes using machines, tools and equipment that turn raw materials to new products.

The Cambridge Nationals in Engineering Manufacture is aimed at learners who wish to study the processes involved in manufacturing new engineered products. Learners are provided with the knowledge and skills required to operate manufacturing tools and equipment used to make products from the requirements of a design specification. Learners will develop their understanding of the processes and systems required to transfer a design concept into a product.

The Cambridge Nationals in Engineering Manufacture can be delivered separately or as part of an engineering curriculum providing useful contextualisation alongside GCSE Design and Technology subjects as well as the application of scientific and mathematic core principles. Centres with access to engineering production equipment such as CAD/CAM could deliver this qualification in association with OCR Cambridge Nationals in Engineering Design.

A practical approach to teaching and learning will provide learners with knowledge in engineering technology and develop critical thinking, creativity and dextrous skills through engaging practical experiences.

This specification contains OCR's Cambridge National Award/Certificate in Engineering Manufacture.

1.2 Qualification summary

The Cambridge Nationals in Engineering Manufacture consist of two qualifications:

The OCR Level 1/2 Cambridge National Award in Engineering Manufacture consists of two mandatory units.

The OCR Level 1/2 Cambridge National Certificate in Engineering Manufacture consists of four mandatory units.

1.3 Qualification size (GLH and TQT)

The size of the qualification is described in terms of Guided Learning Hours (GLH) and Total Qualification Time (TQT).

GLH indicates the approximate time (in hours) the teacher will spend supervising or directing study time and assessment activities. We have worked with people who are experienced in delivering related qualifications to determine what content needs to be taught and how long it will take to deliver.

TQT is comprised of two elements: GLH, and an estimate of the number of hours a learner will reasonably spend on any unsupervised learning or assessment activities (including homework) so they can successfully achieve their qualification.

OCR Level 1/2 Cambridge National Award in Engineering Manufacture is 60 GLH and 65 TQT.

OCR Level 1/2 Cambridge National Certificate in Engineering Manufacture is 120 GLH and 128 TQT.

1.4 Prior learning/attainment

Learners who are taking courses leading to this qualification should normally have followed a corresponding Key Stage 3 Programme of Study within the National Curriculum. There is no requirement for learners to achieve any specific qualifications prior to undertaking this qualification.

1.5 Overview of the qualifications

Units	Assessment method	GLH	J832 Award 60 GLH	J842 Certificate 120 GLH
Mandatory				
R109: <i>Engineering materials, processes and production</i>	Written paper OCR set and marked 1 hour – 60 marks (60 UMS) Learners answer all questions	30	M	M
R110: <i>Preparing and planning for manufacture</i>	Centre-assessed tasks OCR-moderated Approx. 10–12 hours – 60 marks (60 UMS)	30	M	M
R111: <i>Computer aided manufacturing</i>	Centre-assessed tasks OCR-moderated Approx. 10–12 hours – 60 marks (60 UMS)	30	N/A	M
R112: <i>Quality control of engineered products</i>	Centre-assessed tasks OCR-moderated Approx. 10–12 hours – 60 marks (60 UMS)	30	N/A	M
Key: M = mandatory unit				

A bank of set assignments is available free of charge from the OCR website for the internally assessed units R110 – R112.

2 Units

2.1 Guidance on unit content

Use of i.e./e.g. in unit content

The unit content describes what has to be taught to ensure that learners are able to access the highest marks.

Anything which follows an i.e. details what must be taught as part of that area of content.

Anything which follows an e.g. is illustrative, it should be noted that where e.g. is used, learners must know and be able to apply relevant examples in their work, though these do not need to be the same ones provided in the unit content.

Teachers will need to ensure that any modifications to tasks, from the bank of set assignments for the optional units, do not expect the learner to do more than they have been taught, but they must enable them to access the full range of marks as described in the marking criteria.

For externally assessed units, where the content contains i.e. and e.g. under specific areas of content, the following rules will be adhered to when setting questions:

- a direct question may be asked where the unit content is shown with an i.e.
- where unit content is shown as an e.g., a direct question will not be asked about that example. Any questions relating to the area of content will offer learners the opportunity to provide their own examples, as the unit has not specified which examples they should be familiar with.

2.2 Guidance on practical activity

The specification content includes specific requirements associated with health and safety and provides opportunities to promote safe working practice through developing knowledge and understanding during practical activities.

Care must be taken by individual centres to follow all health and safety requirements and quality assurance procedures specific to each practical activity and ensure they have the appropriate health and-safety policies in place relating to the use of equipment by learners, even if the equipment is not specified in the unit content.

Throughout practical activities, centres must exercise continuing supervision to ensure essential compliance with Health and Safety requirements.

2.3 Unit R109: *Engineering materials, processes and production*

Aims

This unit will develop learners' knowledge and understanding of engineering materials and processes, and their application in the manufacture of engineered products. The content of this unit includes basic engineering processes, allowing for a practical approach to be taken in the delivery of the unit.

This unit also covers types of engineering materials such as ferrous and non-ferrous metals, alloys, polymers, thermosetting plastics, ceramics, composites, smart materials and new and emerging materials. Learners will understand properties of engineering materials and learn the theory of hand and machine skills to engineer a product.

On completion of this unit, learners will understand how the properties and characteristics of materials impact on the design specification for the development of a new product and appreciate the different production methods available to produce engineered products.

Learners studying for the Certificate will be able to apply knowledge and understanding gained in this unit to help develop their skills further during the completion of Units R111 and R112.

Learning Outcome 1: Know about properties and uses of engineering materials

Learners must be taught:

- types of engineering materials, i.e.
 - metals:
 - ferrous metals and alloys, i.e.
 - iron
 - carbon steels
 - stainless steel
 - high speed steel
 - non-ferrous metals and alloys, i.e.
 - copper
 - brass
 - bronze
 - aluminium alloys
 - zinc
 - tin
 - lead
 - titanium
 - polymers:
 - thermoplastics, i.e.

- Acrylonitrile-Butadiene-Styrene (ABS)
- polyethylene
- High Impact Polystyrene (HIPS)
- Polyvinyl Chloride (PVC)
- nylon
- polycarbonate
- polypropylene
- thermosetting plastics, i.e.
 - polyester resin
 - urea-formaldehyde
 - epoxy resin
 - phenol-formaldehyde
- o other materials:
 - ceramics, i.e.
 - tungsten carbide
 - glass
 - ceramic bearing material
 - composites, i.e.
 - Glass Reinforced Plastic (GRP)
 - carbon fibre
 - concrete
 - smart materials, i.e.
 - shape-memory alloys
 - thermochromic materials
 - shape-memory plastics
 - Quantum Tunnelling Composite (QTC)
- new and emerging materials (e.g. nanotechnology; advanced metal alloys)
- properties of engineering materials, i.e.
 - o malleability
 - o ductility
 - o conductivity/resistivity
 - o hardness
 - o machinability
 - o corrosion resistance
 - o elasticity/plasticity
- materials testing processes, i.e.
 - o destructive testing (e.g. tensile testing; hardness testing)
 - o non-destructive testing (NDT) (e.g. conductivity testing; crack detection)
- characteristics of engineering materials, i.e.
 - o relative cost
 - o availability
 - o ease of use
 - o safety in use

- forms of supply
- sustainability
- uses of specific materials, i.e.
 - ferrous and non-ferrous metals and alloys – (e.g. cast iron for machine bases; bronze for boat propellers)
 - thermoplastics – (e.g. ABS for appliance casings)
 - thermosetting plastics – (e.g. phenol-formaldehyde for heat resistant saucepan handles)
 - ceramics – (e.g. tungsten carbide for cutting tool tips)
 - composites – (e.g. carbon fibre for bicycle frames)
 - smart materials – (e.g. shape memory alloy in alarm systems)

Learning Outcome 2: Understand engineering processes and their application

Learners must be taught:

- basic engineering processes, i.e.
 - material removal, i.e.
 - sawing
 - filing
 - threading
 - hand forming, i.e.
 - forging
 - casting
 - bending
 - joining methods, i.e.
 - soldering
 - brazing
 - welding
 - riveting
 - adhesives
 - threaded fasteners
 - self-tapping screws
 - heat treatment, i.e.
 - hardening and tempering
 - case hardening
 - annealing
 - normalising
 - nitriding
 - surface finishing, i.e.
 - finishing
 - polishing
 - plastic/powder coating
 - painting

- electroplating
- galvanising
- machine processes, i.e.
 - material removal, i.e.
 - drilling
 - turning
 - milling
 - grinding
 - forming, i.e.
 - die and investment casting
 - shell moulding
 - forging
 - extrusion
 - press forming
 - moulding, i.e.
 - vacuum forming
 - injection moulding
 - blow moulding
 - rotational moulding
 - compression moulding
- safe use of tools and equipment, i.e.
 - features and controls of machines
 - risk assessment
 - appropriate use of Personal Protective Equipment (PPE)
 - safety precautions

Learning Outcome 3: Know about developments in engineering processes

Learners must be taught:

- applications of computer controlled production processes, i.e.
 - Computer Numerical Control (CNC) machining processes, i.e.
 - CNC lathes and milling/router machines
 - multi-axis machining centres
 - water jet cutting
 - punching machines
 - press brake machines
 - laser applications, i.e.
 - laser cutting/welding
- additive manufacturing and rapid prototyping processes, (e.g. Selective Laser Sintering (SLS); Stereolithography (SLA); Direct Metal Laser Sintering (DMLS); Fused Deposition Modelling (FDM)/3D printing; electron beam melting)

Learning Outcome 4: Understand the impact of modern technologies on engineering production

Learners must be taught:

- the impact of modern technologies in engineering production, i.e.
 - automation, i.e.
 - output, i.e.
 - increased output
 - faster to market
 - reduced production times
 - quality, i.e.
 - consistency/zero defects
 - Right First Time
 - workforce, i.e.
 - smaller workforce
 - employee re-training
 - changes in job profiles
 - improved working conditions
 - costs, i.e.
 - initial capital outlay
 - savings in workforce costs
 - reduced overall cost of production
 - digital communications, i.e.
 - uses in research and development, i.e.
 - Internet research
 - Computer Aided Design (CAD)
 - electronic communication of drawings
 - video conferencing
 - material supply and control, i.e.
 - Just-in-Time (JIT)
 - inventory reduction
 - automatic ordering systems
 - stock management
 - electronic transfer of data
 - global manufacturing, e.g.
 - global supply chain (e.g. proximity of skills base and/or raw materials)
 - business benefits (e.g. changing global economies)
 - standardisation of processes and procedures

Assessment guidance

This unit will be assessed through a 1 hour externally assessed examination.

During the external assessment, learners will be expected to demonstrate their understanding through questions that require the skills of analysis and evaluation in particular contexts.

Connections between units for synoptic assessment

Whilst we do not prescribe the order in which units should be assessed, because of the interdependence between units, it is strongly recommended that learners complete the learning for this unit R109 before completing assessment of other units within this qualification, as teaching of this unit will develop key knowledge, skills and understanding which should be applied and assessed in context further throughout the qualification. Further information regarding synoptic assessment within this qualification can be found under section 3.2 *Synoptic Assessment*.

2.4 Unit R110: *Preparing and planning for manufacture*

Aims

This unit develops learners' knowledge and understanding of procedures used during the planning and preparing stages in the manufacture of engineered products. Learners are required to plan and make a pre-production product by conventional (non-Computer Numerical Control (CNC)) methods to develop a suitable product.

This unit enables learners to have the opportunity to apply appropriate processes for making pre-production products using hand-held tools, measuring and marking equipment safely. Learners will also carry out manually controlled machining operations such as drilling, turning and milling and perform quality control checks to review finished pre-production products.

On completion of this unit, learners will understand, and be able to apply, the processes for making pre-production products, using a range of hand tools, measuring and marking equipment safely.

Learners studying for the Certificate will be able to apply knowledge and understanding gained in this unit to help develop their skills further during the completion of Units R111 and R112.

Learning Outcome 1: Be able to plan for the making of a pre-production product

Learners must be taught:

- interpretation of 2D and 3D engineering drawings, i.e.
 - third angle orthographic projection
 - isometric/oblique
- standard drawing conventions on engineering drawings, i.e.
 - sectional views
 - exploded drawings
 - detail views
 - materials and components
 - dimensions
 - tolerances
 - scale
 - annotations
 - revisions
- production of plans for the making of a pre-production product, i.e.
 - interpretation of the details and requirements of a pre-production product from engineering drawings
 - sequence of operations and time estimate
 - tools, equipment and processes
 - health and safety considerations
 - quality control checks

Learning Outcome 2: Be able to use processes, tools and equipment safely to make a pre-production product

Learners must be taught:

- appropriate processes for making pre-production products, i.e.
 - bench work and hand-held tools, i.e.
 - measuring equipment (e.g. rule; digital vernier calliper; micrometer)
 - marking out equipment (e.g. scribing block; engineer's try square; height gauge)
 - hand held saws (e.g. hacksaw; junior hacksaw)
 - files (e.g. hand flat; half round; needle files)
 - manually controlled machining operations, e.g.
 - drilling
 - turning
 - milling
 - fabrication
 - forming
- how to use tools and equipment when making products, i.e.
 - bench work
 - setting of machines/equipment, e.g.
 - milling machines
 - lathes
 - drilling machines
- how to follow safe working procedures when using tools and equipment
- how to use appropriate use Personal Protective Equipment (PPE) appropriately
- use of appropriate quality control checks to review finished pre-production products i.e.
 - compare against engineering drawings
 - important dimensions
 - tolerances
 - finish

Learning Outcome 3: Be able to modify a production plan for different scales of production

Learners must be taught:

- consideration of scales of manufacture, i.e.
 - one-off/job production
 - batch production
 - mass production
- impact of quantities of production on production plans, i.e.
 - processes
 - sequence of individual operations
 - timing of stages
 - health and safety considerations
 - quality control checks
 - suggested modifications

Connections between units for synoptic assessment

Whilst we do not prescribe the order in which units should be assessed, because of the interdependence between units, it is strongly recommended that learners complete the learning for R109 before completing assessment of this unit as they will have been taught key knowledge, skills and understanding which should be applied and assessed in context further in this unit.

Further information regarding synoptic assessment within this qualification can be found under section 3.2 *Synoptic Assessment*.

2.5 Unit R111: Computer aided manufacturing

Aims

This unit covers computer applications in the design and manufacture of engineered products. Learners will produce Computer Aided Design (CAD) drawings of a product to produce a batch of Computer Numerical Control (CNC) manufactured examples. Also, learners will understand how computer control can be used in the high-volume/mass production of engineered products.

Learners will develop knowledge and understanding of computer applications in the design and manufacture of engineered products and know the procedures for setting up CNC equipment to produce a batch of products to the required specification. Learners will also investigate methods used to compare items manufactured by manually controlled and CNC production.

On completion of this unit, learners will be able to use computer applications to manufacture engineered products and produce CAD drawings of a product. Learners will understand how computer control is used to produce engineered products in high-volume.

Learning Outcome 1: Be able to plan the production of components on Computer Numerical Control (CNC) machines

Learners must be taught:

- factors to consider when producing plans for CNC machining operations in the production of components, i.e.
 - planning of operations, i.e.
 - sequence of operations
 - tool changes
 - scale of manufacture – waste minimisation
 - one-off
 - batch
 - mass production
 - type of machine i.e.
 - milling machines
 - turning centres
 - fabrication machines
 - tools required, i.e.
 - setting tools (e.g. spanners; allen keys; clamps)
 - machining tools (e.g. drills; turning tools; end-mills)
 - cutting tools (e.g. cutting blades, CNC router)
 - materials, i.e.
 - speeds and feeds for the size and type of materials

Learning Outcome 2: Be able to interpret information from Computer Aided Design (CAD) to manufacture components on CNC equipment

Learners must be taught:

- use of Computer Aided Design (CAD) packages, i.e.
 - export drawing information to CNC machines
 - on-screen simulation
- factors to consider when performing CNC machine programming operations, i.e.
 - setting datum points
 - co-ordinates (absolute and incremental)
 - tool change-over
 - tool offsets
 - language (e.g. G-codes)

Learning Outcome 3: Be able to set-up and use CNC equipment to manufacture components

Learners must be taught:

- procedures for setting up CNC equipment, i.e.
 - tooling
 - work holding
 - computer interface
 - safety procedures
- procedures to produce products to required specification, i.e.
 - initial setting
 - safe use, i.e.
 - potential hazards
 - appropriate Personal Protective Equipment
- methods used to compare items manufactured by manually controlled and CNC production, i.e.
 - visual (e.g. standard of finish)
 - dimensional (e.g. accuracy – component tolerance)
 - cycle time (e.g. assembly)
 - consistency (e.g. batch tolerance)

Learning Outcome 4: Know about applications of computer control processes used to manufacture products

Learners must be taught:

- applications of computer control, i.e.
 - rapid prototyping, i.e.
 - laminating
 - 3D printing
 - Stereolithography
 - laser sintering
 - manufacturing processes, i.e.
 - CNC machining
 - additive manufacturing
 - robotics, i.e.
 - welding
 - riveting
 - pick-and-place assembly
- computer controlled processes used for different scales of manufacture, i.e.
 - one-off/prototype manufacture
 - batch production
 - high-volume manufacturing

Connections between units for synoptic assessment

Whilst we do not prescribe the order in which units should be assessed, because of the interdependence between units it is strongly recommended that learners complete the learning for unit R109 Engineering materials, processes and production and unit R110 Preparing and planning for manufacture, before undertaking assessment of this unit as key knowledge, skills and understanding developed in those units underpin assessment of this unit.

Further information regarding synoptic assessment within this qualification can be found under section 3.2 *Synoptic Assessment*.

2.6 Unit R112: *Quality control of engineered products*

Aims

This unit will develop learners' knowledge and understanding of techniques and procedures used to ensure the quality of engineered products. Learners will be required to produce and carry out a detailed set of procedures for the quality control of engineered products which will be used in a 'real world' situation involving high-volume manufacture of products. Learners will also gain an understanding of the principles of lean manufacture and how they are applied to improving the quality of the manufacturing process.

On completion of this unit, learners will understand the techniques and procedures used to ensure the quality of engineered products.

Learning Outcome 1: Understand the importance of quality control

Learners must be taught:

- reasons for implementing quality control in production, i.e.
 - early intercept (e.g. problems in production)
 - waste management (e.g. reduce production waste)
 - consistency (e.g. finished products)
 - reduce costs (e.g. materials – time)
 - conformity (e.g. industry standards – regulations)
 - reduce returns (e.g. reputation – customer perception)
- quality procedures, i.e.
 - quality control
 - quality standards
 - quality assurance
 - total quality management

Learning Outcome 2: Be able to assess product quality from inspection and quality control techniques

Learners must be taught:

- quality control techniques used in stages of production, i.e.
 - application of tolerance
 - sampling techniques
 - comparison
 - corrective action
- application of basic inspection checks in stages of production, i.e.
 - visual checks (e.g. surface finish; comparisons with standard)
- use of inspection equipment in stages of production, i.e.
 - measuring equipment

- micrometers
- digital vernier calipers
- gauges
- comparators (e.g. master components; jigs/fixtures)
- X-rays and ultrasonics
- techniques for evaluating product from quality control checks i.e.
 - comparison of product against specification
 - precision and accuracy achieved in making processes
 - quality of outcome
 - measurement (e.g. important dimensions; datum edges/faces)
 - safety checks (e.g. consumer safety; non-destructive tests)

Learning Outcome 3: Know how modern technologies can be used in quality control

Learners must be taught:

- applications of modern technologies, i.e.
 - non-destructive testing (e.g. visual inspection; ultrasonic testing; dye penetrant; X-ray crack testing)
 - 3D scanning
 - CNC measurement checks
 - use of robotics
 - application within Computer Integrated Engineering (CiE)/Computer Integrated Manufacture (CIM)
 - automatic inspection/rejection

Learning Outcome 4: Know the principles of lean manufacturing

Learners must be taught:

- causes of waste in manufacturing, i.e.
 - time
 - materials
 - resources
 - processes
 - supply
 - space
- categories of waste (7 lean wastes – TIMWOOD), i.e.
 - Transportation
 - Inventory
 - Movement
 - Waiting
 - Over-processing
 - Over-production

- Defects
- methods of reducing waste, i.e.
 - Design for Manufacturing Assembly (DFMA), i.e.
 - common fixing strategy
 - standardised components
 - complexity reduction
 - make versus buy
 - handling and processes
 - sustainable design (e.g. material reduction, life cycle analysis, end-of-life disposal, recycled materials)

Connections between units for synoptic assessment

Whilst we do not prescribe the order in which units should be assessed, because of the interdependence between units, it is strongly recommended that learners complete the learning for unit R109 Engineering materials, processes and production and unit R110 Preparing and planning for manufacture, before undertaking assessment of this unit as key knowledge, skills and understanding developed in those units underpin assessment of this unit.

Further information regarding synoptic assessment within this qualification can be found under section 3.2 *Synoptic Assessment*.

3 Assessment

3.1 Overview of the assessment in the Cambridge Nationals in Engineering Manufacture

Entry code	Qualification title	GLH	Qualification Number
J832	OCR Level 1/2 Cambridge National Award in Engineering Manufacture	60	601/1218/9
Made up of:			
<ul style="list-style-type: none"> Units R109 and R110. 			
J842	OCR Level 1/2 Cambridge National Certificate in Engineering Manufacture	120	601/1219/0
Made up of:			
<ul style="list-style-type: none"> Units R109, R110, R111 and R112. 			

Individual unit details below:

Unit R109: <i>Engineering materials, processes and production</i>	
30 GLH 1 hour written paper 60 marks (60 UMS) OCR set and marked	This question paper: <ul style="list-style-type: none"> comprises short-answer and extended-response questions. assesses the quality of written communication.
Unit R110: <i>Preparing and planning for manufacture</i>	
30 GLH Centre-assessed tasks 60 marks (60 UMS) Centre-assessed and OCR-moderated	The centre-assessed task: <ul style="list-style-type: none"> will be practical tasks in the context of an assignment, selected from the OCR bank of set assignments.
Unit R111: <i>Computer aided manufacturing</i>	
30 GLH Centre-assessed tasks 60 marks (60 UMS) Centre-assessed and OCR-moderated	The centre-assessed task: <ul style="list-style-type: none"> will be practical tasks in the context of an assignment, selected from the OCR bank of set assignments.
Unit R112: <i>Quality control of engineered products</i>	
30 GLH Centre-assessed tasks 60 marks (60 UMS) Centre-assessed and OCR-moderated	The centre-assessed task: <ul style="list-style-type: none"> will be practical tasks in the context of an assignment, selected from the OCR bank of set assignments.

A bank of set assignments is available free of charge from the OCR website for the centre-assessed Units R110–R112.

To claim the OCR Level 1/2 Cambridge National Award in Engineering Manufacture (60 GLH) qualification, learners must complete Units R109 and R110.

To claim the OCR Level 1/2 Cambridge National Certificate in Engineering Manufacture (120 GLH) qualification, learners must complete Unit R109, Unit R110, Unit R111 and Unit R112.

3.2 Synoptic assessment

Synoptic assessment is an important aspect of the Level 1/2 Cambridge National Certificate in Engineering Manufacture. Assessment in this qualification is designed to require learners to draw on the skills, knowledge and understanding they have acquired through their studies and utilise them in an appropriate and relevant way to complete the key tasks, leading to a more progressive and holistic understanding of the subject content. We have taken this approach to support learners in developing their ability to go on to apply what they learn from this qualification to new and different situations and contexts.

Learners will take four mandatory units. We do not prescribe the order in which the units are assessed but because of the interdependence between the units, learners will need to synthesize the knowledge, skills and understanding they develop in the first two units, in order to apply them to relevant contexts when they complete the assessment for the other units. For that reason, we strongly recommend that learners complete the learning for the following units Engineering materials, processes and production R109 and Preparing and planning for manufacture R110, before undertaking assessment in other units.

Synoptic assessment is included between Units R109 and R110 and all other units. This specification will support synoptic assessment by:

- showing teaching and learning links between the units across the specification
- giving guidance which supports the marking criteria for the units, about where learners could apply the knowledge and understanding from the core units to improve their performance.

At the end of the marking criteria for each unit, we have provided information on connections between areas of learning to help with the planning of teaching and learning, and to support assessment decisions for the internally assessed units. Learners should sequentially build up their knowledge, skills and understanding between the first two units R109 and R110 and the other units through their programme of learning. You will find that no matter what units are taken, they will always draw on fundamental knowledge, skills and understanding from the first two units. For example, in Unit R109, learners will develop the following knowledge, skills and understanding which can be applied to **all** other optional units within the qualification, such as:

- In unit R111 – learners may build on their learning from R109, relating to engineering materials and their characteristics and of the applications of computer controlled production processes, (CNC) machining processes, for the manufacture of their product components.
- In unit R112 - learners may build on their learning from R109 relating to quality control checks. Learners will have an understanding of 'quality control checks to review finished pre-production products' which can be applied in in this unit.

This qualification also supports synoptic learning and assessment by employing the following principles:

- to enable learners to demonstrate an ability to use and apply a range of different methods and/or techniques
- to provide assessment that encourages learners to put forward different ideas and/or explanations to support decisions they have made
- to develop learners' ability to suggest or apply different approaches to contexts and situations
- to develop and assess learners' use of transferable skills
- to enable learners to demonstrate analytical and interpretation skills (of situations and/or results) and the ability to formulate valid well-argued responses
- to enable learners to evaluate and justify their decisions, choices and recommendations.

3.3 Grading and awarding grades

All results are awarded on the following scale:

- Distinction* at Level 2 (*2)
- Distinction at Level 2 (D2)
- Merit at Level 2 (M2)
- Pass at Level 2 (P2)
- Distinction at Level 1 (D1)
- Merit at Level 1 (M1)
- Pass at Level 1 (P1)

The shortened format of the grade will be displayed on Interchange and some administrative documents provided by OCR. However, the full format of the grade will appear on the certificates issued to learners.

The boundaries for Distinction at Level 2, Pass at Level 2, and Pass at Level 1 are set judgementally. Other grade boundaries are set arithmetically.

The Merit (Level 2) is set at half the distance between the Pass (Level 2) grade and the Distinction (Level 2) grade. Where the gap does not divide equally, the Merit (Level 2) boundary is set at the lower mark (e.g. 45.5 would be rounded down to 45).

The Distinction* (Level 2) grade is normally located as far above Distinction (Level 2) as Merit (Level 2) is below Distinction (Level 2).

To set the Distinction (Level 1) and Merit (Level 1) boundaries, the gap between the Pass (Level 1) grade and the Pass (Level 2) grade is divided by 3, and the boundaries set equidistantly. Where this division leaves a remainder of 1, this extra mark will be added to the Distinction (Level 1)-Pass (Level 2) interval (i.e. the Distinction (Level 1) boundary will be lowered by 1 mark). Where this division leaves a remainder of 2, the extra marks will be added to the Distinction (Level 1)-Pass (Level 2) interval, and the Merit (Level 1)-Distinction (Level 1) interval, i.e. the Distinction (Level 1) boundary will be lowered by 1 mark, and the Merit (Level 1) boundary will be lowered by 1 mark.

For example, if Pass (Level 2) is set judgementally at 59, and Pass (Level 1) is set judgementally at 30, then Distinction (Level 1) is set at 49, and Merit (Level 1) is set at 39.

Grades are indicated on qualification certificates. However, results for learners who fail to achieve the minimum grade (Pass at Level 1) will be recorded as *unclassified* (U or u) and this is **not** certificated.

These qualifications are unitised schemes. Learners can take units across several different series and they can also resit units. Please refer to section 7.4 *Unit and qualification resits*. Grade boundaries are set per unit, per series. As such, grade boundaries may be set in different places for a unit in different series. When working out learners' overall grades, OCR needs to be able to compare performance on the same unit in different series when different grade boundaries may have been set, and between different units. OCR uses a Uniform Mark Scale to enable this to be done.

A learner's uniform mark for each unit is calculated from the learner's raw mark on that unit. The raw mark boundary marks are converted to the equivalent uniform mark boundary. Marks between grade boundaries are converted on a pro rata basis.

When unit results are issued, the learner's unit grade and uniform mark are given. The uniform mark is shown out of the maximum uniform mark for the unit, e.g. 40/60.

The uniform mark boundaries for each of the assessments are shown below:

Unit GLH	Max Unit Uniform Mark	Unit Grade							U
		Distinction* at L2	Distinction at L2	Merit at L2	Pass at L2	Distinction at L1	Merit at L1	Pass at L1	
30	60	54	48	42	36	30	24	18	0

The learner's uniform mark for Unit R109 will be combined with the uniform mark for the centre-assessed units to give a total uniform mark for the qualification. The learner's overall grade will be determined by the total uniform mark. The following table shows the minimum total mark for each overall grade:

Qualification	Max Uniform Mark	Qualification Grade							U
		Distinction* at L2	Distinction at L2	Merit at L2	Pass at L2	Distinction at L1	Merit at L1	Pass at L1	
Award	120	108	96	84	72	60	48	36	0
Certificate	240	216	192	168	144	120	96	72	0

3.4 Performance descriptors

The performance descriptors indicate the level of attainment associated with Distinction at Level 2, Pass at Level 2 and Pass at Level 1. They are for use at awarding meetings. They give a general indication of the levels of attainment likely to be shown by a representative learner performing at these boundaries.

Performance descriptor – Distinction at Level 2

Learners will be able to:

- recall, select and apply **detailed** knowledge and **thorough** understanding of engineering
- present information **clearly** and **accurately**, using a **wide range** of technical language and engineering terminology
- apply **relevant** knowledge, understanding and skills in a **range** of situations to plan and carry out investigations and tasks **effectively**, testing their solutions, and working safely and with a **high degree of precision**
- analyse and evaluate the evidence available, reviewing and adapting their methods **where appropriate**
- make **reasoned** judgements and **substantiated** conclusions
- work **confidently and independently** to create material which reflects **thoughtful** planning, skilled development and **perceptive** evaluation as well as **actively demonstrating** practical skills at a **high level**.

Performance descriptor – Pass at Level 2

Learners will be able to:

- recall, select and apply **sound** knowledge and understanding of engineering
- present information **clearly** and with **some accuracy**, using a **range** of technical language and engineering terminology
- apply knowledge, understanding and skills in a **range** of situations to plan and carry out investigations and tasks, testing their solutions, and working safely and with **precision**
- review evidence available, analysing and evaluating **some** information **clearly** and making **some basic** adaptations to their methods
- make **judgements** and draw **appropriate** conclusions
- work with **some independence** to create material which reflects **effective** planning, development and evaluation and an ability to demonstrate **sound** practical skills.

Performance descriptor – Pass at Level 1

Learners will be able to:

- recall, select and apply knowledge and understanding of **basic** aspects of engineering
- present **basic** information, using **limited** engineering terminology
- apply **limited** knowledge, understanding and skills to plan and carry out **simple** investigations and tasks, with an awareness of the need for safety and precision
- review evidence and draw **basic** conclusions
- show **some evidence of independent work** to create material which demonstrates a degree of planning, development and evaluation and **limited** practical skills.

3.5 Quality of written communication

Quality of written communication (QWC) is assessed in the mandatory externally assessed unit.

Learners are expected to:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
- present information in a form that suits its purpose
- use a suitable structure and style of writing
- use specialist terminology, where applicable.

QWC is integrated into mark schemes and therefore assessed qualitatively, as an integral part of extended response questions.

4 The centre-assessed units (R110-R112)

This section provides guidance on the completion of the centre-assessed units.

4.1 The centre-assessed units

Each of the centre-assessed units (R110–R112) is designed to provide learners with the opportunity to build a portfolio of evidence to meet the learning outcomes for that unit.

We recommend that teaching and development of subject content and associated skills be referenced to real vocational situations, through the utilisation of appropriate industrial contact, vocationally experienced delivery personnel, and real-life case studies.

Units R110–R112 are centre assessed and externally moderated by OCR. Centres can choose whether they would like moderation via the OCR Repository or postal moderation.

Appendix B of this specification contains assessment guidance for the centre-assessed units, which should be referred to in conjunction with the unit content and marking criteria grids to inform delivery of the units. The assessment guidance aims to provide clarification regarding the scope of the learning required in specific areas of the units where this is felt to be beneficial.

4.2 Tasks for the centre-assessed units

4.2.1 Units R110-R112

A bank of set assignments is provided by OCR for Units R110–R112. Centres must select from the set assignments provided to use when assessing their learners. The assignments will be available free of charge from the OCR website. Learners are able to work on the tasks any time until the date the centre collects the work for internal assessment. OCR will review the set assignments annually which may result in an assignment being withdrawn and replaced. It is up to the centre to check the OCR website to see which set assignments are available to be used. We will give approximately 12 months' notice if a set assignment is to be withdrawn and replaced so that we do not disadvantage any learners who have already started working on an assignment that is to be replaced.

Centres can make modifications to the set assignments that OCR provides so that the assignment can be put within a local context that learners might relate to more easily, or to allow for differences in the materials, equipment and facilities at different centres. Guidance on what can be modified is given in each assignment in the section Information for Teachers under *Scope of permitted set assignment modification*. If modifications are made to the set assignment, whether to just the scenario or to both the scenario and tasks, it is up to the centre to ensure that all learning outcomes can be met and that learners can access the full range of marks.

The duration of the assessment for centre-assessed units is included in the guided learning hours for the unit. Guidance will be given within the section “Information for Teachers” in each set assignment as to approximately how long learners should expect to spend on each task.

The OCR set assignments are provided for summative assessment and not as practice materials.

Teachers must ensure learners are clear about the tasks they are to undertake and the criteria which they are expected to meet.

4.2.2 Methods of assessment

It is the assessor's responsibility to choose the best method of assessing a learner in relation to their individual circumstances. The methods chosen must be:

- valid
- reliable
- safe and manageable and
- suitable to the needs of the learner.

Valid

Validity can be compromised if a learner does not understand what is required of them. For example, one valid method of assessing a learner's knowledge and understanding is to question them. If the questions posed are difficult for the learner to understand (not in terms of the content but the way they are phrased, for example) the validity of the assessment method is questionable.

As well as assessment methods being valid, the evidence presented must also be valid. For example, it would not be appropriate to present an organisation's equal opportunities policy as evidence towards a learner's understanding of how the equal opportunities policy operates within the organisation. It would be more appropriate for the learner to incorporate the policy within a report describing different approaches to equal opportunities.

Reliable

A reliable method of assessment will produce consistent results for different assessors on each assessment occasion. Internal moderators must make sure that all assessors' decisions are consistent.

Safe and manageable

Assessors and internal moderators must make sure that the assessment methods are safe and manageable and do not put unnecessary demands on the learner.

Suitable to the needs of the learner

OCR is committed to ensuring that achievement of these awards is free from unnecessary barriers. Centres must follow this commitment through when designing tasks and/or considering assessment.

4.3 Completing the tasks

Teachers/assessors are expected to supervise and guide learners when undertaking work that is centre assessed. It should be remembered, however, that the final pieces of work must be produced solely by the individual learner.

When supervising tasks, teachers/assessors are expected to:

- exercise continuing supervision of work in order to monitor progress and to prevent plagiarism
- exercise continuing supervision of practical work to ensure essential compliance with Health and Safety requirements
- ensure that the work is completed in accordance with the specification requirements and can be assessed in accordance with the specified marking criteria and procedures.

Centre-assessed work should be completed in the course of normal curriculum time, and supervised and marked by the teacher/assessor. Some of the work, by its very nature, may be undertaken outside the centre, for example, research work, testing, etc. As with all centre-assessed work, the teacher must be satisfied that the work submitted for assessment is the learner's own.

Learners are free to revise and redraft work without teacher/assessor involvement before submitting the work for assessment. The advice provided prior to final submission should only enable the learner to take the initiative in making amendments, rather than detailing what amendments should be made. This means that teachers/assessors must not provide templates, model answers or detail specifically what amendments should be made.

Adding, amending or removing any work after it has been submitted for final assessment will constitute malpractice.

4.3.1 Presentation of the final piece of work

Learners must observe the following procedures when producing their final piece of work for the centre-assessed tasks:

- work can be word processed or handwritten
- tables and graphs (if relevant) may be produced using appropriate ICT
- any copied material must be suitably acknowledged
- quotations must be clearly marked and a reference provided wherever possible
- a completed cover sheet must be attached to work submitted for moderation. The cover sheet must include the following information as well as the marks given for each of the assessment criteria:
 - centre number
 - centre name
 - candidate number
 - candidate name
 - unit code and title
 - assignment title.

4.4 Marking and moderating centre-assessed units

All centre-assessed units are internally marked by centre staff using OCR marking criteria and guidance and externally moderated by the OCR-appointed moderator.

The centre is responsible for appointing someone to act as the assessor. This could be the teacher who has delivered the programme or another person from the centre.

The marking criteria must be used to mark the learner's work. These specify the levels of skills, knowledge and understanding that the learner is required to demonstrate.

The primary evidence for assessment is the work submitted by the learner, however, the following assessment methods are considered suitable for teachers/assessors to adopt for these qualifications:

- **observation** of a learner performing a task
- **questioning** of the learner or witness.

Observation

The teacher/assessor and learner should plan observations together but it is the teacher's/assessor's responsibility to record the observation properly (for example, observing a learner undertaking a practical task). Further guidance on recording observations can be found in *Appendix A – guidance on witness statements*.

Questioning

Questioning the learner is normally an ongoing part of the formative assessment process and may, in some circumstances, provide evidence to support achievement of learning outcomes.

Questioning is often used to:

- test a learner's understanding of work which has been completed outside of the classroom
- check if a learner understands the work they have undertaken
- collect information on the type and purpose of the processes a learner has gone through.

If questioning is to be used as evidence towards achievement of specific learning outcomes, it is important that teachers/assessors record enough information about what they asked and how the learner replied, to allow the assessment decision to be moderated.

Questioning witnesses is normally an ongoing part of validating written witness statements. However, questioning witnesses can be used for other purposes. Teachers/assessors should be able to speak to witnesses and record, in whatever way is suitable, the verbal statements of these witnesses. A record of a verbal statement is a form of witness statement and could provide valuable evidence. Further guidance on the use of witness statements can be found in **Appendix A**.

4.4.1 Use of a 'best fit' approach to marking criteria

The assessment tasks should be marked by teachers/assessors according to the OCR marking criteria using a 'best fit' approach. For each of the marking criteria, teachers/assessors select the band descriptor provided in the marking grid that most closely describes the quality of the work being marked.

A range of marks is allocated to each learning outcome. Where marks are allocated to a number of statements within a learning outcome, marks should be awarded using a 'best fit' approach. For each of the learning outcomes, one of the descriptors provided in the mark scheme that most closely describes the quality of the work being marked should be selected.

Marking should be positive, rewarding achievement rather than penalising failure or omissions.

The award of marks **must be** directly related to the marking criteria.

- Each band descriptor covers all the relevant content for the learning outcomes.
- The descriptors should be read and applied as a whole.
- Make a 'best fit' match between the answer and the band descriptors.
- An answer does not have to meet all of the requirements of a band descriptor before being placed in that band. It will be placed in a particular band when it meets more of the requirements of that band than it meets the requirements of other bands.
- Where there is more than one strand within the band descriptors for a learning outcome and a strand has not been addressed at all, it is still possible for the answer to be credited within that mark band depending upon the evidence provided for the remaining strands. The answer should be placed in the mark band most closely reflecting the standard achieved across all strands within the band descriptors for a learning outcome; however, in this scenario, the mark awarded for that band should reflect that a strand has not been addressed.

When deciding the mark within a band, the following criteria should be applied:

- the extent to which the statements within the band have been achieved.

For example:

- an answer that convincingly meets nearly all of the requirements of a band descriptor should be placed at or near the top of that band. Where the learner's work *convincingly* meets the statements, the highest mark should be awarded
- an answer that meets many of the requirements of the band descriptor should be placed in the middle of the band. Where the learner's work *adequately* meets the statements, the most appropriate mark in the middle range should be awarded
- if an answer is on the border-line between two bands but it is decided that it fits better the descriptors for the lower of these two bands, then it should be placed near the top of that band. Where the learner's work *just* meets the statements for the higher band, the lowest mark for that band should be awarded.

Teachers/assessors should use the full range of marks available to them and award full marks in any band for work that fully meets that descriptor. This is work that is 'the best one could expect from learners working at that level'.

4.4.2 Annotation of learners' work

Each piece of internally assessed work should show how the marks have been awarded in relation to the marking criteria.

The writing of comments on learners' work, and cover sheet, provides a means of communication between teachers during the internal standardisation and with the moderator if the work forms part of the moderation sample.

4.5 Authentication

Teachers/assessors must be confident that the work they mark is the learner's own. This does not mean that a learner must be supervised throughout the completion of all work, but the teacher must exercise sufficient supervision, or introduce sufficient checks, to be in a position to judge the authenticity of the learner's work.

Wherever possible, the teacher should discuss work-in-progress with learners. This will not only ensure that work is underway in a planned and timely manner, but will also provide opportunities for teachers/assessors to check authenticity of the work.

Learners must not plagiarise. Plagiarism is the submission of another's work as one's own and/or failure to acknowledge the source correctly. Plagiarism is considered to be malpractice and could lead to the learner being disqualified. Plagiarism sometimes occurs innocently when learners are unaware of the need to reference or acknowledge their sources. It is therefore important that centres ensure that learners understand that the work they submit must be their own and that they understand the meaning of plagiarism and what penalties may be applied. Learners may refer to research, quotations or evidence but they must list their sources. The rewards from acknowledging sources, and the credibility they will gain from doing so, should be emphasised to learners as well as the potential risks of failing to acknowledge such material.

Learners' work must be authenticated as follows:

- **Each learner** must sign a declaration before submitting their work to their teacher. A candidate authentication statement that can be used is available to download from the OCR website. These statements should be retained within the centre until all enquiries about results, malpractice and appeal issues have been resolved. **A mark of zero must be recorded if a learner cannot confirm the authenticity of their work.**
- **Teachers** are required to declare the work submitted for internal assessment is the candidate's own work by completing a centre authentication form (CCS160) for each unit. Centre authentication forms should be retained within the centre until all post-results issues have been resolved.

4.5.1 Internal standardisation

It is important that all teachers/assessors work to common standards. Centres must ensure that, within each unit, the internal standardisation of marks across teachers/assessors and teaching groups takes place using an appropriate procedure.

This can be done in a number of ways. In the first year, reference material and OCR training meetings will provide a basis for centres' own standardisation. In subsequent years, this, or the centres' own archive material, may be used. Centres are advised to hold preliminary meetings of staff involved to compare standards through cross-marking a small sample of work. After most marking has been completed, a further meeting at which work is exchanged and discussed will enable final adjustments to be made.

4.5.2 Submitting marks

All work for centre assessment is marked by the teacher and internally standardised by the centre. Marks are then submitted to OCR; see Section 4.6 for submission dates of the marks to OCR.

There should be clear evidence that work has been attempted and some work produced. If a learner submits no work for a centre-assessed unit, then the learner should be indicated as being absent from that unit. If a learner completes any work at all for a centre-assessed unit, then the work should be assessed according to the marking criteria and the appropriate mark awarded, which may be zero.

4.6 Moderation

The purpose of external moderation is to ensure that the standard of marking is the same for each centre and to ensure that internal standardisation has taken place.

Centres can select from:

- **Moderated via OCR Repository (see section 4.6.1)**
- **Moderated via postal moderation (see section 4.6.2)**

The deadline dates for entries and submission of marks for each moderation method are detailed below. Centres must ensure when selecting a moderation method that the appropriate entry and marks submission deadlines can be adhered to.

Moderation method	January Series		June Series		November Series	
	Entries	Marks	Entries	Marks	Entries	Marks
Moderated via OCR Repository	21st Oct	10th Jan	21st Feb	15th May	4th Oct	5th Nov
Moderated via postal moderation	21st Oct	10th Jan	21st Feb	15th May	4th Oct	5th Nov

When making your entries, the entry option specifies how the work is going to be moderated.

For each unit, you must choose the same moderation method for **all** learners (i.e. all learners for that unit in that series must be entered using the same entry option). However, you can choose different moderation methods for different units and in different series.

Sample requests

Once you have submitted your marks, your exams officer will receive an email telling you which work will be sampled as part of the moderation. Samples will include work from across the range of attainment of the learners' work.

Each learner's work must have a cover sheet attached to it with a summary of the marks awarded for the task. If the work is to be submitted via OCR Repository this cover sheet must also be submitted electronically within each learner's files.

OCR will require centres to release work for awarding and archive purposes and the co-operation of the centre is most appreciated in these instances, as it is imperative to have work available at awarding meetings. If this is required, then centres will be notified as early as possible.

Centres will receive the final outcome of moderation when the provisional results are issued. The following reports will be issued via Interchange:

- Moderation adjustments report – this lists any scaling that has been applied to internally assessed units
- Moderator report to centres – this is a brief report by the moderator on the internal assessment of learners' work.

4.6.1 Moderated via OCR Repository

The OCR Repository is a secure website for centres to upload candidate work and for assessors to access this work digitally. Centres can use the OCR Repository for uploading marked candidate work for moderation.

Centres can access the OCR Repository via OCR Interchange, find their candidate entries in their area of the Repository, and use the Repository to upload files (singly or in bulk) for access by their moderator.

The OCR Repository allows candidates to produce evidence and files that would normally be difficult for postal submissions, for example, multimedia and other interactive unit submissions.

The OCR Repository is seen as a faster, greener and more convenient means of providing work for assessment. It is part of a wider programme bringing digital technology to the assessment process, the aim of which is to provide simpler and easier administration for centres.

All moderated units can be submitted electronically to the OCR Repository via Interchange: please check section 7.2.2 for unit entry codes for the OCR Repository.

There are three ways to load files to the OCR Repository:

1. Centres can load multiple files against multiple candidates by clicking on 'Upload candidate files' in the 'Candidates' tab of the Candidate Overview screen.
2. Centres can load multiple files against a specific candidate by clicking on 'Upload files' in the 'Candidate Details' screen.
3. Centres can load multiple administration files by clicking on 'Upload admin files' in the 'Administration' tab of the Candidate Overview screen.

Instructions for how to upload files to OCR using the OCR Repository can be found on [OCR Interchange](#).

4.6.2 Moderated via postal moderation

Your sample of work must be posted to the moderator within three days of receiving the request. You should use one of the labels provided by OCR to send the learners' work.

We would advise you to keep evidence of work submitted to the moderator, e.g. copies of written work or photographs of practical work. You should also obtain a certificate of posting for all work that is posted to the moderator.

Work may be submitted in digital format (on CD) for moderation but must be in a suitable file format and structure as detailed in Appendix C at the end of this specification.

5 Support

5.1 Free resources

The following materials are available on the OCR website:

- specification
- specimen assessment materials for unit R109
- a bank of set assignments for the centre-assessed units R110–R112.

5.2 Free Teaching and Learning resources

Our resources are designed to provide you with a range of teaching activities and suggestions that enable you to select the best activity, approach or context to support your teaching style and your particular students. Some resources also include sample candidate work and assessment, for exemplification of particular aspects of the specification. The resources are a body of knowledge that will grow throughout the lifetime of the specification. They include:

- Teaching activities
- Resources Links
- Delivery Guides
- Mapping Guides and Progress Trackers
- Examiners' Reports

Endorsed publications

We also work with a number of leading publishers who publish textbooks and resources for our specifications.

OCR

Oxford Cambridge and RSA

An OCR endorsed textbook

OCR

Oxford Cambridge and RSA

An OCR endorsed
supplementary resource

OCR

Oxford Cambridge and RSA

An OCR endorsed
teaching and learning tool

To see endorsed resources for individual subjects, visit the subject page on <https://www.ocr.org.uk/>

For more information on OCR's endorsement process visit <https://www.ocr.org.uk/qualifications/gcse-and-a-level-reform/teaching-and-learning-resources/endorsed-resources/>

5.3 Training

We provide face-to-face courses and live online training events (webinars) where you can benefit from information, advice and guidance from subject experts and network with fellow professionals. We also produce presentations and films that provide detailed information and feedback about specifications, grading criteria and candidate performance in past sessions.

To find out more about professional development, please visit our website.

5.4 OCR Support services

5.4.1 Active results

Active Results is available to all centres offering Cambridge Nationals qualifications.



Active Results is a free results analysis service to help teachers review the performance of individual learners or whole schools.

Devised specifically for the UK market, data can be analysed using filters on several categories such as gender and other demographic information, as well as providing breakdowns of results by question and topic.

Active Results allows you to look in greater detail at your results:

- richer and more granular data will be made available to centres including question level data available from e-marking.
- you can identify the strengths and weaknesses of individual learners and your centre's cohort as a whole.
- our systems have been developed in close consultation with teachers so that the technology delivers what you need.

Further information on Active Results can be found on the [OCR website](#).

5.4.2 OCR Interchange

OCR Interchange has been developed to help you to carry out day-to-day administration functions online, quickly and easily. The site allows you to register and enter learners online. In addition, you can gain immediate and free access to learner information at your convenience. Sign up at <https://interchange.ocr.org.uk>.

6 Access

6.1 Equality Act information relating to Cambridge Nationals in Engineering

Cambridge Nationals in Engineering Manufacture require assessment of a broad range of competences and, as such, prepare learners for further study and higher level courses.

The Cambridge Nationals in Engineering Manufacture qualifications were reviewed to identify whether any of the competences required by the subject presented a potential barrier to any disabled learners. If this was the case, the situation was reviewed again to ensure that such competences were included only where essential to the subject.

6.2 Accessibility

There can be adjustments to standard assessment arrangements on the basis of the individual needs of learners. It's important that you identify as early as possible whether learners have disabilities or particular difficulties that will put them at a disadvantage in the assessment situation and choose a qualification or adjustment that allows them to demonstrate attainment.

If a candidate requires access arrangements in Cambridge Nationals assessments that require awarding body approval, then approval covering Cambridge Nationals must be gained in Access Arrangements Online. Approval from GCSE or GCE applications alone no longer extends to other qualification types. For guidance or support please contact the OCR Special Requirements Team.

The responsibility for providing adjustments to assessment is shared between your centre and us. Please read the JCQ booklet *Access Arrangements and Reasonable Adjustments* at www.jcq.org.uk.

If you have learners who need a post-examination adjustment to reflect temporary illness, indisposition or injury when they took the assessment, please read the JCQ documents *A guide to the special consideration process*.

If you think any aspect of these qualifications unfairly restricts access and progression, please email or call our Customer Support Centre.

The access arrangements permissible for use in this specification are as follows:

Access arrangement	Yes/No	Type of assessment
Readers	Yes	All assessments
Scribes	Yes	All assessments
Practical assistants	Yes	All assessments
Word processors	Yes	All assessments
BSL interpreters	Yes	All assessments
Oral language modifiers	Yes	All assessments
Modified question papers	Yes	Timetabled examinations
Extra time	Yes	All assessments

7 Administration

Full details of the administrative arrangements can be found in the administration area of the OCR website www.ocr.org.uk/administration/ .

7.1 Availability of assessment

There are three assessment series each year in January, June and November. Learners can be entered for different units in different exam series. Assessment availability can be summarised as follows:

	Unit R109	Unit R110	Unit R111	Unit R112
January	✓	✓	✓	✓
June	✓	✓	✓	✓
November	–	✓	✓	✓

Certification is available each January, June and November.

7.2 Making entries

Centres must be registered with OCR in order to make any entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Details on how to register with OCR can be found on the [OCR website](#).

It is essential that unit entry codes are quoted in all correspondence with OCR.

7.2.1 Making estimated entries

Estimated entries are not required for Cambridge Nationals in Engineering Manufacture.

7.2.2 Making final unit entries

When making an entry, centres must quote unit entry code and component codes. For the centre assessed units, centres must decide whether they want to submit learners' work for moderation via the OCR Repository or via postal moderation. Learners' submitting work must be entered for the appropriate unit entry code from the table over the page.

Unit entry code	Component code	Assessment method	Unit title
R109	01	Written paper	<i>Engineering materials, processes and production</i>
R110 A	01	Moderated via OCR Repository	<i>Preparing and planning for manufacture</i>
R110 B	02	Moderated via postal moderation	
R111 A	01	Moderated via OCR Repository	<i>Computer aided manufacturing</i>
R111 B	02	Moderated via postal moderation	
R112 A	01	Moderated via OCR Repository	<i>Quality control of engineered products</i>
R112 B	02	Moderated via postal moderation	

The short title for these Cambridge National qualifications is CAMNAT and will display as such on Interchange and some administrative documents provided by OCR.

You do not need to register your candidates first; individual unit entries should be made for the series in which you intend to submit an internally assessed unit or sit the externally assessed examination.

Only make a certification entry using the overall qualification code (see below) in the final series.

7.3 Certification rules

Learners must be entered for qualification certification separately from unit assessment(s). If a certification entry is **not** made, no overall grade can be awarded.

Learners may be entered for:

- OCR Level 1/2 Cambridge National Award – certification code J832
- OCR Level 1/2 Cambridge National Certificate – certification code J842

Learners may be entered for certification of any combinations of the Award and Certificate qualifications concurrently.

Unit results used to calculate the result for one qualification can be re-used toward certification of other qualifications of a different size. This means that, as learners' progress through the course, they may certificate for the Award once they have completed the first two units and then 'top up' to the Certificate as they complete further units.

There are no terminal requirements for these qualifications therefore learners can complete units in any order.

7.4 Unit and qualification resits

Learners may resit each centre-assessed unit and the best unit result will be used to calculate the certification result.

Learners may resit the externally assessed Unit R109, **once**.

Centres must ensure that when arranging resit opportunities they are fair to all learners and do not give learners an unfair advantage over other learners.

Centres must ensure that when arranging resit opportunities they do not adversely affect other assessments being taken.

Arranging a resit opportunity is at the centre's discretion; resits should only be planned if it is clear that the learner has taken full advantage of the first assessment opportunity and formative assessment process. The summative assessment series must not be used as a diagnostic tool.

Learners may enter for the qualification an unlimited number of times. Learners must retake at least one unit, or take a different optional unit, for a new result to be issued.

7.5 Post-results services

Under certain circumstances, a centre may wish to query the result issued to one or more learners. Reviews of results requests for all units must be made immediately following the series in which the relevant unit was taken (by the reviews of results deadline).

Please refer to the [JCQ Post-Results Services booklet](#) and the [OCR Administration](#) page for further guidance about action on the release of results.

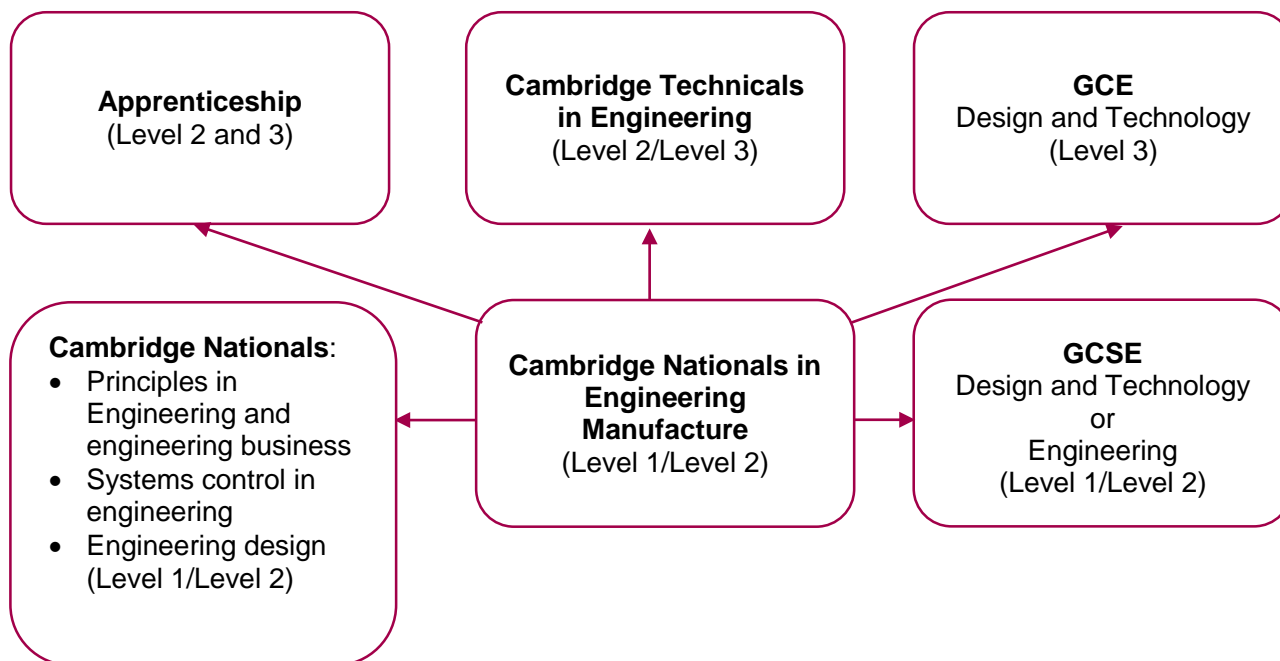
For internally assessed units, the review of results process cannot be carried out for one individual learner; the outcome of a review of moderation must apply to a centre's entire cohort.

7.6 Shelf-life of units

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the qualification.

8 Other information

8.1 Progression from these qualifications



OCR offers a flexible and responsive range of general and vocational engineering qualifications that allow suitable progression routes for all types of learners.

Centres are able to use these qualifications to create pathways that provide learners with the underpinning skills and knowledge that will enable them to choose the most appropriate progression routes for their particular needs (further study, Further Education (FE) or employment).

Progression from OCR Level 1/2 Cambridge National Award/Certificate/in Engineering to Cambridge Technicals in Engineering at Level 2 and Level 3.

Learners can progress from OCR Level 1/2 Cambridge National Award/Certificate in Engineering to **GCSE qualifications** in Engineering or various **GCE qualifications** in Design and Technology which will further develop areas of their learning from Level 1/Level 2.

8.2 Avoidance of bias

OCR has taken great care in preparing this specification and assessment materials to avoid bias of any kind. Special focus is given to the nine strands of the Equality Act with the aim of ensuring both direct and indirect discrimination is avoided.

8.3 Criteria requirements

This specification complies in all respects with the Regulator's General Conditions of Recognition.

8.4 Language

This specification is available in English only.

8.5 Spiritual, moral, ethical, social, legislative, economic and cultural issues

These qualifications provide potential for centres to develop learners' understanding of spiritual, moral, ethical, social, legislative, economic and cultural issues. This specification offers opportunities to contribute to an understanding of these issues in the following topics.

Issue	Opportunities for developing an understanding of the issue during the course
Spiritual issues	<ul style="list-style-type: none">developing knowledge and understanding of: how engineering has changed the way people interact with technology in their daily lives (including communication, shopping, gaming, entertainment, education and training, social networking etc.)
Moral issues	<ul style="list-style-type: none">learning about appropriate uses of materials and finite resources and the impact this could have on the environment, and the safe and responsible use of sustainable products
Ethical issues	<ul style="list-style-type: none">learning about the ethical implications of unregulated labour markets and fair-trade suppliershow engineering can affect the quality of life experienced by people and the responsibility to manufacture responsibly
Social issues	<ul style="list-style-type: none">social issues that can affect users of engineered products, including the use and abuse of communication devices etc.
Legislative issues	<ul style="list-style-type: none">the main aspects of legislation relating to engineering: copyright design and patents acts and other legislation as it applies to the design and production of engineered products
Economic issues	<ul style="list-style-type: none">learning how to make informed decisions about the choice, implementation, and use of materials in engineered products depending upon cost and the efficient management of money and resources
Cultural issues	<ul style="list-style-type: none">helping learners appreciate that engineering contributes to the development of our culture and to our highly technological futurehow learners need to show cultural awareness of their audience when communicating

8.6 Sustainable development, health and safety consideration and European developments with international agreements

These qualifications provide potential to heighten learners' awareness of sustainable development, health and safety considerations and European developments consistent with international agreements.

The specification incorporates learning about relevant health and safety, European and environmental legislation, and could include learning about how each of these factors has affected the use of engineered products for businesses and individuals.

Environmental issues

Learners have the opportunity to learn about how changes in working practices, due to developments in engineered products, have impacted upon the environment. This may include a reduction in carbon emissions due to improved production methods, the globalisation of manufacturing or the more efficient disposal techniques for engineered products that are used today.

Learners could also explore the effect on natural resources in the creation of engineered products including the environmental impact of digital devices and their use, deployment and eventual recycling and disposal.

The understanding of environmental issues will only form part of the assessment requirements where they are relevant to the specific content of the specification and have been identified within the taught content. Learners may choose to produce work that has an environmental theme or to enhance their learning by carrying out further personal study.

Appendix A: Guidance on witness statements

It is anticipated that the majority of evidence will be produced directly by the learner. Indirect evidence, such as witness statements, should only be used where it would be impractical for the learner to produce the evidence themselves.

Witness statements will, ideally, support the direct evidence produced by the learner.

- Care should be taken that a witness statement is impartial and free from bias. The use of relatives and close friends as witnesses should be avoided, if possible.
- In all cases, the witness will be required to declare their relationship to the learner.
- A witness statement should record what the learner has done and in doing so should not seek to repeat or paraphrase the marking criteria.
- The evidence presented by the witness should record the learner's individual contribution and should focus on the contribution made by the individual learner, as distinct from that of the group or team as a whole.
- Witnesses should describe what the learner did and not assess the learner. It is the responsibility of the teacher/assessor to judge the learner's skill, knowledge and understanding against the marking criteria. In doing so, the teacher/assessor will use the witness statement to determine the value of the evidence against the marking criteria and award marks accordingly.
- The teacher/assessor is responsible for briefing anyone who is to provide a witness statement. It is expected that the teacher/assessor will ensure that the witness is appropriately prepared and that any issues related to child protection have been fully considered.
- The role of the witnesses should be that of impartial observers and they should not become involved in carrying out the activity on behalf of the learner.
- In circumstances where a witness does assist the learner in accomplishing a task or activity, their input must be recorded within the statement so that the teacher/assessor can reflect this appropriately in the award of marks.

Where the above guidance has not been followed, the reliability of the witness statement may be called into question. In circumstances where doubt exists about the validity of a witness statement it cannot be used as assessment evidence and no marks may be awarded on the basis of it. If the unreliability of a witness statement becomes apparent during the moderation process moderators will be instructed to adjust centre marks in accordance with this directive.

An exemplar template for recording a witness statement is available from the OCR website and centres are encouraged to use this to assist in recording witness evidence. However, witness evidence may take different forms including digitally recorded spoken commentary or video. In these cases, additional accompanying documentation may be required to corroborate that the guidelines on witness statements detailed above have been followed.

Appendix B: Marking criteria for centre assessment

These qualifications are combined Level 1/Level 2, therefore the marking criteria for the centre-assessed units span both levels.

Unit R110: *Preparing and planning for manufacture*

Marking criteria guidance

0 marks must be given where there is no evidence or no evidence worthy of credit.

For a description of the key words (printed in **bold**) in the marking criteria, please see the *Marking criteria glossary of terms* in Appendix D. Teachers/assessors must use the complete description in the marking criteria and not rely only on the words in bold.

A range of marks is allocated to each learning outcome. Where marks are allocated to a number of statements within a learning outcome, marks should be awarded using a 'best fit' approach. For each of the learning outcomes, one of the descriptors provided in the mark scheme that most closely describes the quality of the work being marked should be selected. Marking should be positive, rewarding achievement rather than penalising failure or omissions. The award of marks **must be** directly related to the marking criteria.

Each band descriptor covers all the relevant content for the learning outcomes.

- The descriptors should be read and applied as a whole.
- Make a 'best fit' match between the answer and the band descriptors.
- An answer does not have to meet all of the requirements of a band descriptor before being placed in that band. It will be placed in a particular band when it meets more of the requirements of that band than it meets the requirements of other bands.
- Where there is more than one strand in the band descriptors for a learning outcome and a strand has not been addressed at all, it is still possible for the answer to be credited within that mark band depending upon the evidence provided for the remaining strands. The answer should be placed in the mark band most closely reflecting the standard achieved across all strands in the band descriptors for a learning outcome; however, in this scenario, the mark awarded for that band should reflect that a strand has not been addressed.

When deciding the mark within a band, the following criterion should be applied:

- the extent to which the statements within the band have been achieved.

For example:

- an answer that convincingly meets nearly all of the requirements of a band descriptor should be placed at or near the top of that band. Where the learner's work *convincingly* meets the statement, the highest mark should be awarded
- an answer that meets many of the requirements of the band descriptor should be placed in the middle of the band. Where the learner's work *adequately* meets the statement, the most appropriate mark in the middle range should be awarded

- if an answer is on the border-line between two bands but it is decided that it fits better the descriptors for the lower of these two bands, then it should be placed near the top of that band. Where the learner's work *just* meets the statement for the higher band, the lowest mark for that band should be awarded.

Teachers/assessors should use the full range of marks available to them and award full marks in any band for work that fully meets that descriptor. This is work that is 'the best one could expect from learners working at that level'. When learners are taking an assessment task, or series of tasks, for this unit they may be able to use relevant, appropriate knowledge, understanding and skills that they will have developed through the completion of Units R111 and/or R112.

Marking criteria grid

LO1: Be able to plan for the making of a pre-production product		
MB1: 1 – 2 marks	MB2: 3 – 4 marks	MB3: 5 – 6 marks
<p>With limited accuracy interprets 2D and 3D engineering drawings.</p> <p>Demonstrates a limited understanding of standard drawing conventions.</p> <p>Identifies some of the relevant details and requirements appropriate to the making of a pre-production product.</p>	<p>With some accuracy interprets 2D and 3D engineering drawings.</p> <p>Demonstrates a sound understanding of standard drawing conventions.</p> <p>Identifies most of the relevant details and requirements appropriate to the making of a pre-production product.</p>	<p>Accurately interprets 2D and 3D engineering drawings.</p> <p>Demonstrates a thorough understanding of standard drawing conventions.</p> <p>Identifies all relevant details and requirements appropriate to the making of a pre-production product.</p>
MB1: 1 – 4 marks	MB2: 5 – 8 marks	MB3: 9 – 12 marks
<p>Produces a basic production plan with limited detail and some reference to manufacturing operations. With regular assistance identifies appropriate tools, equipment and manufacturing processes, showing limited consideration of health and safety requirements and quality control checks.</p>	<p>Produces a production plan with adequate detail, showing a sequence of manufacturing operations. With occasional assistance identifies appropriate tools, equipment and manufacturing processes, showing some consideration of health and safety requirements and quality control checks.</p>	<p>Produces a detailed production plan, showing an effective sequence of manufacturing operations. Independently identifies appropriate tools, equipment and manufacturing processes with clear consideration of health and safety requirements and quality control checks.</p>
LO2: Be able to use processes, tools and equipment safely to make a pre-production product		
MB1: 1 – 4 marks	MB2: 5 – 8 marks	MB3: 9 – 12 marks
<p>Requires regular assistance to apply appropriate working practices when using hand and machine processes.</p> <p>With guidance, uses tools and equipment safely during the making of the product.</p>	<p>Works competently with occasional assistance. Applies appropriate working practices on most occasions when using hand and machine processes.</p> <p>Uses tools and equipment safely with some consistency during the making of the product. Identifies and uses PPE where necessary.</p>	<p>Works independently and competently. Applies appropriate working practices when using hand and machine processes.</p> <p>Consistently uses tools and equipment safely during the making of the product. Identifies and uses PPE where necessary.</p>

MB1: 1 – 6 marks	MB2: 7 – 12 marks	MB3: 13 – 18 marks
<p>Produces a pre-production product that meets some of the requirements of the engineering drawing and may be part finished. Produces a basic review of the quality of the product.</p> <p>Draws upon limited skills/knowledge/understanding from other units in the specification.</p>	<p>Completes a pre-production product that meets most of the requirements of the engineering drawing. Produces a review of the quality of the product using some appropriate quality control checks.</p> <p>Draws upon some relevant skills/knowledge/understanding from other units in the specification.</p>	<p>Completes a pre-production product that meets all of the requirements of the engineering drawing. Produces a thorough review of the quality of the product using appropriate quality control checks.</p> <p>Clearly draws upon relevant skills/knowledge/understanding from other units in the specification.</p>
LO3: Be able to modify a production plan for different scales of production		
MB1: 1 – 4 marks	MB2: 5 – 8 marks	MB3: 9 – 12 marks
<p>Identifies some areas of the production plan that require modification to reflect increased scale of production. Suggests some limited modifications to the production plan for making the product in quantity.</p>	<p>Identifies most areas of the production plan that require modification to reflect increased scale of production. Makes mostly appropriate modifications to the production plan for making the product in quantity.</p>	<p>Identifies all areas of the production plan that require modification to reflect increased scale of production. Makes appropriate modifications to the production plan for making the product in quantity.</p>

0 marks = no response or no response worthy of credit.

Guidance on synoptic assessment

Synoptic assessment is based upon demonstrating a broad and holistic understanding of the subject content. This is achieved by synthesizing the knowledge, skills and understanding that have been studied across the specification and utilising them in an appropriate and relevant way to complete the assessment for this unit.

The connections to content delivered in unit R109 identified below, are guidance only and learners may find other skills/knowledge/understanding that they are able to apply synoptically either in addition to or in place of this guidance. For example:

Learners will be taught properties and uses of engineering materials and engineering processes and their application in unit R109 that can be applied and assessed in context in unit R110 LO1 Be able to plan for the making of a pre-production product and LO2 Be able to use processes, tools and equipment safely to make a pre-production product.

Further, more detailed information regarding synoptic assessment can also be found under section 3.2 *Synoptic Assessment*.

Assessment guidance

Teachers/assessors must only accept evidence for assessment that is **authentic**. If any work is produced outside of direct supervision, the teacher/assessor must be certain that the work is the learners' own. Please see section 4.4 *Marking and moderating centre-assessed units*; 4.5 *Authentication*; for further guidance.

- LO1** – Correct interpretation of engineering drawings is to be evidenced in the production plan and the product made.
- LO2** – Assessment is to be based on the detail and logical sequencing contained in the plan for the making of the product. The engineering drawings given to the learners should be presented with the completed plan.
- LO3** – Learners will be assessed on their preparation/setting of machines and equipment, their application of the making plan, and the safe use of machines/equipment in the making of the product. A combination of hand and machine processes should be required in the making of the product, and the use of a minimum of three different processes must be demonstrated.

Evidence of the setting and safe use of machines/equipment should be provided in the portfolio by videos and/or digital photographs, which may be supported by signed witness statements.

Learners will need to present a justified review of the plan after completion of the making, suggesting any improvements/changes that could be made to any elements of the overall plan.

Learners should then produce a modified plan that would be suitable for use when making the product in larger quantities, such as in batch or mass production.

What do learners need to produce (evidence)	Examples of format of evidence (this list is not exhaustive)
Detailed plan for the making of the product.	<ul style="list-style-type: none">• <i>Paper or electronic portfolio containing engineering drawings, the production plan for the product, and the review and modified plan.</i>
Conventionally (non-CNC) made pre-production product.	<ul style="list-style-type: none">• <i>The portfolio is to include clear photographic evidence of stages in the making of the product, and of the finished product itself.</i>
A review/evaluation of the making plan and product.	<ul style="list-style-type: none">• <i>LO1 may be supported by witness testimony.</i>

A modified plan suitable for quantity production of the product.	
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Unit R111: Computer aided manufacturing

Marking criteria guidance

0 marks must be given where there is no evidence or no evidence worthy of credit.

For a description of the key words (printed in **bold**) in the marking criteria, please see the *Marking criteria glossary of terms* in Appendix D, Teachers/assessors must use the complete description in the marking criteria and not rely only on the words in bold.

A range of marks is allocated to each learning outcome. Where marks are allocated to a number of statements within a learning outcome, marks should be awarded using a 'best fit' approach. For each of the learning outcomes, one of the descriptors provided in the mark scheme that most closely describes the quality of the work being marked should be selected. Marking should be positive, rewarding achievement rather than penalising failure or omissions. The award of marks **must be** directly related to the marking criteria.

- Each band descriptor covers all the relevant content for the learning outcomes.
- The descriptors should be read and applied as a whole.
- Make a 'best fit' match between the answer and the band descriptors.
- An answer does not have to meet all of the requirements of a band descriptor before being placed in that band. It will be placed in a particular band when it meets more of the requirements of that band than it meets the requirements of other bands.
- Where there is more than one strand within the band descriptors for a learning outcome and a strand has not been addressed at all, it is still possible for the answer to be credited within that mark band depending upon the evidence provided for the remaining strands. The answer should be placed in the mark band most closely reflecting the standard achieved across all strands within the band descriptors for a learning outcome; however, in this scenario, the mark awarded for that band should reflect that a strand has not been addressed.

When deciding the mark within a band, the following criterion should be applied:

- the extent to which the statements within the band have been achieved.

For example:

- an answer that convincingly meets nearly all of the requirements of a band descriptor should be placed at or near the top of that band. Where the learner's work *convincingly* meets the statement, the highest mark should be awarded
- an answer that meets many of the requirements of the band descriptor should be placed in the middle of the band. Where the learner's work *adequately* meets the statement, the most appropriate mark in the middle range should be awarded
- if an answer is on the border-line between two bands but it is decided that it fits better the descriptors for the lower of these two bands, then it should be placed near the top of that band. Where the learner's work *just* meets the statement for the higher band, the lowest mark for that band should be awarded.

Teachers/assessors should use the full range of marks available to them and award full marks in any band for work that fully meets that descriptor. This is work that is 'the best one could expect from learners working at that level'. When learners are taking an assessment task, or series of tasks, for this unit they may be able to use relevant, appropriate knowledge, understanding and skills that they will have developed through the completion of Units R110 and/or R112.

Marking criteria grid

LO1: Be able to plan the production of components on Computer Numerical Control (CNC) machines		
MB1: 1 – 3 marks	MB2: 4 – 6 marks	MB3: 7 – 9 marks
<p>Produces a basic plan for the production of components on CNC machines that contains limited detail and considers some relevant factors in the production of components.</p> <p>The plan shows some coherence, but successful application by others would require significant additional information and clarification.</p>	<p>Produces an adequate plan for the production of components on CNC machines that contains some detail and considers most relevant factors in the production of components.</p> <p>The plan is coherent and successful application by others would require some additional information and clarification.</p>	<p>Produces a comprehensive and detailed plan for the production of components on CNC machines that considers all relevant factors in the production of components.</p> <p>The plan is coherent and successful application by others would require minimal clarification.</p>
LO2: Be able to interpret information from CAD to manufacture components on CNC equipment		
MB1: 1 – 4 marks	MB2: 5 – 8 marks	MB3: 9 – 12 marks
<p>Requires regular assistance to interpret a CNC program and needs regular prompting to demonstrate program operation.</p> <p>Considers some relevant factors when performing CNC programming operations</p>	<p>Requires occasional assistance to interpret a CNC program and demonstrates program operation with occasional prompting, making changes where appropriate.</p> <p>Considers most relevant factors when performing CNC programming operations.</p>	<p>Works independently and competently to interpret a CNC program and demonstrates program operation without prompting, making changes where appropriate.</p> <p>Considers all relevant factors when performing CNC programming operations.</p>
LO3: Be able to set-up and use Computer Numerical Control (CNC) equipment to manufacture components		
MB1: 1 – 5 marks	MB2: 6 – 10 marks	MB3: 11 – 15 marks
<p>Requires regular prompting to follow procedures to set-up a CNC machine correctly.</p> <p>Selects appropriate tools and equipment on some occasions, setting them with limited accuracy.</p> <p>Draws upon limited skills/knowledge/understanding from other units in the specification.</p>	<p>Requires occasional prompting to follow procedures to set-up a CNC machine correctly.</p> <p>Selects appropriate tools and equipment on most occasions, setting them with some accuracy.</p> <p>Draws upon some relevant skills/knowledge/understanding from other units in the specification.</p>	<p>Independently follows procedures to correctly set-up a CNC machine.</p> <p>Selects appropriate tools and equipment and sets them accurately.</p> <p>Clearly draws upon relevant skills/knowledge/understanding from other units in the specification.</p>

MB1: 1 – 3 marks	MB2: 4 – 6 marks	MB3: 7 – 9 marks
Requires regular assistance to produce products and follow safe use procedures. Requires prompting on most occasions to identify and use appropriate PPE.	Requires occasional assistance to produce products. Follows safe use procedures with some competence. Requires prompting on some occasions to identify and use appropriate PPE.	Works independently and competently to produce products. Competently follows safe use procedures and identifies and uses appropriate PPE.
MB1: 1 – 2 marks	MB2: 3 – 4 marks	MB3: 5 – 6 marks
Makes limited and occasionally relevant comparisons of manual and CNC produced components.	Makes some considered and mostly relevant comparisons of manual and CNC produced components.	Makes clear, considered and relevant comparisons of manual and CNC produced components.
LO4: Know about applications of computer controlled processes used to manufacture products		
MB1: 1 – 3 marks	MB2: 4 – 6 marks	MB3: 7 – 9 marks
<p>Outlines a limited range of applications of computer controlled processes to manufacture a component.</p> <p>Gives a basic description of computer controlled processes used for different scales of manufacture with few relevant examples</p>	<p>Describes a range of applications of computer controlled processes to manufacture a component in some detail.</p> <p>Gives an adequate description of computer controlled processes used for different scales of manufacture with some relevant examples.</p>	<p>Describes a wide range of applications of computer controlled processes used to manufacture a component in detail.</p> <p>Gives a comprehensive description of computer controlled processes used for different scales of manufacture with clear and relevant examples.</p>

0 marks = no response or no response worthy of credit.

Guidance on synoptic assessment

Synoptic assessment is based upon demonstrating a broad and holistic understanding of the subject content. This is achieved by synthesizing the knowledge, skills and understanding that have been studied across the specification and utilising them in an appropriate and relevant way to complete the assessment for this unit.

The connections to content delivered in unit R109 and unit R110 identified below, are guidance only and learners may find other skills/knowledge/understanding that they are able to apply synoptically either in addition to or in place of this guidance. For example:

Learners will be taught about developments in engineering processes, including applications of CNC, in unit R109 that can be applied and assessed in context in unit R111 LO1 Be able to plan the production of components on Computer Numerical Control (CNC) machines and LO3 Be able to set up and use Computer Numerical Control (CNC) equipment to manufacture components.

Learners will be taught skills to use processes, tools and equipment safely to make a pre-production product in unit R110 that can be applied and assessed in context in R111 LO3 Be able to set up and use Computer Numerical Control (CNC) equipment to manufacture components.

Further, more detailed information regarding synoptic assessment can also be found under section 3.2 *Synoptic Assessment*.

Assessment guidance

Teachers/assessors must only accept evidence for assessment that is **authentic**. If any work is produced outside of direct supervision, the teacher/assessor must be certain that the work is the learners' own. Please see section 4.4 *Marking and moderating centre-assessed units*; 4.5 *Authentication*; for further guidance.

LO1 – Learners should produce sufficiently clear and detailed plans for the production of components on CNC machines to allow successful application by others, with minimal reference back to the plan producer. It would be beneficial if the product made in Unit R110, or a component part thereof, is used as the basis for this exercise, in order to provide continuity through the units.

However, the priority should be to provide a focus for the planning which enables the learner to access the Learning Outcome to the best of their ability, which may be a product determined by the centre for this purpose rather than one derived from learners' study other units. Alternatively, and if necessary due to centre resources, learners could be provided with details of a product to be manufactured by the CNC equipment available. In either case, the product must involve machining operations that require a combination of tooling changes and complex shapes as appropriate.

LO2 – Assessment of this will be based on the effectiveness of the interpretation and the extent to which the learner is able to work independently. The program for the CNC manufacture of the product/component should be proved by on-screen simulation.

Evidence of interpreting a CNC programme and demonstrating programme operation should be provided in the portfolio by videos and/or digital photos, which may be supported by signed witness statements.

LO3 – Learners will be assessed on their efficient setting up of the CNC machines and equipment, and the safe use of machines in the making of components. Components must contain a minimum of two operations from manually controlled and CNC machining.

Evidence of the setting and safe use of machines/equipment should be provided in the portfolio by videos and/or digital photographs, which may be supported by signed witness statements.

Learners should use the results of the exercise and the components made to inform their work when comparing manual and CNC manufacturing methods.

LO4 – Learners must demonstrate their knowledge of applications of computer controlled processes used in product manufacture.

What do learners need to produce (evidence)	Examples of format of evidence (this list is not exhaustive)
The CAD file from which the component is produced.	<ul style="list-style-type: none"> • <i>Paper portfolio or PowerPoint presentation including CAD drawings, programs and making a plan for the CNC manufacture of the product.</i>
A plan for the making of the component.	<ul style="list-style-type: none"> • <i>Photographic evidence of stages of manufacture and of the finished products must be included.</i>
A CNC program for making the component.	<ul style="list-style-type: none"> • <i>Appropriate use of photographs to illustrate other areas of the portfolio, e.g. the final summary/comparison, should be encouraged.</i>
CNC produced components from bench fitting, machining or fabrication.	<ul style="list-style-type: none"> • <i>LO2 and LO3 may be supported by witness testimony.</i>
An evaluation/summary of the process and comparisons with manual manufacturing processes.	
A description of applications of computer controlled processes used to manufacture a component including different scales of manufacture.	

Unit R112: Quality control of engineered products

Marking criteria guidance

0 marks must be given where there is no evidence or no evidence worthy of credit.

For a description of the key words (printed in **bold**) in the marking criteria, please see the *Marking criteria glossary of terms* in Appendix D, Teachers/assessors must use the complete description in the marking criteria and not rely only on the words in bold.

A range of marks is allocated to each learning outcome. Where marks are allocated to a number of statements within a learning outcome, marks should be awarded using a 'best fit' approach. For each of the learning outcomes, one of the descriptors provided in the mark scheme that most closely describes the quality of the work being marked should be selected. Marking should be positive, rewarding achievement rather than penalising failure or omissions. The award of marks **must be** directly related to the marking criteria.

- Each band descriptor covers all the relevant content for the learning outcomes.
- The descriptors should be read and applied as a whole.
- Make a 'best fit' match between the answer and the band descriptors.
- An answer does not have to meet all of the requirements of a band descriptor before being placed in that band. It will be placed in a particular band when it meets more of the requirements of that band than it meets the requirements of other bands.
- Where there is more than one strand within the band descriptors for a learning outcome and a strand has not been addressed at all, it is still possible for the answer to be credited within that mark band depending upon the evidence provided for the remaining strands. The answer should be placed in the mark band most closely reflecting the standard achieved across all strands within the band descriptors for a learning outcome; however, in this scenario, the mark awarded for that band should reflect that a strand has not been addressed.

When deciding the mark within a band, the following criterion should be applied:

- the extent to which the statements within the band have been achieved.

For example:

- An answer that convincingly meets nearly all of the requirements of a band descriptor should be placed at or near the top of that band. Where the learner's work *convincingly* meets the statement, the highest mark should be awarded.
- An answer that meets many of the requirements of the band descriptor should be placed in the middle of the band. Where the learner's work *adequately* meets the statement, the most appropriate mark in the middle range should be awarded.
- If an answer is on the border line between two bands but it is decided that it fits better the descriptors for the lower of these two bands, then it should be placed near the top of that band. Where the learner's work *just* meets the statement for the higher band, the lowest mark for that band should be awarded.

Teachers/assessors should use the full range of marks available to them and award full marks in any band for work that fully meets that descriptor. This is work that is 'the best one could expect from learners working at that level'. When learners are taking an assessment task, or series of tasks, for this unit, they may be able to use relevant, appropriate knowledge, understanding and skills that they will have developed through the completion of Units R110 and/or R111.

Marking criteria grid

LO1: Understand the importance of quality control		
MB1: 1 – 2 marks	MB2: 3 – 4 marks	MB3: 5 – 6 marks
Describes some reasons for implementing quality control in production, with some limited examples. Describes some quality control procedures used in production.	Describes in detail most reasons for implementing quality control in production, with some clear examples. Describes most quality control procedures used in production in some detail.	Describes in detail all the reasons for implementing quality control in production, with a range of clear and relevant examples. Comprehensively describes all quality control procedures used in production.
LO2: Be able to assess product quality from inspection and quality control techniques		
MB1: 1 – 4 marks	MB2: 5– 8 marks	MB3: 9 – 12 marks
Outlines some quality control techniques and inspection checks used in stages of production.	Describes in some detail most quality control techniques and inspection checks used in stages of production.	Comprehensively describes all quality control techniques and inspection checks used in stages of production.
MB1: 1 – 5 marks	MB2: 6 – 10 marks	MB3: 11 – 15 marks
Requires regular assistance to inspect a product using appropriate tools and techniques. Produces a basic evaluation based on some quality control checks. Draws upon limited skills/knowledge/understanding from other units in the specification.	Requires occasional assistance to inspect a product using appropriate tools and techniques. Produces a detailed evaluation based on most quality control checks Draws upon some relevant skills/knowledge/ understanding from other units in the specification.	Works independently and competently to inspect a product using appropriate tools and techniques. Produces a detailed and comprehensive evaluation based on quality control checks Clearly draws upon relevant skills/knowledge/ understanding from other units in the specification
LO3: Know how modern technologies can be used in quality control		
MB1: 1 – 4 marks	MB2: 5 – 8 marks	MB3: 9 – 12 marks
Describes a limited range of applications of modern technologies in quality control.	Describes in some detail a range of applications of modern technologies in quality control.	Describes in detail a wide range of applications of modern technologies in quality control.

LO4: Know the principles of lean manufacturing		
MB1: 1 – 2 marks	MB2: 3 – 4 marks	MB3: 5 – 6 marks
Describes a limited range of categories of waste, with little reference to their cause.	Describes a range of categories of waste, with some references to their cause.	Describes a wide range of categories of waste, with many clear references to their cause.
MB1: 1 – 3 marks	MB2: 4 – 6 marks	MB3: 7 – 9 marks
Outlines methods used to reduce waste, showing limited knowledge of the different aspects of Design for Manufacturing Assembly and sustainable design considerations.	Describes in some detail methods used to reduce waste, showing adequate knowledge of the different aspects of Design for Manufacturing Assembly and sustainable design considerations.	Comprehensively describes methods used to reduce waste, showing detailed knowledge of the different aspects of Design for Manufacturing Assembly and sustainable design considerations.

0 marks = no response or no response worthy of credit.

Guidance on synoptic assessment

Synoptic assessment is based upon demonstrating a broad and holistic understanding of the subject content. This is achieved by synthesizing the knowledge, skills and understanding that have been studied across the specification, and utilising them in an appropriate and relevant way to complete the assessment for this unit.

The connections to content delivered in unit R109, R110 and R111 identified below, are guidance only and learners may find other skills/knowledge/understanding that they are able to apply synoptically, either in addition to, or in place of, this guidance. For example:

Learners will be taught about properties and uses of engineering materials in unit R109 that can be applied and assessed in context in unit R112 LO2 Be able to assess product quality from inspection and quality control techniques.

Learners will be taught skills to use processes, tools and equipment safely to make a pre-production product and the quality control checks in unit R110 that can be applied and assessed in context in R112.

Learners will be taught to set-up and use CNC equipment to manufacture components in unit R111 that can be applied and assessed in context in unit R112 LO3 Know how modern technologies can be used in quality control.

Further, more detailed information regarding synoptic assessment can also be found under section 3.2 *Synoptic Assessment*.

Assessment guidance

Teachers/assessors must only accept evidence for assessment that is **authentic**. If any work is produced outside of direct supervision, the teacher/assessor must be certain that the work is the learner's own. Please see section 4.4 *Marking and moderating centre-assessed units*; 4.5 *Authentication*; for further guidance.

LO1 – Assessment is to be based on the detail provided in the quality control procedure presented. Learners should be able to select, describe and justify appropriate quality control procedures to be applied.

This exercise could be based on the products made in Units 2 and 3, although the centre could provide suitable alternative products as necessary.

Where learners carry out the exercise as a team, it is important that the individual learner's contribution is clearly identified in the portfolio presented.

LO2 – Learners should show theoretical knowledge of a range of inspection and quality control techniques as indicated in the unit content. They will also be assessed on their ability to select and use appropriate tools and equipment to carry out an inspection of a product and evaluate product quality, based on the outcome of the inspection.

Evidence of inspecting a product using appropriate tools and techniques should be provided in the portfolio by videos and/or digital photos, which may be supported by signed witness statements.

LO3 – Learners will be required to demonstrate their knowledge of the use of modern technologies in quality control. A method that could be applied to the high-volume manufacture of the products used for LO1 and LO2 should be selected and described (if appropriate).

This can be research based by presenting a detailed, illustrated description of the process or from a practical application with written commentary.

LO4 – Assessment will be based on the learner’s ability to demonstrate their knowledge of the principles of lean manufacturing which could relate to the products used throughout the unit.

What do learners need to produce (evidence)	Examples of format of evidence (this list is not exhaustive)
Detailed procedure for the quality checking of engineered products.	<ul style="list-style-type: none"> • <i>Paper or electronic portfolio.</i>
Results of carrying out the procedure on the products with justified conclusions drawn.	<ul style="list-style-type: none"> • <i>Video and/or photographic evidence of stages in the procedure should be included in the portfolio.</i>
Description of applications of modern technologies in quality control that could be applied to high-volume manufacture.	<ul style="list-style-type: none"> • <i>Illustrated written descriptions of the application of modern technologies.</i>
Details of the application of lean manufacturing principles with conclusions and appropriate recommendations.	<ul style="list-style-type: none"> • <i>LO1 may be supported by witness testimony.</i> • <i>Description of applications of modern technologies in quality control.</i>

Appendix C: Guidance for the production of electronic internal assessment

Structure for evidence

The centre-assessed units are comprised of Units R110–R112. For each learner, all the tasks together will form a portfolio of evidence, stored electronically. Evidence for each unit must be stored separately.

An internal assessment portfolio is a collection of folders and files containing the learner's evidence. Folders should be organised in a structured way so that the evidence can be accessed easily by a teacher or moderator. This structure is commonly known as a folder tree. It would be helpful if the location of particular evidence is made clear by naming each file and folder appropriately and by use of an index called 'Home Page'.

There should be a top level folder detailing the learner's centre number, OCR candidate number, surname and forename, together with the unit code (R110, R111, R112), so that the portfolio is clearly identified as the work of one learner.

Each learner's internal assessment portfolio should be stored in a secure area on the centre's network. Prior to submitting the portfolio to OCR, the centre should add a folder to the folder tree containing the internal assessment and summary forms.

Data formats for evidence

In order to minimise software and hardware compatibility issues it will be necessary to save learners' work using an appropriate file format.

Learners must use formats appropriate to the evidence that they are providing and appropriate to viewing for assessment and moderation. Open file formats or proprietary formats for which a downloadable reader or player is available are acceptable. Where this is not available, the file format is not acceptable.

Centre-assessed tasks are designed to give learners an opportunity to demonstrate what they know, understand and can do using current technology. Learners do not gain marks for using more sophisticated formats or for using a range of formats. A learner who chooses to use only digital photographs (as required by the specification) and word documents will not be disadvantaged by that choice.

Evidence submitted is likely to be in the form of word-processed documents, presentation documents, digital photos and digital video.

To ensure compatibility, all files submitted electronically must be in the formats listed below. Where new formats become available that might be acceptable, OCR will provide further guidance. OCR advises against changing the file format that the document was originally created in. Files should be exported in a generic format that can be opened on a PC computer system without any specialist software applications. It is the centre's responsibility to ensure that the electronic portfolios submitted for moderation are accessible to the moderator and fully represent the evidence available for each learner.

Standard file formats acceptable as evidence for these Cambridge Nationals qualifications are listed below (please note not all these formats can be submitted via the OCR Repository):

- avi
- bmp
- csv
- doc
- fla
- flv
- gif
- jpg
- mov
- mp3
- mp4
- mpeg
- mpg
- odg
- odp
- ods
- odt
- pdf
- png
- pps
- ppt
- psd
- rar
- rtf
- swf
- sxc
- sxd
- sxi
- sxw
- tga
- tif
- txt
- wav
- wks
- wma
- wmf
- wmv
- xls
- zip

It is suggested that pdf files are supplied for native file types where possible.

N.B. Files created on a Mac must include the file extensions (e.g. webpage.html) to allow non-Mac users to open the files. When saving files created on a Mac, you must make sure the final file is saved as a PC version to allow your work to be moderated.

Accepted File Formats for the OCR Repository
Movie formats for digital video evidence
MPEG (*.mpg)
QuickTime movie (*.mov)
Macromedia Shockwave (*.aam)
Macromedia Shockwave (*.dcr)
Flash (*.swf)
Windows Media File (*.wmf)
MPEG Video Layer 4 (*.mp4)
Audio or sound formats
MPEG Audio Layer 3 (*.mp3)
Graphics formats including photographic evidence
JPEG (*.jpg)
Graphics file (*.pcx)
MS bitmap (*.bmp)
GIF images (*.gif)
Animation formats
Macromedia Flash (*.fla)
Structured markup formats
XML (*.xml)
Text formats
Comma Separated Values (.csv)
PDF (.pdf)
Rich text format (.rtf)
Text document (.txt)
Microsoft Office suite
PowerPoint (.ppt) (pptx, pptm)
Word (.doc) (docx, docm)
Excel (.xls) (xlsx, xlsm)
Visio (.vsd)
Project (.mpp)

Appendix D: Marking criteria glossary of terms

Accurately	Acting or performing within care and precision; within acceptable limits from a standard
Adequately	It is clear that the learner understands the concepts and principles but may not have provided the full details, expansion or examples needed in order to gain the highest marks
Advanced	Being at a high level; progressive
All	All relevant as described in the unit content for a specified area
Appropriate	Relevant to the purpose/task
Basic	The work comprises the minimum required and provides the base or starting point from which to develop. Responses are simple and not complicated; the simplest and most important facts are included
Brief	Accurate and to the point but lacking detail/contextualisation/examples
Clear	Focussed and accurately expressed, without ambiguity
Comment	Present an informed opinion
Communicate	Make known, transfer information
Complex	Consists of several interwoven parts, all of which relate together
Comprehensive	The work is complete and includes everything that is necessary to evidence understanding in terms of both breadth and depth
Confident	Exhibiting certainty; having command over one's information/argument etc.
Consider	Review and respond to given information
Considered	Reached after or carried out with careful thought
Consistently	A level of performance which does not vary greatly in quality over time
Create	To originate (e.g. to produce a solution to a problem)
Critical	Incisive – exposing/recognising flaws
Describe	Set out characteristics
Design	Work out creatively/systematically
Detail	To describe something item by item, giving all the facts
Detailed	Point-by-point consideration of (e.g. analysis, argument)
Discuss	Present, explain and evaluate salient points (e.g. for/against an argument)
Effective	Applies skills appropriately to a task and achieves the desired outcome; successful in producing a desired or intended result
Efficient	Performing or functioning in the best possible manner with the least waste of time and effort; having and using requisite knowledge, skill and effort
<p>Note on effective versus efficient: both express approval of the way in which someone or something works but their meanings are different. Effective describes something which successfully produces an intended result, without reference to morality, economy or effort, or efficient use of resources. Efficient applies to someone or something able to produce results with the minimum expense or effort, as a result of good organisation or good design and making the best use of available resources</p>	

Evaluate	Make a qualitative judgement taking into account different factors and using available knowledge/experience
Explain	Set out the purposes or reasons
Extensive	Large in range or scope
Few	A small number or amount, not many but more than one
Fully	Completely or entirely; to the fullest extent
High	Advanced in complexity or development
Independent	Without reliance on others
Limited	The work produced is small in range or scope and includes only a part of the information required; it evidences partial, rather than full, understanding
List	Document a series of outcomes or events or information
Little	A very small amount of evidence, or low number of examples, compared to what was expected, is included in the work
Many	A large number of (less than 'most' see below)
Most	Greatest in amount; the majority of; nearly all of; at least 75% of the content which is expected has been included
Occasionally	Occurring, appearing or done infrequently and irregularly
Outline	Set out main characteristics
Partly	To some extent, but not completely
Plan	Consider, set out and communicate what is to be done
Present	<ol style="list-style-type: none"> 1. Produce an exposition/résumé for an audience (e.g. at the conclusion of the project to demonstrate what has been done and the outcome) 2. Set out (project) aims, content, outcomes and conclusions clearly/logically for the use/ benefit of others
Range	The evidence presented is sufficiently varied to give confidence that the knowledge and principles are understood in application as well as in fact
Reasoned	Justified, to understand and to make judgements based on practical facts
Relevant	Correctly focused on the activity
Simple	The work is composed of one part only, either in terms of its demands or in relation to how a more complex task has been interpreted by the learner
Some	About 50% of the content which would have been expected is included
Sound	Valid, logical, shows the learner has secured relevant knowledge/understanding
Support	Teacher gives training, instruction, guidance and advice as appropriate and monitors activities to assist learners in tackling/completing their projects, ensuring authenticity and a fair and accurate assessment
Thorough	Extremely attentive to accuracy and detail
Wholly	Entirely; fully
Wide	The learner has included many relevant details, examples or contexts thus avoiding a narrow or superficial approach, broad approach taken to scope/scale; comprehensive list of examples given

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