OCR GCSE IN ENGINEERING (DOUBLE AWARD) (1492)

Foreword

This pack contains OCR's GCSE in Engineering (Double Award) Specification for teaching from September 2002.

First certification will be available in June 2004 and every January and June thereafter.

This specification is approved by QCA, ACCAC and CCEA as a qualification covering Levels 1 and 2 of the National Qualifications Framework.

Qualification Accreditation Number 100/1969/8

Key Features

- Fulfils NC PoS requirements at KS4 for Design and Technology for England.
- A clear progression route to the OCR VCE in Engineering and Manufacturing specifications.
- Specifications written in candidate-friendly language.
- Content similar to that of the OCR Part One GNVQs in Engineering.
- Guidance on the delivery and assessment within the specifications.
- Opportunities to co-teach across all GCSE Design and Technology specifications.
- Coursework can be linked to Key Skills.

Contents

Specimen Assessment Materials are included after this specification.

Specification Summary

SCHEME OF ASSESSMENT

Candidates will study the following **three** mandatory units.

Unit	Title	Type of Assessment	Entry Code	Weighting
1	Design and graphical communication	Portfolio	4866	33.33%
2	Engineered products	Portfolio	4867	33.33%
3	Application of technology	External	4868	33.33%

TIERS

The scheme of assessment consists of one tier covering the whole of the ability range grades A*A* to GG. Candidates achieving less than the minimum mark for grade GG will be unclassified.

INTERNAL ASSESSMENT

All candidates take Units 1 **and** 2.

EXTERNAL ASSESSMENT

All candidates take Unit 3. This unit is assessed through an externally set paper.

The paper comprises structured questions and will be one and a half hours in length. Candidates attempt **all** questions.

AVAILABILITY

External assessment is available in June 2004 and every January and June from 2005.

Portfolio moderation is available in June 2004 and every January and June from 2005. Centres wishing to receive earlier feedback or advice on coursework may arrange with OCR to contact a Portfolio Consultant.

First certification will be available in June 2004 and every January and June thereafter.

1 Introduction

1.1 RATIONALE

This specification leads to a GCSE in Engineering (Double Award) which covers both Levels 1 and 2 (Foundation and Intermediate Levels) of the National Framework of Qualifications and has been designed to raise attainment at these levels. Candidates study **three** units which provide a broad introduction to a wide range of vocational issues.

The specification builds upon the broad educational framework set out in the criteria for GCSEs in vocational subjects from the Qualifications and Curriculum Authority. GCSEs in vocational subjects are broad based vocational qualifications designed to widen participation in vocationally-related learning pre-16 and to encourage post-16 candidates to try a vocationally-related course where maybe another programme has previously not proved appropriate for them.

GCSEs in vocational subjects have been designed to contribute to the quality and coherence of national provision. They have been developed following widespread consultation by QCA in the autumn of 2000 and are based on Part One GNVQs which received positive Ofsted reports. GCSEs in vocational subjects have a clear place in the Government's vision for secondary education for the next ten years.

The GCSE in Engineering (Double Award) has been designed to form a qualification which provides the technical knowledge, skills and understanding associated with the subject at these levels so as to equip candidates with some of the skills they will need in the workplace or in further education or training. It allows candidates to experience vocationally-related learning so as to enable them to decide if it is suitable for them.

A GCSE in Engineering (Double Award) is an ideal qualification for those candidates who want a broad background in Engineering and the course of study prescribed by this specification can reasonably be undertaken by candidates entering this vocational area for the first time. It is designed to enable candidates to make valid personal choices upon completion of the qualification and to progress to further education, training or employment. It provides a suitable basis for further study in this subject or for related courses which could include GNVQs, VCEs, GCEs, NVQs or Modern Apprenticeships. It is designed to be delivered in full-time or part-time education.

Examples of appropriate employment to which a GCSE in Engineering (Double Award) candidate might progress include:

- automotive engineering, such as car and other vehicle manufacture and servicing;
- domestic goods manufacture and servicing;
- telecommunication servicing;
- ICT equipment maintenance;
- large and small scale engineering workshops.

Key Skills are integral to the specification and opportunities to provide evidence for the separate Key Skills qualification are signposted.

The fundamental philosophy of this specification is that, for candidates to appreciate fully the world of engineering, they must be actively involved in the designing and making of real products. This can be achieved by the careful structuring of the teaching of this course, applying various strategies, using local industry, work experience and other work based studies to enhance candidates' learning. Schemes such as Young Enterprise and other initiatives can also be used to provide stimulating and realistic themes.

The GCSE in Engineering (Double Award) has been designed to provide a range of teaching, learning and assessment styles to motivate candidates to achieve the best they can and to empower them to take charge of their own learning and development. Assessment is designed to give credit for what candidates can do as well as what they know. It is based both on portfolio evidence from assignments, set and assessed by the Centre and moderated by OCR, and an external assessment, which is set and marked by OCR.

This specification is supported by users as well as a range of professional institutes and Further and Higher Education Institutions including EMTA, the national training organisation for this vocational area.

'We are looking forward to moving from a variety of GCSEs and GNVQs into a single well balanced subject, giving all candidates the same starting point and opportunities' – JD (Head of D&T).

OCR has taken great care in the preparation of this specification and assessment material to avoid bias of any kind.

1.2 CERTIFICATION TITLE

This specification will be shown on a certificate as:

OCR GCSE in Engineering (Double Award).

1.3 LEVEL OF QUALIFICATION

This qualification is approved by QCA at Levels 1 and 2 of the National Qualifications Framework.

Candidates who gain grades GG to DD will have achieved an award at Level 1.
Candidates who gain grades CC to A*A* will have achieved an award at Level 2.

This qualification is of a standard which is broadly equivalent to two GCSEs at grades G to A*.

1.4 SPECIFICATION AIMS

Engineering covers a wide range of disciplines including mechanical, electrical, electronic, aeronautical, marine and automotive sectors. The GCSE in Engineering (Double Award) specification will enable candidates to develop a broad knowledge and understanding of the engineering industry, its organisation, products and processes through investigation, research and practical application.

The qualification will prepare candidates for employment, including work-based training, progression to Level 3 qualifications and provide an insight into engineering for candidates pursuing other career pathways. The qualification will introduce the skills, knowledge and understanding needed in engineering.

The qualification will build on candidates' previous experience in a number of National Curriculum subjects at Key Stages 1, 2 and 3 and will satisfy the requirements of the programme of study at Key Stage 4 for Design and Technology for England.

1.5 ASSESSMENT OBJECTIVES

Candidates for this qualification will be expected to demonstrate their ability to:

AO1 recall and apply their knowledge, skills and understanding specified in the subject content in a range of vocational situations;

AO2 plan and carry out investigations and tasks, using a range of tools, equipment, material, components and processes, in which they analyse vocational issues and problems; and gather, record and analyse relevant information, data and other forms of evidence;

AO3 evaluate evidence, make reasoned judgements and present conclusions accurately and appropriately.

The weightings for the assessment objectives over the whole qualification are:

AO1	43%
AO2	32%
AO3	25%

The weightings for the assessment objectives per unit are:

	Unit 1	**Unit 2**	**Unit 3**
AO1	30%	30%	70%
AO2	40%	40%	15%
AO3	30%	30%	15%
	100%	100%	100%

1.6 RECOMMENDED PRIOR LEARNING

Candidates entering this course should have achieved a general educational level equivalent to Entry Level 3 in the National Qualifications Framework, or Level 3 of the National Curriculum.

Prior learning, skills and aptitudes particularly relevant include:

- basic craft skills
- some aptitude for ICT;
- basic drawing skills;
- some motivation to work independently.

There is however no prior knowledge required for this specification.

1.7 PROGRESSION

1.7.1 Progression into Employment

This specification is designed to enable candidates to enter the world of work, rather than remain in full time education, to gain employment at operative or technician level within a wide range of engineering environments. Such candidates would normally enter employment through a work-related training programme.

The engineering sector is an important and fast moving area of employment and the well developed personal skills (e.g. initiative, teamwork, problem-solving) combined with work-related knowledge gained within a GCSE in Engineering (Double Award) means that candidates are particularly suitable for recruitment in a range of employment categories, e.g. general engineering, civil, mechanical, automotive, electrical, aeronautical engineering.

1.7.2 Progression to Further Qualifications

Candidates who achieve this qualification at Level 1 may wish to continue to courses such as GNVQ Engineering or NVQ Engineering at Level 1, or, if suitably qualified in other areas, could progress to courses such as Intermediate GNVQ Engineering or NVQ Engineering at Level 2.

Candidates who achieve this qualification at Level 2 may wish to continue to courses such as an Intermediate GNVQ Engineering or NVQ Engineering at Level 2, or, if suitably qualified in other areas, could progress to courses leading to the VCE in Engineering or GCE in Design and Technology or NVQ Engineering at Level 3.

A GCSE (Double Award) qualification may also be considered as equivalent to two GCSEs at grades A* to G for the purposes of admission to other level courses within the National Qualifications Framework, including GCSEs in other vocational areas.

1.8 RELATED QUALIFICATIONS

1.8.1 GCSEs/GNVQs

The units of this qualification have a significant overlap of content with the OCR GCSE Design and Technology, although it is expected that the teaching and assessment methods will be significantly different. The units also have a significant overlap of content with the OCR GNVQ in Engineering and the OCR GCSE in Manufacturing (Double Award).

The content of the three units of the GCSE in Engineering (Double Award) is very similar to that of Units 1, 2 and 3 of the six-unit GNVQs in Engineering.

1.8.2 Relationship to NVQs

This specification broadly introduces the candidate to skills relevant to a range of work placed NVQs, though the assessment methods are not designed to guarantee occupational competence. However, this qualification will support candidates working towards National Occupational Standards, detailed guidance for which will be issued by QCA in early 2002.

Unit 2: *Engineered products*, in particular, broadly contributes knowledge, understanding and skills for NVQ work based learning Levels 1, 2 and 3.

1.8.3 Exclusions

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Owing to overlap of content, there are restrictions on entering candidates for the following qualifications: GNVQ Engineering (Foundation or Intermediate); GNVQ Manufacturing (Foundation or Intermediate); GCSE Manufacturing. Such restrictions, if not prevented at the point of entry, will be picked up both when funding is calculated and when results leading to points towards performance tables are aggregated, as all of the above qualifications will have the same classification code and so be discounted for funding and performance table purposes.

1.9 SPIRITUAL, MORAL, ETHICAL, SOCIAL AND CULTURAL ISSUES

Engineering offers a wide range of opportunities for the exploration of spiritual, moral, ethical, social and cultural issues.

It is hoped that candidates studying this subject will gain an awareness of the effect of engineering and technological changes and how this influences communities, populations and individuals.

It is expected that this specification will be presented in ways which give scope for candidates to investigate how trends in engineering have had an impact on employment and related changes in the work place.

Legal issues are addressed in each unit, where appropriate.

Signposting

The purpose of the table on the following page is to signpost possible opportunities for delivering Spiritual, Moral, Ethical, Social and Cultural (SMESC) related issues.

Key:

Sp Spiritual **M** Moral **E** Ethical **So** Social **C** Cultural

Unit	Content	Sp	M	E	So	C
1	• **Sp So C** (tenuous) issues will have a bearing on design briefs of clients intended markets/customer base.	*			*	*
	• Communicating the design solution: **Sp So C**, in that clients represent varying sectors of society and preferences for styling aesthetics.	*			*	*
	• Awareness of regulations including health and safety introduces **M** and **E**.		*	*		
	• Research and analysis introduces **M** and **E** obligation when accessing and using source data and in meeting the design brief without compromising the integrity of the project.		*	*		
	• Communicating the final design solution: **So C** (tenuous).				*	*
2	• Schedule for manufacture: **Sp So C** (e.g. taking into account religious holiday and festivities affecting days available for work).	*			*	*
	• Quality control and health, safety and hygiene will introduce **M** and **E** considerations in terms of what is 'right', 'best' and/or fit for purpose, and in the use of certain products and processes and professional practice.		*	*		
	• The use of certain processes may be due to new developments/trends, hence a **So** aspect.				*	
3	• Implications of technology introduce **M** and **E** (e.g. increased technology such as robotics may lead to job losses). This will have a **So** impact which may differ across **Sp** and **C** groups.	*	*	*	*	*
	• Certain materials or processes may be by particular **Sp** or **C** groups.	*				*

1.10 CITIZENSHIP

Through the study of this subject it is hoped that candidates will develop further their social and moral responsibility. They will also be given the opportunity to develop their self-confidence and socially and morally responsible behaviour, both in and beyond the classroom.

The nature of this subject will enable candidates to develop a greater understanding of the role of engineering and employment in their community.

They will also have the opportunity to look at the influence politics has on the field of engineering, locally, regionally and nationally, and how political influences can help in a global market.

Signposting

The purpose of the following table is to signpost further possible opportunities for delivering Citizenship related issues.

Unit	Content
1	• Design briefs of clients intended markets/customer base (tenuous).
2	• Quality control and health, safety and hygiene, in terms of what is 'right', 'best' and/or fit for purpose, and in the use of certain products and processes and professional practice.
3	• Implications of technology (e.g. how computer literacy has affected rights etc.)

1.11 ENVIRONMENTAL ISSUES

OCR has taken account of the 1988 Resolution of the Council of the European Community and the Report *Environmental Responsibility: An Agenda for Further and Higher Education*, 1993 in preparing this specification and associated specimen assessments.

In Unit 1: *Design and graphical communication* and Unit 2: *Engineered products*, candidates are expected to consider environmental issues such as:

- the moral and legal responsibilities of designers and manufacturers to the end user and society in general;
- the importance of product labelling and product descriptions;
- where appropriate, any legislation, e.g. Health and Safety at Work, British Standards, food labelling;
- the difference between scrap and waste and how scrap and waste can be disposed of;
- recyclability and effects on the environment of both manufacturing processes and end products;
- the life cycle of a product.

Signposting

The purpose of the following table is to signpost further possible opportunities for delivering environment related issues.

Unit	Content
1	• Design specifications and the methods and materials.
2	• Quality control and health, safety and hygiene may introduce environmental issues in terms of what is 'right', 'best' and/or fit for purpose and in the use of certain products and processes and professional practice. • The use of certain processes may be due to new developments/trends with possibly an environmental aspect.
3	• Implications of technology. • The global environment and sustainability. • The use of certain materials may involve environmental concerns.

1.12 THE EUROPEAN DIMENSION

OCR has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen assessments. European examples should be used where appropriate in the delivery of the subject content. Relevant European legislation is identified within the specification where applicable.

Whilst at this level, local and national issues will predominate, teachers are expected to take appropriate opportunities to consider issues in the European context.

The nature of engineering can be strongly influenced through the impact of companies utilising skills in engineering in different European countries. Because of this it is expected that candidates will investigate the role of the UK and its influence in engineering terms within the European Union.

Signposting

The purpose of the following table is to signpost further possible opportunities for delivering European related issues.

Unit	Content
1	• Design specifications and the methods and materials. • Awareness of regulations including health and safety. • Engineering drawings and standards and conventions (i.e. BS numbers).
2	• Quality control and health, safety and hygiene will introduce legislation in terms of fitness for purpose and/or in the use of certain products and processes and professional practice.
3	• Implications of technology. • The use of certain materials may involve European concerns.

1.13 HEALTH AND SAFETY

Candidates are introduced to health and safety issues in the context of this sector and should be made aware of the significance of safe working practices.

Candidates should be made aware, at all times, of the need for working in a safe environment.

Candidates should develop an understanding of wider health and safety issues, such as pollution, and other environmental dangers to which engineering can contribute.

Candidates need to be aware of any legislation pertaining to Health and Safety which will have an impact upon either their working practices or the product on which they are working.

1.14 STATUS IN WALES AND NORTHERN IRELAND

This specification has been approved by ACCAC for use by Centres in Wales and by CCEA for use by Centres in Northern Ireland.

Candidates in Wales or Northern Ireland should not be disadvantaged by terms, legislation or aspects of government that are different from those in England. Where such situations might occur, including in the external assessment, the terms used have been selected as neutral, so that candidates may apply whatever is appropriate to their own situation.

OCR will provide specifications, assessments and supporting documentation in English. Further information concerning the provision of assessment materials in Welsh and Irish may be obtained from the Information Bureau at OCR (telephone 01223 553998)[1].

[1] The OCR Information Bureau is open to take your calls between 8.00am and 5.30pm. Please note that as part of our quality assurance programme your call may be recorded or monitored for training purposes.

2 Scheme of Assessment

2.1 NATURE OF ASSESSMENT

The assessment will be conducted in accordance with the GCSE, GCE, VCE and GNVQ Code of Practice. Two units will be assessed internally, through a teacher-assessed portfolio (see Section 2.3) and one unit will be assessed externally with the assessment set and marked by OCR (see Section 2.4). All internal assessment will be moderated by OCR.

2.2 UNITS

The content of each unit, together with detailed assessment evidence requirements, is described in Sections 5 to 8.

Candidates will study the following **three** mandatory units.

Unit	Title	Type of Assessment	Entry Code	Weighting
1	Design and graphical communication	Portfolio	4866	33.33%
2	Engineered products	Portfolio	4867	33.33%
3	Application of technology	External	4868	33.33%

External assessment is available in June 2004 and every January and June from 2005.
Portfolio moderation is available in June 2004 and every January and June from 2005.
First certification will be available in June 2004 and every January and June thereafter.

2.3 PORTFOLIO ASSESSMENT

2.3.1 Supervision and Authentication of Portfolios

OCR expects teachers to supervise and guide candidates who are producing portfolios. The degree of teacher guidance in candidates' work will vary according to the kind of work being undertaken. However, it should be remembered that candidates are required to reach their own judgements and conclusions.

When supervising candidates, teachers are expected to:

- offer candidates advice about how best to approach their tasks;
- exercise continuing supervision of work in order to monitor progress and to prevent plagiarism;
- 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.

Work on portfolios may be undertaken outside the Centre and in the course of normal curriculum time. As with all internally assessed work, the teacher must be satisfied that the work submitted for assessment is the candidate's own work. This does not prevent groups of candidates working together in the initial stages, but it is important to ensure that the individual work of a candidate is clearly identified separately from that of any group in which they work.

Throughout the course, the teacher should encourage the candidate to focus on achieving the criteria listed in the *Assessment Evidence Grids*. Teachers may set internal deadlines for candidates submitting work to them. Teachers may comment on a candidate's unit portfolio and return it for redrafting without limit until the deadline for the submission of marks to OCR. Internal Assessors must record details of any assistance given and this must be taken into account when assessing candidates' work. Once the mark for the unit portfolio has been submitted to OCR, no further work may take place.

2.3.2 Production and Presentation of Portfolios

Candidates must observe the following when producing portfolios:

- Any copied material must be suitably acknowledged.
- Quotations must be clearly marked and a reference provided wherever possible.
- Work submitted for moderation must be marked with the:

  Centre number;
  Centre name;
  candidate number;
  candidate name;
  specification code and title;
  unit code.
- All work submitted for moderation should be removed from cardboard files, ring binders and plastic wallets. Work must be held together by using treasury tags or an appropriate alternative (not paper clips).

2.3.3 Administering Portfolio Assessment

OCR will conduct all administration of GCSEs in vocational subjects through the Examination Officer at the Centre. Teachers are strongly advised to liaise with their Examination Officer to ensure that they are aware of key dates in the administrative cycle.

Assessment Record materials, including full details of administrative arrangements for portfolio assessment, will be forwarded to Examination Officers in Centres in Autumn 2002, following receipt of provisional entries. At the same time the materials will be made available within the Teacher's Guide and on the OCR website (www.ocr.org.uk). The materials will include master copies of mandatory forms on which to record assessments and will also include optional recording materials for the convenience of Centres. Forms may be photocopied and used as required.

The Assessment Evidence Grids

Centres are required to carry out internal assessment of portfolios using the *Assessment Evidence Grids* in accordance with OCR procedures. The process of using these grids is described in Section 2.3.4. Candidates' marks are recorded on the Unit Recording Sheets (URS).. One URS should be completed for each candidate's unit portfolio. This URS should be attached to the front of the candidate's portfolio for the unit when sent to the Moderator.

When candidates are given their assignments, they should also be issued with a reference copy of the appropriate *Assessment Evidence Grid*.

Candidates' portfolios should be clearly annotated to demonstrate where, and to what level, criteria have been achieved. This will help in the moderation process. If teachers do this well it will be very much in the interests of their candidates. On completion of a unit, the teacher must complete the URS and award a mark out of 50 for the unit. Details of this process are described in Section 2.3.4.

Internal Standardisation

It is important that all internal assessors, working in the same subject area, work to common standards. Centres are required to ensure that internal standardisation of marks across 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 Centres' own archive material, may be used. Centres are advised to hold a preliminary meeting 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.

Submission of Marks to OCR

The involvement of OCR begins on receipt of entries for a portfolio unit from a Centre's Examinations Officer. Entries for units to be included in any assessment session must be made by the published entry date from OCR. Late entries attract a substantial penalty fee.

By an agreed internal deadline the teacher submits the marks for the unit to the Examinations Officer. Marks will need to be available by the portfolio mark submission dates published by OCR and internal deadlines will need to reflect this. OCR will supply Centres with *MS1 Internal Assessment Mark Sheets* to record the marks and instructions for completion. It is essential that Centres send the top copy of these completed forms to OCR, the second copy to the Moderator and keep the third copy for their own records.

Moderation

Moderation will take place by post in January and June. Shortly after receiving the marks, the Moderator will contact the Centre and inform them of the sample of candidates' work that will be required, as outlined in Section 2.3.5.

2.3.4 Applying the Assessment Criteria

Sources of Guidance

The starting point in assessing portfolios is the *Assessment Evidence Grid* within each unit. These contain levels of criteria for the skills, knowledge and understanding that the candidate is required to demonstrate. The *Guidance for Teachers* within the unit expands on these criteria and clarifies the level of achievement the assessor should be looking for when awarding marks.

Before the start of the course OCR will produce a *Handbook for Teachers*. At INSET sessions in the autumn term OCR will provide examples of candidates' work which help to exemplify standards at grades AA, CC and FF that have been agreed with QCA and the other Awarding Bodies.

In the Autumn and Spring terms OCR will hold training meetings on portfolio assessment led by senior GCSE Moderators. Details of these are in the OCR INSET booklets which are sent to Centres in the Summer term or they may be obtained from the Training and Customer Support Division on 01223 552950. They are also published on the OCR website (www.ocr.org.uk).

OCR also operates a network of Portfolio Consultants. Centres can obtain advice on assessment of portfolios from an OCR Portfolio Consultant. These are both subject specialists and senior Moderators. Details of these may be obtained from the OCR Subject Officer.

Determining a Candidate's Mark

Each unit portfolio should be marked by the teacher according to the criteria in the *Assessment Evidence Grid*. Each row in the grid comprises a strand showing the development of a given criterion and corresponds to a point (a, b, c etc.) in the banner.

Each column describes the work undertaken by a candidate working within a range of grades. The criterion in the first column describes typical attainment of a candidate working within the range of grades GG to EE. The second column describes the work of a typical candidate working at grades DD, CC and the lower half of grade BB whilst the third column describes the work of a typical candidate working at the upper half of grade BB, grades AA and A*A*.

The maximum mark for that strand is shown in the right hand column.

Teachers use their professional judgement and circle the mark that *best fits* the work of the candidate and also record it on the URS in the column headed *Mark*.

Centres should use the full range of marks available to them; Centres must award *full* marks in any band for work which fully meets the criteria. This is work which is 'the best one could expect from candidates working at GCSE (Double Award) level'.

Only one mark per strand/row will be entered. The final mark for the candidate is out of a total of 50 and is found by totalling the marks for each strand.

Centres may find it helpful to use the assessment criteria holistically when initially assessing candidates' work. The outcome can then be compared with the final grade awarded through the procedure outlined above. If these differ, an explanation should be sought and the differences resolved.

2.3.5 Portfolio Moderation

After the unit portfolio is internally marked by the teacher and marking has been internally standardised, marks are submitted to OCR by a specified date, published in the Key Dates poster, after which moderation takes place in accordance with OCR procedures.

The purpose of moderation is to ensure that the standard of the award of marks for internally assessed work is the same for each Centre and that each teacher has applied the standards appropriately across the range of candidates within the Centre.

It is essential that the rank order of marks supplied to a Moderator is correct. If Centre assessment is inconsistent, work will be returned to the Centre for re-assessment.

The sample of work which is presented to the Moderator for moderation must show how the marks have been awarded in relation to the marking criteria defined in the unit.

Moderation for all units will be available in the January and June sessions.

Principles of Moderation

The following principles, agreed by the Awarding Bodies and QCA, indicate, in broad terms, how portfolio units will be moderated. OCR has detailed procedures that Moderators will follow to implement the moderation process.

Centres submit unit marks to OCR and to the Moderator by the published OCR submission dates.

The Moderator will select, from each unit, a sample of candidates' portfolios that covers a range of grades.

If the work seen overall has been assessed accurately and consistently to agreed national standards, within agreed tolerances, all unit marks submitted by the Centre are accepted with no adjustments.

Adjustments, where required, will be carried out by OCR using its normal procedure. Centres are not required to amend marks except if administrative issues, errors or order of merit problems are discovered.

Whilst Moderators may seek clarification from a Centre, they cannot negotiate portfolio marks in any way. OCR will inform Centres of the outcome of the moderation process at the time of publication of results. This will include a written report on any significant issues that arose during this process.

2.4 EXTERNAL ASSESSMENT

2.4.1 Tiering

The scheme of assessment consists of one tier covering the whole of the ability range grades A*A* to GG. Candidates achieving less than the minimum mark for grade GG will be unclassified.

2.4.2 Nature of External Assessment

OCR has designed external assessments which allow candidates to apply the knowledge and understanding they have gained from teacher-designed activities and assignments based on the *What You Need to Learn* section of the units.

It should be emphasised that unit delivery should not be focused on preparing candidates solely for the external assessment with the result that wider learning opportunities are missed. The external assessment forms only a small proportion of the learning within the unit but the grade achieved through it is based on the GNVQ approach to learning which involves practical work, assignments and independent research.

Specimen assessment material is included with this specification.

2.4.3 Re-sits

Candidates will be permitted to re-sit each assessment unit once only with better mark counting towards the final grade. Candidates may, however, retake the whole qualification more than once. For the purposes of the re-sit rule, it is the results of, not the entry for, a unit that counts.

The shelf life of assessment unit results is limited only by the shelf life of the qualification.

2.5 ADMINISTRATIVE ARRANGEMENTS

All administrative arrangements regarding entries, submission of marks, moderation, receipt of results documentation etc. are to be made through Examinations Officers.

Please note that it is very important for Examinations Officers to register provisional entries for Centres since this is the mechanism which triggers the issue of assessment recording materials and pre-release materials etc. to Centres.

2.5.1 Unit and Certificate Entries

Note that entry for units will *not* generate a final certificate – a separate certification entry for code 1492 must be made. This will usually be along with the final unit entries.

A candidate who has completed all the units required for a qualification may enter for certification at a later examination series. For example, a candidate who has completed all the required units but who has not entered for certification may do so in the *same* examination series within a specified period after the publication of results.

First certification will be available in June 2004 and every January and June thereafter.

2.5.2 Unit Availability

External assessment is available in June 2004 and every January and June from 2005.
Portfolio moderation is available in June 2004 and every January and June from 2005.

2.5.3 Moderation Arrangements

Portfolio moderation is offered in January and June. Centres wishing to receive earlier feedback or advice on coursework may arrange with OCR to contact a Portfolio Consultant.

Centres submit unit marks to OCR and to the Moderator by the published OCR submission dates.

2.5.4 Issue of Results

Individual assessment unit Statement of Results will be issued for all units (both portfolio units and external units) and will include, for each unit, the unit title, the unit UMS mark, information enabling UMS marks to be equated to GCSE (Double Award) grades and the date the unit was taken.

Candidates must be entered for certification code 1492 to claim their overall grade.

Note that entry for units will *not* generate a final certificate – a separate certification entry must be made at the appropriate time.

Certificates will include an explanatory note on the nature of double awards.

2.5.5 Fresh Start

To cater for candidates who need to restart a qualification, the Centre may request that all previous unit results relating to that qualification should be deleted. For example, a candidate may wish to make a *fresh start* after a period spent out of education. In such cases, OCR will use its discretion to decide whether such a request can be granted, given the time-scales involved and the need to uphold the integrity of the re-sit rules outlined above. Such requests will not normally be granted for whole cohorts of candidates.

2.6 GRADE DESCRIPTIONS

The following grade descriptions indicate the level of attainment characteristic of the given grade for this GCSE (Double Award). They give a general indication of the required learning outcomes at each specified grade. The descriptions should be interpreted in relation to the content outlined in the specification; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performances in others.

Grade FF Candidates are able to recall and apply basic knowledge, skills and understanding to engineering problems and tasks. Candidates will make use of a limited range of sources of information to analyse engineering problems and will clarify their ideas through discussion, drawing and modelling. With some support and guidance, candidates will plan and carry out investigations and will work with a range of tools, materials, equipment, components and processes with some precision in a safe and appropriate manner. Candidates will check their work as it develops and modify their approach in the light of progress. They will gather, record and analyse information from a limited range of evidence to test and evaluate their solutions to manufacturing problems. They will present conclusions based on a limited evaluation of the evidence.

Grade CC Candidates are able to recall and apply knowledge, skills and understanding to a range of engineering problems and tasks. Candidates will make use of a wide range of appropriate sources of information to analyse engineering problems and develop ideas. They will use a range of strategies to develop, clarify and communicate ideas, using appropriate media. With limited guidance, candidates will plan and carry out investigations, producing plans that make effective use of time and resources and will work with a range of tools, materials, equipment, components and processes. They will organise their work so that they can carry out processes accurately and consistently, and use tools, equipment, materials and components with precision in a safe and appropriate manner. They will adapt their methods of manufacture to changing circumstances, providing a sound explanation for any changes from the plan. Candidates will gather, record and analyse information from a range of sources, selecting appropriate techniques to test and evaluate solutions. They will present reasoned conclusions, based on their evaluation of the evidence.

Grade AA Candidates will recall and apply knowledge, skills and understanding to range of complex engineering problems and tasks. Candidates will be discriminating in their selection and use of a wide range of information sources to analyse engineering problems and develop ideas. They will identify conflicting demands on the design, manufacture and use of products. They will use a wide range of strategies to develop, clarify and communicate appropriate ideas and solutions using appropriate media. Candidates will independently plan and carry out investigations, making effective use of time and resources. They will demonstrate a sound understanding of materials, processes and components, and will work with a range of tools, equipment, materials and components to a high degree of precision in a safe and appropriate manner. They will organise their work so that they can carry out processes accurately and consistently and will review and adapt their methods of manufacture to changing circumstances, providing a well-reasoned explanation for any changes to the plan. They will gather, record and analyse information from a wide range of appropriate sources and will identify and apply a broad range of criteria for evaluating and testing their solutions. They will present carefully reasoned and appropriate conclusions, based on a systematic evaluation of the evidence.

2.7 AWARDING AND REPORTING

A new section of the Code of Practice, for GCSE (Double Award) qualifications, is to be introduced in September 2002. The qualifications will comply with the grading, awarding and certification requirements of this section of the Code of Practice.

A uniform mark scale (UMS) will be used to aggregate individual assessment units to generate qualification grades.

2.7.1 Unit Grades

Teachers assess each portfolio unit and award a raw score on a scale of 0-50. The evidence required to support the award of marks is given in the *Assessment Evidence* section of each unit. The OCR awarding committee will consider portfolios and will determine the grade thresholds for each unit.

The following table indicates the notional thresholds for the unit, but these are subject to adjustment by the awarding committee.

Grade	**A*A***	**AA**	**BB**	**CC**	**DD**	**EE**	**FF**	**GG**
Mark	45	40	35	30	25	20	15	10

The externally assessed unit will be marked by OCR. The maximum raw score will be stated on the front cover of the question paper.

2.7.2 Uniform Marks

Once the raw score for each unit has been established, it will be converted by OCR and reported to candidates as a Uniform Mark out of 100.

Uniform marks correspond to *unit* grades as follows:

	A*A*	**AA**	**BB**	**CC**	**DD**	**EE**	**FF**	**GG**
UMS (max 100)	90	80	70	60	50	40	30	20

Candidates who fail to achieve the standard for a grade GG will be awarded a Uniform Mark in the range 0-19 and will be recorded as UU (unclassified).

2.7.3 Overall Grade

The uniform marks awarded for each unit will be aggregated and compared to pre-set boundaries. Results for the qualification will be awarded on a scale of A*A* to GG and will be recorded twice on the certificate as such.

Uniform marks correspond to *overall* grades as follows:

	A*A*	**AA**	**BB**	**CC**	**DD**	**EE**	**FF**	**GG**
UMS (max 300)	270	240	210	180	150	120	90	60

2.8 SPECIAL ARRANGEMENTS

Candidates with special requirements must cover the assessment objectives. There may be more suitable ways of doing this than those used by the Centre with other candidates. Any Centre wishing to start candidates with special requirements on the course who might not be able to meet the requirements of the assessment must consult the Special Requirements Unit before doing so (telephone 01223 552505).

2.9 RESULTS ENQUIRIES AND APPEALS

Under certain circumstances, a Centre may wish to query the grade available to one or more candidates or to submit an appeal against the outcome of such an enquiry. Enquiries about unit results must be made immediately following the series in which the relevant unit was taken.

For procedures relating to enquiries on results and appeals, Centres should consult the Handbook for Centres and the document *Enquiries about Results and Appeals - Information and Guidance for Centres* produced by the Joint Council. Further copies of the most recent edition of this paper can be obtained from OCR.

3 Further Information and Training for Teachers

To support teachers using this specification, OCR will make the following materials and services available:

- a full programme of In-Service Training meetings arranged by its Training and Customer Support Division (telephone 01223 552950);
- a dedicated subject-specific telephone number (01223 552732);
- a website that will include materials to assist with delivery (www.ocr.org.uk);
- teacher support material;
- exemplar candidate work;
- candidate guides;
- specimen assessments;
- past external examinations;
- a report on the examination, compiled by senior examining personnel after each examination session;
- individual feedback to each Centre on the moderation of portfolios;
- a portfolio consultancy service.

A Publications Catalogue may be obtained from OCR's publications department:

- tel. 0870 870 6622
- fax 0870 870 6621
- e-mail: publications@ocr.org.uk

The OCR Information Bureau:

- tel. 01223 553998
- e-mail: helpdesk@ocr.org.uk

The OCR website address is www.ocr.org.uk

The website contains copies of the specification, example assessments, support materials and current information of relevance to Centres.

4 Key Skills Guidance

Key Skills are central to successful employment and underpin future success in learning independently. Whilst they are certificated separately, the *Key Skills Guidance* for this qualification has been designed to support the teaching, learning and assessment of the vocational content, as well as that of the Key Skills. Opportunities for developing the Key Skills of *Communication*, *Application of Number*, *Information Technology*, *Working with Others*, *Problem Solving* and *Improving Own Learning and Performance* are indicated for each unit.

Key Skills and vocational achievement are interdependent, especially at Level 1. This guidance has been developed to show how vocational and Key Skills achievement can be successfully combined.

The guidance has been split into two sections: *Keys to Attainment* and *Signposts*. The two sections should be used in conjunction with, and are intended to complement, each other.

Keys to Attainment show where the units contain clear opportunities for generating Key Skills portfolio evidence. A *Key to Attainment* does not negate the need for candidates to develop and practise the key skill during teaching and learning.

Signposts ∫ show where the units contain opportunities for developing the Key Skill, and possibly for generating portfolio evidence if teaching and learning is focused on that aim.

Aspects of Key Skills are distributed throughout the units, usually as *Signposts* but sometimes as *Keys to Attainment*. This may appear repetitive, but occurs because some Key Skills may be achieved in several different ways (multiple *Signposts*), but others are genuinely key to the achievement of the vocational aspect (*Keys to Attainment*). For example, IT1.1 - 'find, explore and develop information for **two** different purposes', will appear more than once in any GCSE (Double Award) because the Key Skill needs to be achieved in **two** different contexts. Another example of where a Key Skill may be split between units is C1.1 - 'take part in a *one-to-one* discussion and a *group* discussion...', because the **two** discussions can be completely independent of each other.

KEY SKILLS MAPPING

🔑 the unit contains clear opportunities for generating Key Skills portfolio evidence.
∫ the unit contains opportunities for developing the Key Skill, and possibly for generating portfolio evidence if teaching and learning is focused on that aim.
8 there are no obvious opportunities for the development or assessment of the Key Skill in the unit.

Key Skill (Level 2)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
C2.1a: Contribute to a discussion about a straightforward subject.	**1**	🔑	Discussing the design brief with the client to clarify their requirements, or with other members of the design team to formulate a design specification, generate ideas etc.
	2	∫	Discussing the product specification with other members of the production team to derive information for inclusion in the production plan. Discussions during production e.g. of quality control findings.
	3	∫	Identifying and discussing the impact of new technology, with the class or others e.g. an engineer with long experience of manufacturing technology. Considering advantages and disadvantages for e.g. the workforce and the environment etc.
C2.1b: Give a short talk about a straightforward subject, using an image.	**1**	🔑	Presenting a range of design solutions and ideas to the client for their feedback, explaining how the solutions were developed and why. Presenting the final design solution to the client, making use of drawings, models etc as necessary.
	2	∫	Conveying information to the production team, on e.g. the performance of materials or components, the quality of the finished product, any modifications felt to be necessary etc. using appropriate visual aids.
	3	∫	Presenting results of the investigation of an engineered product, using drawings and sketches, or of an investigation of a particular form of new technology such as polymers.
C2.2: Read and summarise information from **two** extended documents about a straightforward subject. **One** of the documents should include at least **one** image.	**1**	∫	Design briefs and design specifications, relevant regulations, data sheets, manuals, textbooks etc. There must be evidence that information from such sources has been summarised in the candidate's written work.
	2	🔑	Product specifications, data sheets, manuals and guides for parts and components, health and safety regulations, quality manuals, textbooks, etc. There must be evidence that information from such sources has been summarised in the candidate's written work.
	3	∫	Product information: manuals, guides etc, promotional materials for companies using new technology, suppliers catalogues, textbooks, trade magazines etc. There must be evidence that information from such sources has been summarised in the candidate's written work.
C2.3: Write **two** different types of documents about straightforward subjects. **One** piece of writing should be an extended document and include at least **one** image.	**1**	🔑	A design specification and a design solution based on the design brief. The design solution should include an explanation of the brief and how it was met, with drawings and models etc as appropriate. Design ideas in their development e.g. sketches, prototypes etc also supported by text.
	2	∫	A production plan based on the product specification, with explanatory text. Analysis of materials data, quality control data, the operation of parts and components, reasons for choice of materials, tools and components, etc.
	3	∫	Reports on particular examples of new technology, with drawings. Product reviews or reports about products featuring new technology, identifying the sector in which they were manufactured, the main stages in their manufacture, the role of the new technology and an explanation of their operation, purpose etc.

Key Skill (Level 2)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
N2.1: Interpret information from **two** different sources, including material containing a graph.	**1**		Interpreting numerical information on production methods, the properties of materials, scales of production, costs etc. as part of developing design solutions. Interpreting engineering drawings.
	2		Interpreting technical information in a product specification, information on materials properties, quality control data, drawings etc.
	3	∫	Interpreting technical information on the properties of materials, on the structure and form of engineered products etc.
N2.2a: Carry out calculations to do with amounts and sizes.	**1**		Calculating resources for manufacture: amounts of raw materials, costs etc., calculating quantities, calculating the size of the product in three dimensions, measuring materials, calculating tolerances etc.
	2		Calculating resources requirements, cost, dimensions, quantities etc, making any modifications necessary during production.
	3		Investigating the structure and composition of an engineered product: dimensions, quantities manufactured etc.
N2.2b: Carry out calculations to do with scales and proportions.	**1**		Working with scale models, making decisions about materials, using different projections in engineering drawings etc.
	2	∫	Working with dimensions e.g. in relation to the properties of materials, the size of components, etc.
	3	∫	Working with dimensions and producing scale drawings to explain how a product works.
N2.2c: Carry out calculations to do with handling statistics.	**1**		Working with quality control information, considering markets for the product or service etc.
	2		Working with quality control data.
	3		Quantifying the different products made by the engineering and manufacturing sectors, and the impact of new technologies in terms of e.g. market share, range of products available, energy consumption etc.
N2.2d: Carry out calculations to do with using formulae.	**1**		Considering and applying scientific principles underpinning the functioning of the product or service.
	2	∫	Where the scientific principles of e.g. force and power are relevant to production.
	3	∫	Explaining the operation of an engineered product in terms of its underlying scientific principles.
N2.3: Interpret the results of your calculations and present your findings. You must use at least **one** graph, **one** chart and **one** diagram.	**1**		Presenting the results of calculations of cost, quantity, product size, tolerances, etc in the final design solution, using a range of appropriate graphical methods.
	2	∫	Presenting numerical information in the production plan, on e.g. costs, quantities, tolerances, quality control, based on own calculations and using appropriate graphical methods.
	3	∫	Presenting the results of investigations of an engineered product, showing its properties, dimensions, how new technology has influenced the design/sales etc, using appropriate graphical methods.

Key Skill (Level 2)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
IT 2.1: Search for and select information for **two** different purposes.	**1**	∫	Using the internet, CD ROMS, databases etc as possible sources of technical data e.g. on materials. They might also inform research into a new product or service, providing details of markets, existing products/services, sources of materials, ideas for design and aesthetics, and images which might be used in presentations etc.
	2	∫	Using the internet, CD ROMS, databases etc to obtain information on the properties and characteristics of materials, parts and components, tools and equipment, production methods and processes etc.
	3	∫	Using the internet, CD ROMS, databases etc as sources of product information and for information on the operation and impact of new technologies.
IT 2.2: Explore and develop information, and derive new information, for **two** different purposes.	**1**	∫	Using CAD, developing design ideas through manipulating and finalising text and images, carrying out calculations, simulations etc.
	2	∫	Using CAM, recording test data e.g. on materials or quality, and manipulating it to derive conclusions and inform production planning, carrying out calculations, etc.
	3	∫	Carrying out calculations to use when describing and explaining products, drafting and finalising text to use in reports on new technology, importing images, CAD drawings, etc.
IT 2.3: Present combined information for **two** different purposes. Your work must include at least **one** example of text, **one** example of images and **one** example of numbers.	**1**	∫	Presenting final design solutions using WP, CAD drawings, imported images, graphical information on cost, materials, production, timescales etc. Presenting design ideas and specifications, production information etc to the client during the development of the final design.
	2	∫	Presenting production plans, using WP, the results of testing and measurement, drawings, graphical information on quality and quantity etc.
	3	∫	Reporting on new technology, using WP, imported text and images, etc. Drafting and finalising product reports, using CAD, recording, manipulating and presenting numerical data etc.

Key Skill (Level 2)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
WO2.1: Plan straightforward work with others, identifying objectives and clarifying responsibilities, and confirm working arrangements.	**1**	∫	Tackling the design brief as a team, allocating group and individual objectives agreeing and planning how work is to be carried out, with reference to timescales, resources, opportunities for feedback etc. Could fulfil the group-working requirement for this Key Skill.
	2	∫	Team working to develop and execute the production plan, which should be supported by the clear allocation of production responsibilities e.g. for quality control, ensuring availability of materials, testing components etc. The plan should indicate timescales, resources, quality control points etc.
	3	8	
WO2.2: Work co-operatively with others towards achieving identified objectives, organising tasks to meet your responsibilities.	**1**	∫	Allocating responsibilities to individuals which they must then pursue to achieve the group's objectives e.g.. costing materials, researching the scale of production, identifying relevant regulations, testing materials etc. Showing co-operative and safe working, and seek advice as appropriate. If work in pairs or liaise with client, could satisfy one-to-one working requirement for this Key Skill.
	2	∫	Allocating responsibilities to individuals which they must then pursue to achieve the group's objectives. Showing co-operative and safe working, and seek advice as appropriate. If work in pairs could satisfy one-to-one working requirement for this Key Skill.
	3	8	
WO2.3: Exchange information on progress and agree ways of improving work with others to help achieve objectives.	**1**	∫	Planning the group's work to allow for progress checking, feedback and brainstorming e.g. on ideas for solving a technical problem in the design.
	2	∫	Planning the group's work to allow for progress checking, feedback and brainstorming e.g. on the choice of parts, ways of using particular processes etc.
	3	8	

Key Skill (Level 2)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
PS2.1: Identify a problem and come up with **two** options for solving it.	**1**	🔑	The design brief is the 'problem'. Identifying its key features, and the client's requirements of the product or service, researching information and data about materials, production, maintenance etc, generating ideas and solutions, choosing ones which might work, and identifying constraints, taking advice where necessary. Also applies to decisions about e.g. choice of finish during design process.
	2	🔑	Analysing the product specification and identifying essential product information. Identifying the range of materials, parts and components, processes etc. which might fulfil the specification and choosing those which seem the most suitable.
	3	8	
PS2.2: Plan and try out at least **one** option for solving the problem, obtaining support and making changes to your plan when needed.	**1**	🔑	Developing design solutions based on research, showing how the product might be made or the service provided, testing solutions and making changes to the solution or design specification as necessary on the basis of testing and feedback.
	2	🔑	Planning the testing of materials and parts and components as part of developing the production plan, and carrying out those tests. Making changes and seeking advice as necessary while testing. Also, implementing the production plan itself, and making any changes which become necessary.
	3	8	
PS2.3: Check if the problem has been solved by applying given methods, describe results and explain your approach to problem solving.	**1**	🔑	Comparing the product or service with the design brief and design specification, and drawing conclusions as to how well they were met. In the presentation of the design solution, explaining decisions at each stage of the planning and production process, and why they were necessary, evaluating the strengths and weaknesses of decisions, and any reflections on tackling such briefs again.
	2	∫	Comparing a sample product to the product specification. Applying any tests of size, function, quality etc given in the specification, and drawing conclusions as to how well it was met on the basis of those measurements and other feedback. Explaining decisions taken about materials, components and processes at each stage and why they were necessary, evaluating strengths and weaknesses in meeting the specification, with reflections on how production, or its planning, might be improved.
	3	8	

Key Skill (Level 2)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
LP2.1: Help set short-term targets with an appropriate person and plan how these will be met.	**1**	∫	Supporting the development of a design solution with structured planning on a one-to-one basis with the candidate. Setting targets e.g. to produce a high quality engineering drawing or to identify relevant scientific principles, and deadlines and action points for achieving these e.g. to practice different types of drawings, study a textbook etc.
	2	∫	Supporting the development of engineering skills such as the use of different processes and the calibration of machinery with structured planning on a one-to-one basis with the candidate. Setting targets e.g. to produce a sample of the product, with deadlines and action points for achieving these e.g. to practice using the machinery etc.
	3	8	
LP2.2: Take responsibility for some decisions about your learning, using your plan and support from others to help meet targets. Improve your performance by: • Studying a straightforward subject • Learning through a straightforward practical activity.	**1**	∫	If the candidate takes responsibility for successfully executing the plan agreed in LP2.1, and chooses different approaches to learning, e.g. reading textbooks and making notes, looking at professional engineering drawings etc. Taking advice where appropriate.
	2	∫	If the candidate takes responsibility for successfully executing the plan agreed in LP2.1, and chooses different approaches to learning, e.g. comparing their product to a commercially produced one, consulting manuals etc. Taking advice where appropriate.
	3	8	
LP2.3: Review progress with an appropriate person and provide evidence of your achievements, including how you have used learning from one task to meet the demands of a new task.	**1**	∫	Reviewing what has been learned and how they went about it, on a one-to-one basis with the candidate, e.g. in tutorials.
	2	∫	Reviewing what has been learned and how they went about it, on a one-to-one basis with the candidate, e.g. in tutorials.
	3	8	

Key Skill (Level 1)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
C1.1: Take part in a one-to-one discussion and a group discussion about *different* straightforward subjects.	**1**		Discussing the design brief with the client to clarify their requirements, or with other members of the design team to formulate a design specification, generate ideas etc.
	2	∫	Discussing the product specification with other members of the production team to derive information for inclusion in the production plan. Discussions during production e.g. of quality control findings.
	3	∫	Identifying and discussing the impact of new technology, with the class or others e.g. an engineer with long experience of manufacturing technology. Considering advantages and disadvantages for e.g. the workforce and the environment etc.
C1.2: Read and obtain information from **two** different types of documents about straightforward subjects, including at least **one** image.	**1**	∫	Simple design briefs and design specifications, summaries of relevant regulations, data sheets, manuals, textbooks etc.
	2		Product specifications, data sheets, manuals and guides for parts and components, extracts and summaries from health and safety regulations, quality manuals, textbooks, etc.
	3	∫	Product information: manuals, guides etc, promotional materials for companies using new technology, suppliers catalogues, textbooks, trade magazines etc.
C1.3: Write **two** different types of documents about straightforward subjects. Include at least **one** image in **one** of the documents.	**1**		A design specification and a design solution based on the design brief. The design solution should describe the brief and how it was met, with drawings and models etc as appropriate. Design ideas in their development e.g. sketches, prototypes etc, also supported by text.
	2	∫	A production plan based on the product specification, with text. Descriptions of materials data, quality control data, the operation of parts and components, reasons for choice of materials, tools and components, etc.
	3	∫	Reports on particular examples of new technology, with drawings. Product reviews or reports about products featuring new technology, identifying the sector in which they were manufactured, the main stages in their manufacture, the role of the new technology and a description of their operation, purpose etc.

Key Skill (Level 1)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
N1.1: Interpret straightforward information from **two** different sources. At least **one** source should be a table, chart, diagram *or* line graph.	**1**	🔑	Interpreting basic numerical information on production methods, the properties of materials, scales of production, costs etc. as part of developing design solutions. Interpreting engineering drawings.
	2	🔑	Interpreting basic technical information in a product specification, information on materials properties, quality control data, drawings etc.
	3	∫	Interpreting straightforward technical information on the properties of materials, on the structure and form of engineered products etc.
N1.2a: Carry out straightforward calculations to do with amounts and sizes.	**1**	🔑	Calculating resources for manufacture: amounts of raw materials, costs etc., calculating quantities, calculating the size of the product in 3 dimensions, measuring materials, calculating tolerances etc.
	2	🔑	Calculating resources requirements, cost, dimensions, quantities etc.
	3	🔑	Investigating the structure and composition of an engineered product: dimensions, quantities manufactured etc.
N1.2b: Carry out straightforward calculations to do with scales and proportion.	**1**	🔑	Working with scale models, making decisions about materials, using different projections in engineering drawings etc.
	2	🔑	Working with dimensions e.g. in relation to the properties of materials, the size of components, etc.
	3	🔑	Working with dimensions and producing scale drawings to explain how a product works.
N1.2c: Carry out straightforward calculations to do with handling statistics.	**1**	🔑	Working with quality control information, considering markets for the product or service etc.
	2	🔑	Working with quality control data.
	3	🔑	Quantifying the different products made by the engineering and manufacturing sectors, and the impact of new technologies in terms of e.g. market share, range of products available, energy consumption etc.
N1.3: Interpret the results of your calculations and present your findings. You must use **one** chart and **one** diagram.	**1**	🔑	Presenting the results of calculations of cost, quantity, product size, tolerances, etc in the final design solution, using appropriate graphical methods.
	2	∫	Presenting numerical information in the production plan, on e.g. costs, quantities, tolerances, quality control, based on own calculations and using appropriate graphical methods.
	3	∫	Presenting the results of investigations of an engineered product, showing its dimensions, how new technology has influenced the design/sales etc, using appropriate graphical methods.

Key Skill (Level 1)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
IT 1.1: Find, explore and develop information for **two** different purposes.	**1**	∫	Using given sources from the internet, CD ROMS, databases and other media as possible sources of technical data e.g. on materials. These sources might also inform research into a new product or service by providing details of: markets, existing products/services, sources of materials, as well as ideas for design and aesthetics and images which might be used in developing work.
	2	∫	Using given sources from the internet, CD ROMS, databases and other media to obtain information on the properties and characteristics of materials, on parts and components, tools and equipment, production methods and processes etc.
	3	∫	Using given sources from the internet, CD ROMS, databases and other media as sources of product information and for information on the operation and impact of new technologies.
IT 1.2: Present information for **two** different purposes. Your work must include at least **one** example of text, **one** example of images and **one** example of numbers.	**1**	∫	Presenting final design solutions using WP, imported images, information on cost, materials, production, timescales etc. Using IT to present design ideas and specifications, production information etc to the client during the development of the final design.
	2	∫	Presenting production plans using WP, the results of testing and measurement, drawings, graphical information on quality and quantity etc.
	3	∫	Reporting on new technology using WP, imported text and images, etc. Drafting and finalising product reports, using CAD, recording, manipulating and presenting numerical data etc.

Key Skill (Level 1)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
WO1.1: Confirm what needs to be done to achieve given objectives, including your responsibilities and working arrangements.	**1**	∫	If the design brief is tackled by a team, identifying the group's objectives and what needs to be done, including confirming both group and individual responsibilities. Reference might be made to timescales, resources, opportunities for feedback etc. Could fulfil the group-working requirement for this Key Skill.
	2	∫	Team working to make a product. Identifying individual responsibilities and group aims, as well as methods for scheduling production, making sure everyone is clear on individual responsibilities e.g. for testing samples for quality control, ensuring availability of materials etc, and timing activities.
	3	8	
WO1.2: Work with others towards achieving given objectives, carrying out tasks to meet your responsibilities.	**1**	∫	Allocating responsibilities to individuals which they must then pursue to achieve the group's objectives e.g.. costing materials, researching the scale of production, identifying relevant regulations, testing materials etc. Showing co-operative and safe working, and seeking advice as appropriate. If working in pairs or liaising with client, could satisfy the one-to-one working requirement for this Key Skill.
	2	∫	Individuals will be given their own responsibilities and instructed in the working methods they are expected to use. Carrying out individual production tasks e.g. quality control, safely and effectively, asking for help and supporting other members of the production team. If working in pairs or liaising with client, could satisfy the one-to-one working requirement for this Key Skill.
	3	8	
WO1.3: Identify progress and suggest ways of improving work with others to help achieve given objectives.	**1**	∫	If group working is planned to allow discussion of progress, where good ways of tackling aspects of the design brief are identified, as well as problems and how they were dealt with, with a view to suggesting better ways of working together.
	2	∫	If group working is planned to allow discussion of progress, where good ways of working are identified e.g. ways of using particular processes, as well as problems and how they were dealt with, with a view to suggesting better ways of working together.
	3	8	

Key Skill (Level 1)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
PS1.1: Confirm your understanding of the given problem with an appropriate person and identify **two** options for solving it.	**1**		The design brief is the 'problem'. With support from an appropriate person or people, identifying the client's requirements of the product or service e.g. its key features. Working with others to establish options for meeting the brief, including researching materials, production methods, generating ideas and solutions, etc. Identifying which options are likely to work best. Also applies to decisions during the development of designs e.g. about choosing a material.
	2		Analysing the product specification and identifying essential product information. Identifying materials, parts and components, processes etc which might fulfil the specification and choosing those which seem the most suitable.
	3	8	
PS1.2: Plan and try out at least **one** option for solving the problem, using advice and support given by others.	**1**		Planning the design process, e.g. areas for research, timescales etc, showing how the product might be made or the service provided, testing different solutions and making changes to the solution or design specification as necessary.
	2		Planning the testing of materials and parts and components as part of developing the production plan, and carrying out those tests. Making changes and seeking advice as necessary while testing. Also, implementing the production plan itself, and making any changes which become necessary.
	3	8	
PS1.3: Check if the problem has been solved by following given methods and describe the results including ways to improve your approach to problem solving.	**1**		Comparing the product or service with the design brief and design specification, and saying how well they were met. In the presentation of the design solution, describing the planning and production process, what went well and what didn't, and how problems were tackled. Also making suggestions for avoiding those problems.
	2	∫	Comparing a sample product to the product specification. Applying any tests of size, function, quality etc given in the specification and describing results. Describing what went well in production and what didn't, and how problems were tackled. Also making suggestions for avoiding those problems in future.
	3	8	

Key Skill (Level 1)	Unit	Examples of opportunities for developing the Key Skill or for generating Key Skills portfolio evidence Note: these are illustrative only.	
LP1.1: Confirm understanding of your short-term targets and plan how these will be met, with the person setting them.	**1**	∫	If the group's work is planned to allow an appropriate person to set individual targets e.g. to produce an engineering drawing, and also to identify: action points e.g. to practice different types of drawings, study a textbook etc., deadlines, arrangements for reviewing progress, and who to ask for help.
	2	∫	If the group's work is planned to allow an appropriate person to set individual targets e.g. to produce a first sample of the product. And also to identify: action points e.g. to practice using the machinery, deadlines, arrangements for reviewing progress, and who to ask for help.
	3	8	
LP1.2: Follow your plan, using support given by others to help meet targets. Improve your performance by: • Studying a straightforward subject • Learning through a straightforward practical activity.	**1**	∫	If the candidate follows the plan agreed in LP1.1, seeking support where necessary, and uses different approaches to learning, e.g. reading textbooks and making notes, looking at professional engineering drawings etc. Also acting on suggestions for improvements.
	2	∫	If the candidate follows the plan agreed in LP1.1, seeking support where necessary, and uses different approaches to learning, e.g. comparing their product to a commercially produced one, consulting manuals etc. Also acting on suggestions for improvements.
	3	8	
LP1.3: Review your progress and achievements in meeting targets, with an appropriate person.	**1**	∫	Reviewing what has been learned and how the candidate went about it, on a one-to-one basis e.g. in tutorials, with encouragement to identify good work and bad, with suggestions for improvements.
	2	∫	Reviewing what has been learned and how the candidate went about it, on a one-to-one basis e.g. in tutorials, with encouragement to identify good work and bad, with suggestions for improvements.
	3	8	

5 Specification Units

Units will have some or all of the following sections:

About this unit

This includes a brief description for the candidate of the content, purpose and vocational relevance of the unit.
It states whether the unit is assessed externally or through portfolio evidence.

What you need to learn

This specifies the underpinning knowledge, skills and understanding candidates need to apply in order to meet the requirements of the portfolio evidence or external assessment.

Assessment evidence

This specifies the evidence candidates need to produce in order to meet the requirements of each portfolio unit. It is divided into the following parts:

- *You need to produce* – this banner heading sets the context for providing the evidence, e.g. a report, an investigation, etc;
- *A typical candidate at grades GG to EE etc. will*: – this describes the quality of the work a candidate needs to demonstrate in order to achieve the grades specified.

Guidance for teachers

This provides advice on teaching and assessment strategies.

There will be advice on:

- the provision of the vocational context of the unit;
- accurate and consistent interpretation of national standards;
- the use of appropriate internal assessments, taking into account the full range of grades to be covered.

There may also be advice on:

- exploiting local opportunities (e.g. information sources, events, work experience);
- resources.

Key Skills guidance

This signposts opportunities for developing and assessing Key Skills within the unit.

6 Unit 1: Design and Graphical Communication

6.1 ABOUT THIS UNIT

There is some element of engineering in virtually everything we use from the clothes we wear and the food we eat, to the transport we use, from the micro components in modern electronic devices to the structures in the largest civil engineering projects. This unit is about the process of designing. You will learn about the following aspects of the design process:

- analysing client design briefs;
- developing design specifications and solutions;
- applying scientific principles;
- producing and reading engineering drawings;
- selecting appropriate drawing techniques;
- communicating a design solution.

Using the design process, you will develop your understanding and skills in design and graphical communication. You will learn to choose appropriate techniques for a given purpose or audience and to present your solutions.

Engineering drawings are used to present information. You will learn about the different engineering drawing techniques used for electrical, electronic and mechanical products and their servicing. You will learn to read engineering drawings and to understand specific engineering sector standards.

This and other units will utilise prior learning in design and technology. This unit links with Unit 2: *Engineered products* and Unit 3: *Application of technology* as the design ideas you develop may draw on what you know about making engineered products and on how products and production may use new technology. It will also help you to progress to some units in VCE Engineering.

This unit provides some of the underpinning knowledge and understanding for the National Vocational Qualification in Performing Engineering Operations.

You will also have the opportunity to develop your Key Skills when you are working towards this unit.

*You should be **selective** and include in your portfolio work from this unit that **meets the evidence requirements**.*

This unit is assessed solely through portfolio assessment.

6.2 WHAT YOU NEED TO LEARN

6.2.1 Design Briefs

Before you begin a design, you need to understand what the client wants. You will learn how to analyse the client design brief to identify the key features of an engineered product or an engineering service. The key features are:

- function – where and what the product will be used for;
- quality standards – sector and/or client quality standards;
- styling aesthetics – the appearance and appeal of the product;
- performance – how well the product has to perform;
- intended markets – who might use the product, competition with other similar products, client's own customer base;
- size – the approximate size in three dimensions;
- maintenance – how this is planned for in design and during the product's use;
- production methods and materials;
- cost – including design, production and material costs;
- regulations – including health and safety;
- scale of production – quantity required, use of mass or batch production.

You will learn that there may be more than one design solution that meets the needs of a client and you must learn how to evaluate the strengths and weaknesses of different design solutions.

6.2.2 Design Specifications and Solutions

To enable you to produce a design solution that meets the needs of the client, you must first analyse the design brief and related engineering drawings to identify the key design features. You must then be able to explain what is required, showing clear details and decisions you have made about the intended product. This is called a design specification and it will help you to produce your design solution.

You must to be able to use your design specification to produce a design solution that meets the client's and sector's requirements. To produce a design solution, you must learn how to use all of the following techniques to develop your design ideas:

- research and analysis of information and data;
- consideration of scientific principles, for example recognition and use of structures and how to support and reinforce them;
- generation of ideas and solutions;
- evaluation of ideas, solutions, testing and subsequent modifications;
- 2D and 3D drawing and sketching techniques;
- modelling techniques.

You must be able to select the most appropriate design solution from the range of initial design ideas. To do this, you need to devise and apply tests against the design criteria at critical points in the development. Your final design solution must include:

- justification for your final choice that refers to the key features in the client design brief and your design specification;
- details of your final design idea;
- an explanation of how you met the client's requirements and complied with sector standards.

6.2.3 Engineering Drawings

You must learn to read and use engineering drawings as well as produce a selection of engineering drawings using both manual and computer techniques.

All your engineering drawings and diagrams must comply to sector specific standards and conventions, e.g. BS308, BS3939. Engineering drawings produced using third angle orthographic projection, for example, should have a title, name block, a scale and borders.

You must to be able to read electrical/electronic, pneumatic/hydraulic and mechanical engineering drawings and diagrams so that you can explain the purpose of the components and the features used. You must learn to recognise a selection of appropriate standard symbols.

Typical standard symbols you must be able to recognise include:

- electrical/electronic components – resistors, thermistors, LEDs, capacitors, bulbs, batteries, motors, buzzers, variable resistors, diodes;
- mechanical features – holes, screw threads (internal and external);
- dimensions – including toleranced dimensions, radii, centres, springs;
- pneumatic/hydraulic valves, cylinders, reservoirs, pipework, filters.

You must be able to produce engineering drawings that are sufficient to communicate your final design solution by selecting and using the following techniques appropriately:

- freehand sketches;
- isometric projection;
- oblique projection;
- perspective drawing;
- block diagrams;
- flow diagrams;
- schematic diagrams;
- circuit diagrams;
- first angle orthographic projection;
- third angle orthographic projection;
- assembly diagrams;
- exploded diagrams.

You are not expected to become expert in any of these techniques but you must learn how to produce drawings, or appropriate parts of drawings and diagrams, by both manual and computer generated methods. You must be able to use computer-aided design (CAD) and link this with computer-aided manufacture (CAM).

6.2.4 Choosing Engineering Drawing Techniques

When you are choosing drawing techniques, you must take account of the purpose of the engineering drawing and the intended audience. Your drawing may be:

- a working/manufacturing drawing;
- a servicing/repairing drawing;
- an assembly drawing.

The types of audiences to consider are:

- service engineers;
- manufacturing engineers;
- technical customers.

6.2.5 Presenting a Design Solution

You must be able to explain your final design solution to other people. Your presentation must:

- give reasons for your final choice that refer to the key features in the design brief and your design specification;
- show details of your final design idea;
- give an explanation of how your final design solution meets the client design brief;
- respond to feedback, checking against the design criteria and suitability for the user, and modify your proposed solution if necessary.

6.3 ASSESSMENT EVIDENCE FOR UNIT 1: DESIGN AND GRAPHICAL COMMUNICATION

You need to produce evidence in your portfolio of a product design specification and a design solution for an engineered product working from a customer design brief. Your design specification and design solution **must** include:

a details of the customer design brief, the design specification and associated information [9 marks];

b evidence of your technical skills, drawing techniques and knowledge of drawing standards [7 marks];

c identification of the stages involved in making your design solution with related quality control procedures, including health and safety issues [9 marks];

d how you communicated your selected design solution to the customer, by developing sketches, notes and working drawings [10 marks];

e consideration of how your final product will be made, identifying the engineering processes and quality standards that will be used to produce it [15 marks].

A typical candidate at grades GG, FF, EE will:	A typical candidate at grades DD, CC, BB will:	A typical candidate at grades BB, AA, A*A* will:	Mark	Max
a1 Produce a design specification from a given design brief. **0 1 2 3**	**a2** Produce a detailed design specification, using customer feedback and associated information. **4 5 6**	**a3** Justify their final design specification by explaining how they used customer feedback and associated information. **7 8 9**		**9**
b1 Demonstrate a basic level of accuracy in drawing, using appropriate drawing standards. **0 1 2 3**	**b2** Use drawing techniques and appropriate standards accurately in developing a range of design ideas. **4 5**	**b3** Fully justify the use and accuracy of the drawing techniques that they have used to develop their design ideas. **6 7**		**7**
c1 Identify health and safety issues related to their design solution. **0 1 2 3 4**	**c2** Identify the quality control procedures that would be used in each stage of making the product in their design solution. **5 6 7**	**c3** Evaluate quality control, quality assurance and total quality management applied to making the product in their design solution. **8 9**		**9**

d1 Use diagrams, sketches and other appropriate methods to present their design solution to the customer. **0 1 2 3 4 5**	**d2** Use diagrams, sketches and other appropriate methods, including modelling, to explain their design solution to the customer. **6 7 8**	**d3** Use diagrams, sketches, working drawings and other appropriate methods, including modelling, to justify their design solution to the customer. **9 10**		**10**
e1 Identify the engineering processes that would be used to produce their final product. **0 1 2 3 4 5 6 7**	**e2** Identify the stages and associated quality assurances that will be used to make their final product. **8 9 10 11**	**e3** Evaluate and justify the stages and associated quality assurances they will use to make their final product, with particular reference to 'real world' engineering. **12 13 14 15**		**15**

Note: Although you will be given an interim mark out of 50 by your teacher, this mark will be moderated by OCR to make sure that it is in line with national standards. The grade (A*A* to GG) equivalent to this moderated mark will be determined at an Awarding Meeting convened for each examination series.

Total	**50**

6.4 GUIDANCE FOR TEACHERS

6.4.1 Guidance on Delivery

Engineers are often asked to provide ideas to solve engineering problems. The client presents the problem in the form of a design brief. The engineer then provides various solutions, one of which can be taken forward and developed as a final design solution.

In this unit candidates are to develop graphical techniques, using the design process. It is important that the final design solution is not merely a manufacturing specification.

A range of graphical techniques will need to be taught including those mentioned within the unit, although it is not the aim of this unit to produce occupational competences in these techniques at this level.

For many engineering sectors it is important that candidates are able to design an electro-mechanical product that includes a variety of components from electrical and mechanical fields. However, for teaching purposes, it may be more relevant to look at these separately and then bring them together in terms of the product at a later stage.

Real contexts such as modifying an existing design may make assignments more manageable and interesting to the candidates.

It is important that, throughout the unit, candidates develop the ability to interpret engineering drawings and become conversant with the conventions used.

6.4.2 Guidance on Assessment

Coursework evidence can take a number of forms. A candidate portfolio can consist of any appropriate form of evidence, including teacher/tutor comments, photographs, taped and video evidence, supported witness statements and paper based evidence.

Where Centres are unable, for logistical reasons, to visit, or receive input from, local engineering companies, teachers/tutors should use video and simulations to give candidates a feel for industrial manufacturing processes.

When grading the portfolio for this unit you must consider the following general qualities which distinguish between grades. The candidate shows:

- increasing depth of understanding of the unit content, showing greater depth and breadth;
- increasing coherence, comparison and a greater ability to draw valid conclusions when designing;
- greater independence and originality of design ideas;
- increasing skill and confidence in carrying out design work;
- greater skills in using a variety of graphical communication techniques.

Each portfolio should be marked by the teacher according to the criteria in the *Assessment Evidence Grid* in Section 6.3. Photocopiable URS will be supplied and will be sent to Centres at the start of the course.

Each row in the grid comprises a strand showing the development of a given criterion, each row corresponding to a point (**a**, **b**, **c** etc.) in the banner.

Please note that the second column describes the work of a typical candidate working at grades DD, CC and *the lower half of grade BB* whilst the third column describes the work of a typical candidate working at *the upper half of grade BB,* grades AA and A*A*.

The maximum mark for each criteria strand is shown in the right hand column.

Teachers use their professional judgement and circle the mark that *best fits* the work of the candidate and also record it on the URS in the column headed *Mark*.

Centres should use the full range of marks available to them; Centres must award *full* marks in any band for work which fully meets the criteria. This is work which is 'the best one could expect from candidates working at GCSE (Double Award) level'.

Only one mark per strand/row will be entered. The final mark for the candidate is out of a total of 50 and is found by totalling the marks for each strand.

Example: For a candidate's work that comfortably satisfies criterion **d2** and may be perceived as equivalent to the work of a grade CC candidate, a mark of **7** should be awarded on the scale for this strand of 0-10.

A typical candidate at grades GG, FF, EE will:	**A typical candidate at grades DD, CC, BB will:**	**A typical candidate at grades BB, AA, A*A* will:**	**Mark**	**Max**
d1 Use diagrams, sketches and other appropriate methods to present their design solution to the customer. **0 1 2 3 4 5**	**d2** Use diagrams, sketches and other appropriate methods, including modelling, to explain their design solution to the customer. **6 (7) 8**	**d3** Use diagrams, sketches, working drawings and other appropriate methods, including modelling, to justify their design solution to the customer. **9 10**	**7**	**10**

The following table indicates which criteria in the *Assessment Evidence Grid* meet which assessment objectives:

Criterion	AO1	AO2	AO3
a1	8	8	4
a2	4	4	4
a3	4	4	4
b1	4	8	8
b2	4	4	8
b3	4	4	4
c1	4	8	8
c2	4	4	8
c3	4	4	4
d1	4	4	8
d2	4	4	8
d3	4	4	4
e1	4	8	4
e2	4	4	4
e3	4	4	4

6.4.3 Resources

Equipment

To fulfil this unit candidates will need access to a range of drawing tools including drawing boards and ancillary equipment. Sketching and drawing media, e.g. pencils, crayons, drawing pens are a requirement of the course plus ICT access with CAD programs. They will also require access to real life examples of engineering designs.

Engineering Companies

Ideally candidates should visit local engineering companies. Where this is not possible, video, books and visits from external speakers will be necessary.

Teaching Skills

Whilst Resistant Materials teachers will be ideal for the delivery of this course, they will need to have a deep up to date understanding of engineering working practices across the engineering sectors.

Books

For *all* candidates:

Design in the Making; Longman
A book with a Teachers Guide aimed essentially at 11-14 year olds, but with a quantity of useful information and worksheets suitable for GCSE in Engineering (Double Award) at Key Stage 4.

Books are available covering Resistant Materials: Candidate Book, ISBN 0582 36589 9 (Teachers Pack, ISBN 0582 36587 2).

Royal College of Art Routes series; Hodder and Stoughton

A series of books and Teachers Guides aimed at Key Stages 3 and 4 (Food ISBN 0340 67392 3, Textiles ISBN 0304 67391 5, Graphics ISBN 0304 67393 1, Control ISBN 0304 67390 7, Resistant Materials ISBN 0304 67394 X) and post-16 (ISBN 0-340-70528-0) containing useful information for GNVQ candidates across all material areas, including examples from various manufacturing industries.

Design & Make It! Resistant Materials Technology; Stanley Thornes ISBN 0 7487 2470 2
This book has been designed essentially to support GCSE Design and Technology but provides a good foundation in the use of resistant materials.

For more advanced candidates and teachers:

Advanced Manufacturing Design & Technology; Hodder & Stoughton.
A book developed by the Royal College of Art Technology Project, aimed at VCE and A level candidates of manufacturing and engineering. ISBN 0 340 70528 0.

Manufacturing Technology; Delmar Publishers Inc.
An American candidates' book offering a broad approach to issues across manufacturing technologies. Care needs to be taken as measurements and financial data are in US units. ISBN 0 8273 3462 1.

Fundamentals of Engineering, author R.L. Timings; Longman.
A book aimed at NVQ Engineering candidates. It has some good practical content. ISBN 0 282 30583 7

Engineers in Business, author Mike Lanigan; Addison Wesley Publishing.
This is a book aimed at degree level candidates, but contains a large amount of useful information. ISBN 0 201 41695 6.

6.4.4 Key Skills Mapping

Details on delivery are given in Section 4.

🔑 this unit contains clear opportunities for generating Key Skills portfolio evidence.
∫ this unit contains opportunities for developing the Key Skill, and possibly for generating portfolio evidence if teaching and learning is focused on that aim.
8 there are no obvious opportunities for the development or assessment of the Key Skill in this unit.

Criterion	C	N	IT	WO	PS	LP
1.1	🔑	🔑	∫	∫	🔑	∫
1.2	∫	🔑	∫	∫	🔑	∫
1.3	🔑	🔑		∫	🔑	∫
2.1	🔑	🔑	∫	∫	🔑	∫
2.2	∫	🔑	∫	∫	🔑	∫
2.3	🔑	🔑	∫	∫	🔑	∫

7 Unit 2: Engineered Products

7.1 ABOUT THIS UNIT

In this unit you will make an engineered product. The unit will develop your understanding of the process of producing a product.

In the unit you will learn to:

- use product specifications;
- read and interpret engineering drawings and diagrams;
- select suitable materials, parts and components for a product;
- create a production plan;
- use processes, tools and equipment, including Computer Aided Manufacture (CAM), required to make an engineered product;
- check the quality of your work conforms to the standards required;
- apply health and safety procedures.

This and other units will utilise prior learning in design and technology. The unit builds on Unit 1: *Design and graphical communication* and will allow you to use what you learn about technology in Unit 3: *Application of technology*. It will also help you to progress to some of the units in VCE Engineering.

This unit provides some of the underpinning knowledge and understanding for the National Vocational Qualification in Performing Engineering Operations.

You will also have the opportunity to develop your Key Skills when you are working towards this unit.

*You should be **selective** and include in your portfolio work from this unit that **meets the evidence requirements**.*

This unit is assessed solely through portfolio assessment.

7.2 WHAT YOU NEED TO LEARN

7.2.1 Using a Product Specification

To make an engineered product, you need to know the specific requirements for the all the different parts of the product. This information is contained within the product specification and on the working drawings and/or diagrams. You need to be able to understand and use the information in the product specification to make decisions about the development of a product. You must learn how to use a product specification and be able to recognise the following essential information required for a product:

- size, shape, form;
- materials, parts and components;
- process methods, where these are specified;
- quantity required, for example single unit, batch and volume production;
- time scales.

7.2.2 Production Planning

The production plan gives all the details required to make the product. You must be able to produce a production plan for your product. The plan will give information about:

- materials, parts and components to be used;
- processes to be used;
- tools, equipment and machinery to be used;
- the sequence of production including critical production and quality control points;
- production scheduling including realistic deadlines;
- how quality will be checked and inspected;
- health and safety factors.

You must be able to modify your plans as circumstances change.

7.2.3 Choosing Materials, Parts and Components

You must learn how to select materials and components with suitable characteristics and properties to meet a product specification. If you need to use alternative materials, parts or components you must explain why.

Materials and their properties may be considered in the following groups:

- ferrous and non-ferrous metals and alloys;
- polymers, such as thermosetting polymers and thermoplastic polymers;
- ceramics;
- composites which combine the properties of different materials, e.g. bi-metal strips, carbon composites and sintered metals.

You must learn to recognise and understand the function of mechanical, electrical/electronic and pneumatic/hydraulic parts and components and be able to select and use appropriate parts and components for the development of an engineered product, including:

- mechanical components, such as nuts, bolts, screws, springs, rivets, pins, clips, keys and drive mechanisms including gear trains;
- electrical/electronic components, such as resistors, capacitors, diodes, LEDs, bulbs, wire, cable, insulators, batteries, motors, buzzers, variable resistors, thermistors, transistors and integrated circuits;
- pneumatic/hydraulic components, such as directional and flow control valves, cylinders, reservoirs and filters.

The materials and components available have properties, characteristics and features that may affect your choice. You must learn to appreciate these when selecting and using appropriate materials for your product. These properties, characteristics and features might include:

- ability to be shaped and formed, for example by hammering, casting, forging, forming, bending and coiling;
- ability to be treated, for example by heat or chemicals;
- ability to be given a surface finish, for example by painting or chrome plating;
- ease of handling, for example by being small, light, no sharp edges;
- cost, for example the relative cost compared with other alternative materials and components;
- availability, form and supply for example by being available in standard sizes and standard values.

7.2.4 Using Processes

For your chosen product you must be able to use the following processes and to understand their importance for functional and aesthetic reasons:

- material removal, such as turning, drilling, etching, milling and grinding;
- shaping and manipulation, such as hammering, forming and bending;
- joining and assembly, such as crimping, soldering, adhesion, wiring, threaded fasteners, welding and brazing;
- heat and chemical treatment, such as annealing, tempering, hardening, etching, plating;
- surface finishing, such as polishing and coating.

7.2.5 Quality Control Techniques

You must be able to inspect, test, measure and compare engineered products to their product specification to ensure that they comply with the standards required. Important features in a specification include:

- the dimensions;
- the tolerances;
- the fit;
- the finish;
- the performance;
- the quality.

7.2.6 Tools and Equipment

You must learn to select and use appropriate tools and equipment, including Computer Aided Manufacture (CAM), needed for producing an engineered product. Your selection should take account of availability, cost, ease of handling, properties of materials and components. You must learn to care for tools and equipment and to maintain them where appropriate.

7.2.7 Health and Safety

You must be aware of health and safety issues relating to the use of materials, components, tools and equipment required for your engineering activities. These usually include:

- taking reasonable care of yourself and others in an engineering environment;
- wearing appropriate clothing and using safety equipment as appropriate;
- carry out risk assessments;
- following health and safety procedures and instructions;
- keeping a safe, clean and tidy workplace;
- ensuring that tools, equipment and machinery are properly maintained and fit for use.

7.3 ASSESSMENT EVIDENCE FOR UNIT 2: ENGINEERED PRODUCTS

You need to produce evidence in your portfolio that you have made an engineered product that includes at least **one** process from **each** of the following categories: material removal; jointing and assembly; treatment processes; surface finishing. Your portfolio **must** include:

a evidence of a production plan and associated quality control [9 marks];

b a schedule for making the product, with the key features identified [7 marks];

c identification of the production technique and critical control points [9 marks];

d evidence of the use of ICT in the making of your product [10 marks;

e a record of how you made your product [15 marks].

A typical candidate at grades GG, FF, EE will:	A typical candidate at grades DD, CC, BB will:	A typical candidate at grades BB, AA, A*A* will:	Mark	Max
a1 Describe a simple engineering process, using ICT as appropriate. **0 1 2 3**	**a2** Produce a production plan that identifies the engineering processes and quality control involved in making their product. **4 5 6**	**a3** Evaluate their production plan, in relation to the engineering processes and quality control involved in making their product. **7 8 9**		**9**
b1 Describe the importance of accurate production planning and of meeting the product specification.. **0 1 2 3**	**b2** Identify in their production plan the schedule for making their product. **4 5**	**b3** Evaluate their production plan in terms of how the schedule for making their product could be improved. **6 7**		**7**
c1 Identify key control points during the making of their product and describe the importance of health and safety. **0 1 2 3 4**	**c2** Use quality control tests and carry out work, when making their product, with due regard to health and safety, including reference to appropriate safety systems. **5 6 7**	**c3** Explain and justify how the production planning and scheduling for making their product could be improved. **8 9**		**9**

d1 Describe how they used ICT in making their product. **0 1 2 3 4 5**	**d2** Explain why they used ICT in making their product. **6 7 8**	**d3** Evaluate the use of ICT in making their product. **9 10**		**10**
e1 Describe how they produced their product using appropriate tools and equipment. **0 1 2 3 4 5 6 7**	**e2** Explain why the tools and equipment used when making their product were appropriate to the task and identify any changes they have made to their production plan. **8 9 10 11**	**e3** Evaluate their product in terms of the tools, equipment and processes they have used in making it and comment on how these would be modified in 'real world' engineering. **12 13 14 15**		**15**

Note: Although you will be given an interim mark out of 50 by your teacher, this mark will be moderated by OCR to make sure that it is in line with national standards. The grade (A*A* to GG) equivalent to this moderated mark will be determined at an Awarding Meeting convened for each examination series..

Total	**50**

7.4 GUIDANCE FOR TEACHERS

7.4.1 Guidance on Delivery

Engineers must work within constraints. Therefore it is important that Centres think carefully about the product specification with which the candidate will be working. It should be designed to suit the materials, tools, equipment and other resources available to the Centre. However, it should also reflect the diverse nature of engineering and the products made by the various sectors. Centres need to write their own product specification and from this develop an appropriate production plan that the majority of candidates can follow.

Candidates must be given adequate information and training prior to using a process or piece of equipment. Often basic skills will have been taught in Key Stage 3, however for many candidates this unit will be an introduction to some of the manual operations and processes that they will further develop in their chosen field of employment.

In addition to making an engineered product, the candidate needs to develop an understanding of the reasons for selecting materials, components and processes to fulfill the design specification and achieve a quality product.

Health and safety information must be provided covering all processes, skills and knowledge that the candidate will employ whilst following this unit.

Owing to the practical nature of this unit, it may be advisable in some Centres to arrange candidates in groups and run a carousel system. In this case, administration can be problematic and the use of instruction/process or job cards can prove helpful.

7.4.2 Guidance on Assessment

Coursework evidence can take a number of forms. A candidate portfolio can consist of any appropriate form of evidence, including teacher/tutor comments, photographs, taped and video evidence, supported witness statements and paper based evidence.

Where Centres are unable, for logistical reasons, to visit, or receive input from, local engineering companies, teachers/tutors should use video and simulations to give candidates a feel for industrial manufacturing processes.

When grading the portfolio for this unit you must consider the following general qualities which distinguish between grades. The candidate shows:

- increasing depth of understanding of the unit content, showing greater depth and breadth;
- increasing coherence, comparison and a greater ability to draw valid conclusions when making;
- increasing understanding of the production process;
- greater skills in using tools, equipment and processes.

Each portfolio should be marked by the teacher according to the criteria in the *Assessment Evidence Grid* in Section 7.3. Photocopiable URS will be supplied and will be sent to Centres at the start of the course.

Each row in the grid comprises a strand showing the development of a given criterion, each row corresponding to a point (**a**, **b**, **c** etc.) in the banner.

Please note that the second column describes the work of a typical candidate working at grades DD, CC and *the lower half of grade BB* whilst the third column describes the work of a typical candidate working at *the upper half of grade BB,* grades AA and A*A*.

The maximum mark for each criteria strand is shown in the right hand column.

Teachers use their professional judgement and circle the mark that *best fits* the work of the candidate and also record it on the URS in the column headed *Mark*.

Centres should use the full range of marks available to them; Centres must award *full* marks in any band for work which fully meets the criteria. This is work which is 'the best one could expect from candidates working at GCSE (Double Award) level'.

Only one mark per strand/row will be entered. The final mark for the candidate is out of a total of 50 and is found by totalling the marks for each strand.

Example: For a candidate's work that comfortably satisfies criterion **e2** and may be perceived as equivalent to the work of a grade CC candidate, a mark of **10** should be awarded on the scale for this strand of 0-15.

A typical candidate at grades GG, FF, EE will:	**A typical candidate at grades DD, CC, BB will:**	**A typical candidate at grades BB, AA, A*A* will:**	**Mark**	**Max**
e1 Describe how they produced their product using appropriate tools and equipment. **0 1 2 3 4 5 6 7**	**e2** Explain why the tools and equipment used when making their product were appropriate to the task and identify any changes they have made to their production plan. **8 9 (10) 11**	**e3** Evaluate their product in terms of the tools, equipment and processes they have used in making it and comment on how these would be modified in 'real world' engineering. **12 13 14 15**	**10**	**15**

The following table indicates which criteria in the *Assessment Evidence Grid* meet which assessment objectives:

Criterion	AO1	AO2	AO3
a1	4	8	8
a2	4	4	8
a3	4	4	4
b1	4	4	8
b2	4	4	8
b3	4	4	4
c1	8	8	4
c2	8	4	4
c3	4	4	4
d1	8	4	8
d2	8	4	4
d3	4	4	4
e1	8	4	8
e2	4	4	8
e3	4	4	4

7.4.3 Resources

Equipment

To fulfil this unit candidates will need access to a range of engineering tools including cutting and wasting tools, electronics equipment, e.g. soldering iron and ancillary equipment. They will need access to normal workshop facilities and to a range of engineering materials. Candidates will require access to Computer Aided Manufacturing equipment such as a CAD/CAM lathe, milling machine or cutter. They will also require access to real life examples of engineering designs.

Engineering Companies

Ideally candidates should visit local engineering companies. Where this is not possible, video, books and visits from external speakers will be necessary.

Teaching Skills

Whilst Resistant Materials teachers will be ideal for the delivery of this course, they will need to have a deep up to date understanding of engineering working practices across the engineering sectors.

Books

For *all* candidates:

Supported by OCR approved Heineman Texts.

Design in the Making; Longman
A book with a Teachers Guide aimed essentially at 11-14 year olds, but with a quantity of useful information and worksheets suitable for GCSE in Engineering (Double Award) at Key Stage 4.

Books are available covering Resistant Materials: Candidate Book, ISBN 0582 36589 9 (Teachers Pack, ISBN 0582 36587 2).

Royal College of Art Routes series; Hodder and Stoughton

A series of books and Teachers Guides aimed at Key Stages 3 and 4 (Food ISBN 0340 67392 3, Textiles ISBN 0304 67391 5, Graphics ISBN 0304 67393 1, Control ISBN 0304 67390 7, Resistant Materials ISBN 0304 67394 X) and post-16 (ISBN 0-340-70528-0) containing useful information for GNVQ candidates across all material areas, including examples from various manufacturing industries.

Design & Make It! Resistant Materials Technology; Stanley Thornes ISBN 0 7487 2470 2
This book has been designed essentially to support GCSE Design and Technology but provides a good foundation in the use of resistant materials.

For more advanced candidates and teachers:

Advanced Manufacturing Design & Technology; Hodder & Stoughton.
A book developed by the Royal College of Art Technology Project, aimed at VCE and A level candidates of manufacturing and engineering. ISBN 0 340 70528 0.

Manufacturing Technology; Delmar Publishers Inc.
An American candidates' book offering a broad approach to issues across manufacturing technologies. Care needs to be taken as measurements and financial data are in US units. ISBN 0 8273 3462 1.

Fundamentals of Engineering, author R.L. Timings; Longman.
A book aimed at NVQ Engineering candidates. It has some good practical content. ISBN 0 282 30583 7

Engineers in Business, author Mike Lanigan; Addison Wesley Publishing.
This is a book aimed at degree level candidates, but contains a large amount of useful information. ISBN 0 201 41695 6.

7.4.4 Key Skills Mapping

Details on delivery are given in Section 4.

🔑 this unit contains clear opportunities for generating Key Skills portfolio evidence.
∫ this unit contains opportunities for developing the Key Skill, and possibly for generating portfolio evidence if teaching and learning is focused on that aim.
8 there are no obvious opportunities for the development or assessment of the Key Skill in this unit.

Criterion	C	N	IT	WO	PS	LP
1.1	∫	🔑	∫	∫	🔑	∫
1.2	🔑	🔑	∫	∫	🔑	∫
1.3	∫	∫		∫	∫	∫
2.1	∫	🔑	∫	∫	🔑	∫
2.2 (a) **(b)** **(c)** **(d)**	🔑	🔑 ∫ 🔑 ∫	∫	∫	🔑	∫
2.3	∫	∫	∫	∫	∫	∫

8 Unit 3: Application of Technology

8.1 ABOUT THIS UNIT

Technology affects every stage in the design and manufacture of products. In this unit you will investigate the impact of modern technology on the design and manufacture of a range of products in different engineering and manufacturing sectors. You will learn how new technology has helped to develop design and manufacturing processes and to improve the quality of products and the service offered to customers. You will also learn about the benefits and implications modern technology has for the work force, the wider community, the global environment and sustainability.

You will investigate the impact of:

- information and communications technology (ICT);
- new components and a range of modern materials, including smart materials;
- control technology.

This and other units will utilise prior learning in design and technology. This unit links with Unit 1: *Design and graphical communication* and Unit 2: *Engineered products* where you will have the opportunity to use new technology and materials. This unit may also help you to progress to VCE Engineering or VCE Manufacturing. This unit also forms part of the GCSE in Manufacturing (Double Award).

This unit provides some of the underpinning knowledge and understanding for the National Vocational Qualification in Performing Manufacturing Operations and Performing Engineering Operations.

You will also have the opportunity to develop your Key Skills when working towards this unit.

This unit is assessed solely through an externally set test.

8.2 WHAT YOU NEED TO LEARN

8.2.1 Manufacturing and Engineering Sectors

You will investigate the impact of technology on the design and manufacture of different products across a range of the manufacturing and engineering sectors listed below:

Manufacturing	Engineering	
biological and chemical	aeronautical	fluid
engineering fabrication	automotive	marine
food and drink	civil	mechanical
paper and board	computer	process control
printing and publishing	construction	telecommunications
textiles and clothing	electrical and electronic	

When investigating products, you must be able to identify in which sector the product was made.

8.2.2 New Technology

You will learn about, and look at examples of, how modern technology is involved in the design and manufacture of a range of products across the different sectors. The modern technologies you will learn about are:

The Use of Information and Communications Technology, including:

- sourcing and handling information and data, such as databases, spreadsheets and internet sites;
- CAD (computer-aided design) techniques;
- CAM (computer-aided manufacture);
- communications technology;
- control technology.

The Use of Modern and Smart Materials and Components, including:

- polymers, including plastics, adhesives and coatings;
- metals and composites, including shape memory alloys;
- biological, chemical and food products, modified ingredients and methods of preparation and production;
- computer technology, including microprocessors and memory devices;
- micro-electronic components and parts, including integrated circuits and display devices;
- textile technology, including liquid crystal coated fabrics and thermocromic dyes.

The Use of Systems and Control Technology to Organise, Monitor and Control Production, including:

- process/quality control and automation, including programmable logic controllers (PLCs) and embedded computers such as those used in both industrial and domestic appliances;
- robotics, including continuous operation, improved reproducibility, increased speed, work in hazardous environments;
- ICT as applied to integrated manufacturing/engineering systems, computer integrated engineering (CIE), computer integrated manufacturing (CIM) and including CAD/CAM links.

You must understand the impact of these modern technologies on:

- range, types and availability of products;
- design and development of products;
- materials, components and ingredients used;
- safety and efficiency of modern methods of production in terms of materials, energy consumption and time;
- improved characteristics of products, such as size, weight/density, ease of use, disposability and reclaimability;
- markets for the products.

You must also understand the advantages and disadvantages that the use of modern technology has brought to society. These might include:

- changes in the type and size of the workforce;
- changes in the working environment;
- impact on the global environment and sustainability.

8.2.3 Stages in Engineering and Manufacturing a Product

Making a product involves a number of important stages and activities. These can be generally grouped as:

- design;
- marketing;
- production planning;
- material supply and control;
- processing – production;
- assembly and finishing;
- packaging and dispatch.

When you look at a product, you must be able to identify the main stages and activities in making the product.

You also need to understand the impact of modern technology on the stages of manufacturing.

8.2.4 Investigating Products

You will learn how to investigate products from a variety of sectors that use modern technology by:

- researching information from manufacturers and suppliers;
- handling and examining individual products;
- carrying out simple assessment of properties, such as structure, heaviness, colour and feel of surfaces, scratch and wear resistance, areas likely to be damaged;
- evaluating the need for the technology, materials and components used.

When investigating the impact of technology on the design and manufacture of a range of products in different sector, you should consider:

- the role the modern technology plays in the design and manufacture of the product;
- the technology or process it replaced;
- the benefits of using the technology;
- the implications of using the technology for the product and the manufacturer.

You must be able to use the information you have gathered, together with drawings, diagrams and sketches, to explain how a product works in terms of its:

- purpose;
- structure and form;
- materials and components;
- technology used.

8.3 GUIDANCE FOR TEACHERS

8.3.1 Guidance on Delivery

The examination paper is common to both the GCSE in Engineering (Double Award) and the GCSE in Manufacturing (Double Award). This allows Centres flexibility to co-teach the two specifications. Where Centres decide to co-teach two groups in this way, engineering candidates will focus on the use of engineering materials, material removal, joining, assembly, treatment processes and surface finishes. Manufacturing candidates will focus on the production of made products in one or more material areas from: food, textiles, paper and card, chemicals, resistant materials and ceramics.

Candidates will be expected to answer questions to show how well they understand the importance of technology in manufacturing and engineering. Their answers will need to include:

- information relating to the sectors outlined in the unit specification;
- information detailing an investigation into products manufactured from one or a number of the sectors;
- new materials and how they can be used;
- the use of ICT in the manufacturing process including CAD and CAM;
- details of the impact the product(s) they have investigated have had upon the manufacturer, user and other sectors of manufacturing/engineering;
- details of the different methods of production used in the sectors outlined in the specification of this unit.

8.3.2 Resources

For *all* candidates:

ICT Textbooks:

Heinemann OCR ICT B; ISBN 0 435 45496 X. This text book has been written to explore vocational use of ICT and contains some useful information on contexts. The book is supported by a teacher pack.

Hodder & Stoughton GCSE in Information and Communication Technology (Double Award); this book is to be published in June 2002, essentially to support the GCSE in Information and Communication Technology (Double Award) offered by the awarding bodies. Again, while not being specific to manufacturing and engineering, the book provides a useful resource for vocational use of Information and Communication Technology.

Design and Technology Books:

Design in the Making; Longman
A book with a Teachers Guide aimed essentially at 11-14 year olds, but with a quantity of useful information and worksheets suitable for GCSE in Engineering (Double Award) at Key Stage 4.

Books are available covering Resistant Materials ISBN 0582 36589 9 (Teachers Pack, ISBN 0582 36587 2), Textiles ISBN 0582 34437 9 (Teachers Pack, ISBN 0582 34438 7) and Food Technology ISBN 0582 36590 2 (Teachers Pack, ISBN 0582 36588 0).

For more advanced candidates and teachers:

Advanced Manufacturing Design and Technology; Hodder & Stoughton.
A book developed by the Royal College of Art Technology Project, aimed at VCE and GCE candidates of manufacturing and engineering. ISBN 0 340 70528 0.

Manufacturing Technology; Delmar Publishers Inc.
An American candidates' book offering a broad approach to issues across manufacturing technologies. Care needs to be taken as measurements and financial data are in US units. ISBN 0 8273 3462 1.

Fundamentals of Engineering, author R.L. Timings; Longman.
A book aimed at NVQ Engineering candidates. It has some good practical content. ISBN 0 282 30583 7.

Engineers in Business, author Mike Lanigan; Addison Wesley Publishing.
This is a book aimed at degree level candidates, but contains a large amount of useful information. ISBN 0 201 41695 6.

8.3.3 Key Skills Mapping

Details on delivery are given in Section 4.

🔑 this unit contains clear opportunities for generating Key Skills portfolio evidence.
∫ this unit contains opportunities for developing the Key Skill, and possibly for generating portfolio evidence if teaching and learning is focused on that aim.
8 there are no obvious opportunities for the development or assessment of the Key Skill in this unit.

Criterion	C	N	IT	WO	PS	LP
1.1	∫	∫	∫	8	8	8
1.2	∫	🔑	∫			
1.3	∫	∫				
2.1	∫	∫	∫	8	8	8
2.2 (a) **(b)** **(c)** **(d)**	∫	🔑 ∫ 🔑 ∫	∫			
2.3	∫	∫	∫			