Engineering

Level 2 Principal Learning

Specification (2760-02)

Assessment 2013 onwards

This Principal Learning specification should be read in conjunction with:

- Specimen assessment materials and mark schemes for Principal Learning
- Teacher guidance materials for Principal Learning
- Examiners' Reports for Principal Learning

This specification will be published annually on our website www.cityandguilds.com. We will notify centres in writing of any changes to this specification. We will also publish changes on our website. The version of the specification on our website will always be the most up-to-date version, although it may be different from printed versions.

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1 Introduction

1.1 Why choose City & Guilds?

City & Guilds is a household name for vocational qualifications. City & Guilds offers over 500 awards across a range of industries. With over 8500 centres in over 100 countries, City & Guilds is recognised by employers worldwide. It works closely with employers and industry bodies to ensure that its qualifications provide the benchmark standard for workplace skills and knowledge.

Why is City & Guilds so popular?

Specifications

These are designed to the highest standards, so that teachers, learners and learners' parents or guardians can be confident that a City & Guilds award provides an accurate measure of achievement. Assessment structures have been designed to achieve a balance between rigour, reliability and demands on learners and teachers.

Support

City & Guilds runs the most extensive programme of Principal Learning support meetings available in the UK; these are free of charge in the first years of a new specification and are offered at a very reasonable cost thereafter. These meetings explain the specification and suggest practical teaching strategies and approaches that really work.

Service

We are committed to providing an efficient and effective service and we are at the end of a phone when you need information, advice or guidance. We will try to resolve issues the first time you contact us and will work with you to find the solution.

Ethics

City & Guilds is a registered charity. We have no shareholders to pay. We exist solely for the good of education. Any surplus income is ploughed back into educational research and our service to you, our customers. We don't profit from education, you do.

If you are an existing customer, we thank you for your support. If you are thinking of adopting City & Guilds for Principal Learning, we look forward to welcoming you.

1.2 Why choose the Engineering Principal Learning?

The Engineering Principal Learning introduces learners to the world of engineering. It provides a gateway to the different sectors of engineering and the underlying systems and structures. Learners will acquire an understanding of the contribution engineering makes to modern life and of the career opportunities available.

The Principal Learning will enable learners to progress into further and higher education and future employment.

1.3 How do I start using this specification?

You will need to register your centre with us. (See Section 5.2.) This will enable us to ensure that you receive all the material you need to help you to deliver units and to enter your learners for examinations. This is particularly important where examination material is issued before the entry deadline. You can let us know by completing the appropriate registration forms. We will send copies to your exams officer and they are also available on the City & Guilds website: **www.cityandguilds.com**

If your centre is new to City & Guilds, please contact your local City & Guilds Regional Office.

2 Specification at a glance

2.1 Level 2 Engineering Principal Learning at a glance

All eight units are compulsory

Unit 1 60 GLH
The engineered world Externally assessed

Unit 2 60 GLH
Engineering design Internally set and marked

Unit 3 60 GLH
Engineering applications of computers Internally set and marked

Unit 4 60 GLH
Producing engineering solutions Internally set and marked

Unit 5 30 GLH
Construct electronic and electrical systems Internally set and marked

Unit 6 60 GLH
Manufacturing engineering Internally set and marked

Unit 7 30 GLH
Maintenance Internally set and marked

Unit 8 60 GLH
Innovation, enterprise and technological advance Internally set and marked

3 Principal learning

3.1 Personal, Learning and Thinking Skills

The Framework of Personal, Learning and Thinking Skills 11-19 comprises six groups of skills that, together with the Functional Skills of English, mathematics and ICT, are essential to success in learning, life and work. For each group there is a focus statement that identifies the main PLTS in that group. This is followed by a set of outcome statements that are indicative of behaviours and personal qualities associated with each group of skills.

Each group of skills is distinctive and coherent. The groups are also inter-connected. Learners are likely to encounter skills from several groups in any one learning experience.

Listed below are the PLTS that are integrated within the assessment criteria in each unit. A copy of the PLTS framework should be given to each learner. Following these descriptors is a table showing the PLTS in the eight units of the Level 2 Engineering Principal Learning.

Independent enquirers
Focus: Young people process and evaluate information in their investigations, planning what to do and how to go about it. They take informed and well-reasoned decisions, recognising that others have different beliefs and attitudes.
Young people: IE1 identify questions to answer and problems to resolve IE2 plan and carry out research, appreciating the consequences of decisions IE3 explore issues, events or problems from different perspectives IE4 analyse and evaluate information, judging its relevance and value IE5 consider the influence of circumstances, beliefs and feelings on decisions and events IE6 support conclusions, using reasoned arguments and evidence

Creative thinkers
Focus: Young people think creatively by generating and exploring ideas, making original connections. They try different ways to tackle a problem, working with others to find imaginative solutions and outcomes that are of value.
Young people: CT1 generate ideas and explore possibilities CT2 ask questions to extend their thinking CT3 connect own and others' ideas and experiences in inventive ways CT4 question own and others' assumptions CT5 try out alternatives or new solutions and follow ideas through CT6 adapt ideas as circumstances change

Reflective learners
Focus: Young people evaluate their strengths and limitations, setting themselves realistic goals with criteria for success. They monitor their own performance and progress, inviting feedback from others and making changes to further their learning.
Young people: RL1 assess themselves and others, identifying opportunities and achievements RL2 set goals with success criteria for their development and work RL3 review progress, acting on the outcomes RL4 invite feedback and deal positively with praise, setbacks and criticism RL5 evaluate experiences and learning to inform future progress RL6 communicate their learning in relevant ways for different audiences

Team workers
Focus: Young people work confidently with others, adapting to different contexts and taking responsibility for their own part. They listen to and take account of different views. They form trusting relationships, resolving issues to reach agreed outcomes.
Young people: TW1 co-operate with others to work towards common goals TW2 reach agreements, managing discussions to achieve results TW3 adapt behaviour to suit different roles and situations TW4 show fairness and consideration to others TW5 take responsibility, showing confidence in themselves and their contribution TW6 provide constructive support and feedback to others

Self-managers
Focus: Young people organise themselves, showing personal responsibility, initiative, creativity and enterprise with a commitment to learning and self-improvement. They actively embrace change, responding positively to new priorities, coping with challenges and looking for opportunities.
Young people: SM1 seek out challenges or new responsibilities and show flexibility when priorities change SM2 work towards goals, showing initiative, commitment and perseverance SM3 organise time and resources, prioritising actions SM4 anticipate, take and manage risks SM5 deal with competing pressures, including personal and work-related demands SM6 respond positively to change, seeking advice and support when needed

Effective participators
Focus: Young people actively engage with issues that affect them and those around them. They play a full part in the life of their school, college, workplace or wider community by taking responsible action to bring improvements for others as well as themselves.
Young people: EP1 discuss issues of concern, seeking resolution where needed EP2 present a persuasive case for action EP3 propose practical ways forward, breaking these down into manageable steps EP4 identify improvements that would benefit others as well as themselves EP5 try to influence others, negotiating and balancing diverse views to reach workable solutions EP6 act as an advocate for views and beliefs that may differ from their own

This table shows the coverage of PLTS in the eight units of the Level 2 Engineering Principal Learning.

Level 2 Engineering Principal Learning

PLTS	IE	CT	RL	TW	SM	EP
Unit 1	*	*	*	*		*
Unit 2	*	*	*			*
Unit 3	*	*			*	*
Unit 4	*	*	*		*	*
Unit 5	*				*	
Unit 6	*	*	*	*	*	
Unit 7	*	*			*	
Unit 8	*	*				

3.2 Functional Skills signposting

The units may use and/or contribute towards the underpinning skills and knowledge of the Functional Skills in the following areas, depending on the precise nature of the work done in the Principal Learning.

The Principal	**Functional Skills**		
Unit	**English**	**Mathematics**	**Information and communication technology**
Unit 1 The engineered world	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2		• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2
Unit 2 Engineering design	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2	• Representing solutions using Mathematics Level3 • Analysing and processing using Mathematics Level 2 • Interpreting and presenting results Level 2	• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2
Unit 3 Engineering applications of computers	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2	• Representing solutions using Mathematics Level3 • Analysing and processing using Mathematics Level 2 • Interpreting and presenting results Level 2	• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2
Units 4 Producing engineering solutions	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2	• Representing solutions using Mathematics Level3 • Analysing and processing using Mathematics Level 2 • Interpreting and presenting results Level 2	• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2
Unit 5 Construct electronic and electrical systems	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2		• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2 •
Unit 6 Manufacturing engineering	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2	• Representing solutions using Mathematics Level3 • Analysing and processing using Mathematics Level 2 • Interpreting and presenting results Level 2	• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2

Unit	English	Mathematics	Information and communication technology
Unit 7 Maintenance	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2	• Representing solutions using Mathematics Level3 • Analysing and processing using Mathematics Level 2 • Interpreting and presenting results Level 2	• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2
Units 8 Innovation, enterprise and technological advance	• Speaking and listening Level 2 • Reading Level 2 • Writing Level 2	• Representing solutions using Mathematics Level3 • Analysing and processing using Mathematics Level 2 • Interpreting and presenting results Level 2	• Use ICT systems Level 2 • Find and select information Level 2 • Develop, present and communicate information Level 2

3.3 The three themes of the Level 2 Engineering Principal Learning

The principal learning of the Level 2 Engineering Principal Learning is centred around three themes:

Theme A: The engineered world introduces learners to the role of engineers and engineering's contribution to society.

Theme B: Discovering engineering technology enables learners to understand the importance and breadth of the technologies used in engineering.

Theme C: Engineering the future encourages learners to think about how engineering will be used in the future and its potential contribution to and impact upon society.

3.4 Level 2 Units

Level 2 Unit 1: The engineered world (ENG2U1)

What is this unit about?

The purpose of this unit is to provide learners with a broad knowledge of the Engineering industry and the diverse career opportunities available within it. Learners will understand work and career opportunities, including training and education. The importance of current legislation concerning Health and Safety and employment is emphasised in this unit. This will underpin the work learners should be carrying out during their work experience.

The role of professional bodies and other organisations involved in setting standards for the industry will be studied and learners will be encouraged to identify how standards can benefit the individual and the sector as a whole.

Learners will develop planning, research and investigative skills when exploring significant engineering Achievements of the 19th to 21st centuries. Since team working is regarded as vitally important in engineering, as in most other industrial sectors, learners will work in teams and develop presentation and communication skills.

Learners must both review their own work and get feedback from others. They should use the review and the feedback to improve their work. This learning should be put into practice when learners are engaged in similar activities in other Level 2 units, so that the experience gained in this research-based unit is of use elsewhere.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. know about sectors that make up the Engineering industry, and their products and services
2. know about the career and training opportunities, job roles, career paths and the role of professional bodies in engineering
3. understand the purpose of employment legislation
4. understand the contribution of 19th, 20th and 21st century engineering achievements.

Assessment criteria

1. Sectors that make up the Engineering industry

The learner can:

1.1 identify the sectors of engineering such as:
   a. oil, gas and chemical manufacture
   b. energy generation and distribution
   c. nuclear technologies
   d. waste management and water resources
   e. transport infrastructure and vehicle systems
   f. built environment engineering
   g. engineering manufacture and maintenance
   h. medical and sports engineering

1.2 describe engineering sectors and their products and services.

2. Career and training opportunities, job roles, career paths and the role of professional bodies in engineering

The learner can:

2.1 recognise the job roles in engineering:
   a. professional
   b. technical
   c. operatives

2.2 explain career and training opportunities, and describe career paths within engineering

2.3 identify the purpose and role of professional bodies in relation to:
   a. engineering sectors
   b. the part they play in setting and maintaining standards and operating registration schemes.

3. The purpose of employment legislation

The learner can:

3.1 explain the purpose of current employment legislation

3.2 explain the rights and responsibilities of employers and employees (IE6).

4. Significant engineering achievements of the 19th to 21st centuries

The learner can:

4.1 investigate significant engineering achievements of the 19th to 21st centuries through (CT2):
   a. team work:
   - allocating roles (TW3)
   - taking responsibility (TW3)
   - providing support and feedback to others (TW6)
   b. effective participation within the group (EP4)

4.2 describe how these achievements have contributed to our social and economic development(IE6) (RL6).

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 60 guided learning hours be spent on this unit.

Assessment

This unit is assessed through an external examination which is set and marked by City & Guilds.
The external assessment is a compulsory component of the qualification and is designed to test learners' ability to relate their learning to varying contexts, and to demonstrate the level of understanding they have reached about various aspects of the engineered world.
Examinations will be available twice a year and the dates will be published at the start of each academic year. The examination will take place under controlled examination conditions.
The examination will consist of two parts:

Part A

This will cover Assessment criteria Topic 4 and will be based on pre-release material. At a specified date prior to the examination, learners will be given pre-release case study material on one significant 19th, 20th or 21st century engineering achievement. In preparation for the examination, learners will need to investigate this engineering achievement and how it has contributed to social and economic development.

The investigations will be carried out in teams and the findings shared and communicated to the group as a whole. Engaging in this activity will enable learners to participate effectively, undertake independent enquiry and develop skills in research, analysis and investigation. In communicating their findings, the learner will cover a wide range of Personal, Learning and Thinking Skills. Learners will need to participate in group work in order to be fully prepared for the examination. The team work element of the task will be covered by the examination.

Learners will only be allowed to take the pre-release case study material into the examination with them and will answer short, structured questions on the engineering achievement.

Part B

This will cover Assessment criteria Topics 1, 2 and 3 and will consist of short answer questions. This will enable learners to demonstrate their knowledge and understanding of the roles of the sectors within the engineering industry, and the products they produce and services they provide. They will need to be familiar with different career pathways within engineering and the job roles performed by people employed in engineering.

Employment legislation forms the final element of the examination and learners will need to be familiar with the reasons for the existence of legislation, and the rights and responsibilities of employers and employees.

Examination specification

Duration: 90 minutes
Assessment type: Short answer questions
Marks: 48 marks

Assessment criteria topic	Subtopic	No of items	Total mark	%
Part A				
4. Significant engineering achievements of the 19th to 21st centuries	Explain why the development was needed	4	24	50
	Describe the achievement	4		
	Compare with existing/competing solutions	4		
	Evaluate the contribution the development has made to people's lives	3		
	Team working	9		
Part B				
1. Sectors that's make up the Engineering Industry	Identify sectors	3	11	23
	Describe the products of the engineering sectors	4		
	Describe the services of the engineering sectors	4		
2. Career and training opportunities , job roles, career paths and the rile of the professional bodies in engineering	Identify job roles	3	9	19
	Explain career and training opportunities	2		
	Describe career paths in engineering	2		
	Identify the purpose and role of the professional bodies	2		
3. The purpose of employment legislation	Explain the purpose of current employment legislation	2	4	8
	Explain the rights and responsibilities of employers and employees in engineering	2		
	Totals	**48**	**48**	**100**

Guidance for delivery

This unit will provide learners with knowledge of a wide range of Engineering sectors, and their products and services. For example, built environment engineering includes building services engineering, civil engineering and structural engineering. An essential part of this unit is for learners to develop an understanding of the important role engineering plays in supporting and maintaining modern life. This sets the context for other units, and learners will be able to use the knowledge that they have gained from this unit in other Level 2 units.

At a personal level, learners will develop their understanding of career pathways in engineering; job roles including professional, technical and operative roles; ways of gaining skills; and work and career opportunities including training and education.

Learners will explore the role of professional bodies in setting standards and operating registration schemes. They should also appreciate that engineers may often work in conditions which involve several organisations, including professional bodies and trade unions.

Learners will learn about the responsibilities and duties between employers and employees, and the purpose of current legislation such as Health and Safety and Employment Legislation, along with how this legislation has led to improvements in the workplace. This understanding will form an essential underpinning of the work learners will be carrying out during work experience.

Delivery would benefit from visiting speakers who could share their first hand experience of engineering sectors and their associated careers and job roles. Learners could be given the opportunity to talk to guest presenters and ask them relevant questions.

As part of their work on this unit, learners could be given the task of studying the work of a past engineer such as Thomas Telford or Isambard Kingdom Brunel and investigating the impact that their work has had on our everyday lives. Alternatively they might need to track the development of current products such as personal computers or mobile phones in order to understand how they have evolved and appreciate the emergence of the technologies which support them.

Typical technologies might include:

- electrification and the National Grid
- vehicle design, technology and safety
- water treatment, distribution and waste management
- electronics, computers and telecommunications
- agricultural mechanisation
- household appliances and refrigeration
- chemical engineering
- aerospace technologies.

As detailed in the Assessment section of this unit, the specific context for this work will be provided through pre-release material made available to centres at a specified date, prior to the examination. Learners will work together in small teams to explore various aspects of the task.
The following are some resources that may facilitate or enhance the learning covered in this unit:

- Biographies on historical engineering figures such as Thomas Telford or Isambard Kingdom Brunel
- Books and DVD resources related to engineering inventions and innovations
- HowStuffWorks **www.howstuffworks.com**
- workSMART **www.worksmart.org.uk**
- Young Engineers **www.youngeng.org**

Opportunities for applied learning

Opportunities for applied learning will largely be through project work, case study research and investigation of specified topics.

Structured and appropriate visits to sites such as industrial plants, science parks or industrial museums could be used to increase the learner's awareness of the topics covered by the unit. It would also be useful for learners to visit local engineering businesses which could provide a local insight into Engineering industries and their achievements.

The content of this unit will enable learners to set their own experiences within a context, which should become apparent as their understanding of engineering processes and achievements grows during the study of this and other units. Learners should be able to identify the contribution of engineers to society, and how the engineering profession is organised and regulated.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the Achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone. Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- planning and carrying out research on the impact of engineering on our everyday lives
- analysing and evaluating the information obtained as part of the research process
- judging the relevance and value of the information obtained

Creative thinkers

- generating ideas based on information obtained from research
- asking questions of peers and teachers as part of the research process to further develop ideas and extend thinking

Reflective learners

- setting goals on the achievement of the tasks required to carry out the research
- inviting feedback and reviewing progress on the research
- communicating learning in a style to meet audience requirements

Team workers

- providing constructive support and feedback to others

Self-managers

- working towards goals and organising time and resources to meet these goals as a part of project management

Effective participators

- identifying improvements in, for example, working with professional bodies that would benefit themselves, as well as others.

Level 2 Unit 2: Engineering design (ENG2U2)

What is this unit about?

The purpose of this unit is to provide learners with an understanding of the importance of engineering design. For a chosen product design specification, learners will produce a design solution.

Research and investigative skills will be developed throughout the unit and learners will be expected to research existing products in order to plan and prepare their design solution. They will check the suitability of a design proposal against the specification and customer design brief in order to generate a number of design solutions.

The use of conventional and computer-based drafting and design techniques to produce working drawings will be covered in this unit. The importance of current engineering standards, projections and symbols will be emphasised throughout the development process. It is important that consideration is given to design constraints linked to materials, components and manufacturing processes in order to identify the best medium for presenting a final design solution.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. be able to plan and produce a product design specification from a design brief
2. be able to produce engineering drawings to meet a product design specification
3. be able to present engineering designs using drawing standards and conventions.

Assessment criteria

1. Plan and produce a product design specification

The learner can:

1.1 explain the need for good functional design to ensure efficient performance of an engineering product

1.2 identify the key requirements of design briefs

1.3 produce a product design specification from a given customer design brief (CT1)

1.4 explain how the design process takes the following constraints into consideration (IE2) (CT2):

- a. existing patents and copyrights
- b. standards and legislation
- c. the type(s) of material to be used
- d. how products will be manufactured
- e. the operating conditions in which they will work

1.5 identify the variables that influence the final solution, such as performance, quality and cost

1.6 investigate the relationship between a product specification and a design brief (IE2)

1.7 explain how basic mathematical and scientific principles influence the selection of materials and processes, and enable a design to become a functioning product or service (IE5)

1.8 carry out research and investigation activities including practically dismantling engineering products (IE2) (CT2)

- a. describe a method for proving the design.

2. Produce engineering drawings to meet a product specification

The learner can:

2.1 evaluate relevant information and data, and the implications of patent protection and copyright laws on published items and data (IE4, 5)

2.2 communicate through and interpret drawings and sketches (IE4) (CT5)

2.3 use conventional and Computer Aided Drawing (CAD)-based drawing methods

2.4 identify materials and components as required from charts or manufacturers' publications

2.5 experiment with more than one proposal for a final design (CT1, 5)

2.6 produce a preferred design solution using current standards, conventions and symbols (CT6)

2.7 review and evaluate the effectiveness of the design solution (RL1).

3. Present engineering designs using drawing standards and conventions

The learner can:

3.1 use a range of traditional manual and modern CAD methods and techniques to present design proposals and to understand the importance of working to current standards and using recognised symbols (IE3) (CT1, 5)

3.2 check and confirm a design proposal against the specification

3.3 present a final design using an appropriate method (EP2)

3.4 relate the design solution to the manufacturing requirements.

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 60 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

The learner will complete an assignment which will enable them to complete this practical unit and to meet the evidence requirements in their local context. The assignment may use different starting points to engage learners. These might include an industry-set brief from a local engineering company, or an investigation into existing engineered products, and associated evaluation and analysis to identify possible improvement.

The assignment will take approximately 15 of the 60 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes. Research-based work may be carried out independently, but all submitted work must be prepared under controlled conditions.

Learners will need to be provided with a customer design brief.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the Learner will produce:

1. a product specification and a summary of the sources of information used and research carried out
2. a selection of drawings outlining the design against the product specification
3. the presentation of a final design solution to current standards using recognised drawing conventions
4. a written evaluation of the effectiveness of the design solution and its presentation.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

Assignment structure

A suggested assignment structure, which would allow learners to meet the evidence requirements, may include the following steps:

- Using the provided customer design brief, produce a product specification that can be used to generate a number of design solutions.
- On the provided sheet, describe the sources of research and the types of investigations used in preparation of the product specification. Briefly summarise any information obtained.
- Produce design solutions against the product specification.
- Compare the examples and explain:
    - how closely they match the specification any manufacturing considerations
    - the reasons for selecting the preferred design solution.
- Produce a final design solution to current standards, using recognised drawing conventions.
- Demonstrate, using appropriate methods, how the final design solution meets the customer design brief.

Weighting of assessment criteria topics

Assessment criteria	Weighting	Marks
1. Plan and produce a product design specification	25%	12
2. Produce engineering drawings to meet a product specification	50%	24
3. Present engineering designs using drawing standards and conventions	25%	12
Total	**100%**	**48**

Assessment grid

This statement of performance should be read in association with the assessment criteria for this unit. Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	**Band 1**	**Band 2**	**Band 3**
	The leaner has:		
1. Plan and produce a product design specification	**0 – 4 marks** Superficially interpreted the design brief to produce a basic product specification with some mention of the functional requirement in the specification Relied predominantly on a single source of information Made minimum reference to the design constraints	**5 – 8 marks** Used the design brief to produce a clear product specification, which included essential information; show some important aspects of functional requirements in the specification Used more than one source of information Identified a few of the design constraints	**9 – 12 marks** Produced a detailed and clear product specification that met the requirements of the customer design brief; explained the need for good functional design and identified the key featured of the design Obtained information from more than one source including practically dismantling Engineering products Identified many of the design constraints including existing design protection, manufacturing requirements and operating conditions

2. Produce engineering drawings to meet a product specification	**0 – 8 marks**	**9 – 16 marks**	**17 – 24 marks**
	Produced one idea from the design brief	Produced several ideas from the design brief	Produced several viable ideas from the design brief
	Produced a few feasible drawings using conventional techniques	Used a range of drawing techniques and worked within tolerance to produce drawings	Used a wide range of graphical methods and techniques; produced accurate, detailed drawings; drawings conformed to current standards
	Made minimal reference to changes or modifications	Adequately justified any modifications or alterations required and possible limitations	Recorded in detail original design ideas and criteria for selecting preferred solution
	Attempted to provide a basic evaluation	Provided an evaluation of the methods and techniques used	Provided a comprehensive and justified evaluation of the methods and techniques used
	Produced a possible design but limited solution that met basic drawing standards	Produced a realistic design solution and showed how it met the requirements of the brief	Produced an effective design solution and provided an analytical evaluation of the methods and techniques used; explained its range of functions and how it could be manufactured

3. Present engineering designs using drawing standards and conventions	**0 – 4 marks** Understood the need for drawing standards and conventions Used either CAD or conventional drawing with limited success Made little reference to manufacturing requirements and mentioned some specification points when discussing the final solution	**5 – 8 marks** Complied with some current conventions Used either CAD or conventional drawing with success Made reference to come manufacturing requirements and confirmed that some aspects of the final solution met the specification	**9 – 12 marks** Produced drawings that met the quality standards and included most of the key details Used both CAD and conventional drawing techniques with success Made detailed reference to several manufacturing requirements and confirmed that the final solution met the specification

Guidance for delivery

It is important that this unit integrates with the content of other Level 2 units, and it is expected that applied learning gained from other units will be used for part of the activities involved in producing realistic designs. It is recommended that this unit precedes Level 2 Unit 5: Construct electronic and electrical systems; Level 2 Unit 6: Manufacturing engineering; and Level 2 Unit 7: Maintenance.

Throughout this unit, learners will be encouraged to work with others, inviting advice or feedback to improve design concepts and proposing practical ways of problem solving. Learners must both review their own work and get feedback from others. They should use the review and the feedback to improve their work. The opportunities to link this work with other Level 3 units such as Unit 3: Engineering applications of computers; Unit 4: Producing engineering solutions; Unit 6: Manufacturing engineering and also to Unit 8: Innovation, enterprise and technological advance should not be missed. In particular, Unit 4 provides opportunities to test and evaluate ideas more conclusively, once they have been realised by building a prototype.

Learners should research and investigate manufactured products. They should look at a variety of engineering products, both retail and industrial, to establish the design brief. Variables which affect design should be considered, for example:

- purpose (function)
- size and shape
- tolerances
- weight
- working conditions
- cost
- appearance
- batch size
- special features, considerations, constraints.

Group discussion should be encouraged as it is a useful way of stimulating the conceptual stages of the design process. However, learners should be given the scope to demonstrate flair and inventiveness by investigating existing products, materials and manufacturing processes. They may develop a specification from which to generate design ideas using:

- internet sites
- manufacturers' publications
- retailers' publications
- current standards
- existing products.

Learners should seek approval for their design specification before providing outline design solutions to meet a customer's design brief. They should be encouraged to look for simple solutions even if the design involves consideration of more complex mechanisms such as electro-mechanical systems. They should check final design solutions for patent infringements. The reproduction and use of reference material from manufacturers, retailers and current standards should be cleared to avoid copyright infringements. Exploring the implications of legislation in greater depth is considered outside the scope of this Level 2 unit

Learners should be encouraged to use well-established techniques for generating ideas, such as mind-mapping, outline sketching, and concept modelling. The results should be evaluated against the customer's brief and feasibility of production before being shaped into realistic proposals. The importance of using current engineering standards, projections and symbols should be emphasised throughout the development process. The range of methods to communicate the preparatory and final technical design information should embrace the following accepted techniques:

- sketching and annotating
- drawing using 2D and 3D techniques (conventional and CAD):
    - orthographic
    - pictorial
- mathematical modelling, using easily manipulated materials and computer systems
- prototyping, including breadboarding, using constructional kits and rapid prototyping systems
- discussion.

The key to success in this unit is the acceptance that practically every man-made item we use in our everyday lives is a structure of some form or another that has been designed for a specific purpose. By recognising this basic principle, learners will begin to understand how good design is the answer to avoiding catastrophes like falling buildings, collapsing bridges or wings falling off aircraft.

When considering design proposals, learners should be encouraged to draw on their knowledge of materials, manufacturing processes and maintenance practices, taking into account:

- production method
- production cost
- product retail costsuitability of materials and components
- availability of materials and components
- serviceability (life cycle)
- legislation
- environmental concerns.

This unit will have an integrating effect on content learnt in other units, and it is expected that applied learning gained from other units will be used as part of the activities involved in producing realistic designs. In particular, the learner should begin to recognise the importance of taking into account the principles underlying material processing and behaviour in the design process, including:

- Hooke's law
- Young's Modulus of Elasticity (Design constant)
- Bending moment
- pre-treatments
- cutting, forming and machining
- joining and fastening
- component ratings
- testing
- the need for good functional design to ensure efficient performance.

Learners should work to current standards or use technical publications, details of which should be included in the presentation of the final proposal. The presentation should make full use of visual aids and, in particular, CAD systems and software packages to improve the communication of feasible design solutions.

The following are some resources that may facilitate or enhance the learning covered in this unit:

- IT facilities to support research and investigations into product design.
- Manufacturers' and retailers' publications or catalogues for product research.
- Engineering drawing and sketching facilities to enable drafting to current standards.
- CAD equipment and suitable software packages for design and presentation requirements.
- Access to current drawing and development standards.
- Facilities for modelling and prototyping.

Opportunities for applied learning

The learners will apply their knowledge by:

- investigating and researching existing publications and internet sites
- generating ideas from conceptual thoughts
- using CAD-based drafting and design software
- applying problem-solving techniques
- carrying out simple calculations
- using a range of presentation methods and discussion forums
- considering quality assurance and environmental factors
- dismantling existing engineering products.

What activities might be involved in this unit?

- Developing details of a product specification.
- Producing evidence of research and investigations.
- Recording design ideas developed to meet the requirements of the specification.
- Completing engineering drawings to a suitable scale.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone. Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- independently researching and investigating existing commercial products
- analysing findings to assist the preparation of a product specification
- checking the suitability of a design proposal against the specification and customer design brief
- generating design ideas using a range of methods

Creative thinkers

- evaluating alternative solutions for a product design

Reflective learners

- considering design constraints linked to materials, components and manufacturing processes
- considering the best medium for presenting a final design solution

Team worker

- working with others, discussing ideas and providing advice or feedback as necessary

Self-managers

- organising time and resources to experiment with more than one design solution from which to select the best proposal

Effective participators

- inviting advice or feedback to improve design concepts
- proposing practical ways of problem-solving.

Level 2 Unit 3: Engineering applications of computers (ENG2U3)

What is this unit about?

The purpose of this unit is to develop the learner's knowledge of, and skills in, the use of computers in engineering applications such as manufacturing, communicating data, the proving of products and process control.

Learners will explore why engineering systems use diagnostics and communication systems and will be encouraged to try out alternatives or new solutions when diagnosing or fault-finding. They should be prepared to repeat the work if it does not meet the required standard, or modify the procedures used on a subsequent occasion. Particularly important is co-operating with others when working towards common goals, such as repairing or designing a system. There should be particular emphasis placed on the co-operative aspect of team work and discussions relating to issues of concern. These skills are highly regarded in the Engineering industry as they play a role in finding resolutions that ensure that projects make headway and are co-ordinated.

Learners are also expected to plan, record and evaluate their ideas and testing processes, and to communicate these to peers, supervisors and customers in relevant ways. Learners must both review their own work and get feedback from others. They should use the review and feedback to improve their work.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. understand the use and advantages of Computer Aided Engineering systems for different activities
2. be able to plan, prepare, demonstrate and record the use of computers in a range of engineering applications.

Assessment criteria

1. Understand the use of Computer Aided Engineering systems

The learner can:

1.1 explain why computer-based diagnostics are necessary in repair and maintenance, eg for automotive repair or error detection and recovery

1.2 explain the advantages of using Computer Aided Engineering compared with traditional methods (IE4)

1.3 describe how robotics and automated systems can be used in manufacturing or process control

1.4 explain how to achieve the sensing and control of temperature, fluid level and flow (EP3)

1.5 state the reasons why microprocessor control is used in domestic products and systems (IE6).

2. Plan, prepare, use and record Computer Aided Engineering processes

The learner can:

2.1 plan and prepare data for transmission by a range of communication methods (SM3)

2.2 demonstrate the use of computer-based communication systems in engineering by:

a. using e-mail for transmitting information

b. the use of mobile telephone technology

2.3 use simple expert systems for problem-solving in engineering:

a. for diagnosing, fault-finding or predicting performance of a system (IE1,3)

b. producing and testing simple control programs, eg for robotics, process control or manufacturing applications (IE2) (CT3)

2.4 record data using appropriate methods.

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 60 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

Learners will complete an assignment consisting of two parts. Part 1 is a core assignment intended to allow the learner to demonstrate their understanding of the use and advantages of computers across a diverse range of engineering applications. Part 2 of the assignment will allow the centre to select a mini- project which addresses the learner's needs in terms of:

- sector activities
- availability of practical resources
- local employer requirements
- developing specific interests or applications of the use of computers in engineering.

Part 1: an overview of the use and advantages of Computer Aided Engineering systems

The first part of the assignment should require the learner to engage in researching the wider aspects of the use of computers in engineering applications. Learner should evaluate both the reasons for the adoption of this technology and the advantages that have resulted from these decisions.

Part 2: a mini-project which involves the practical use of a Computer Aided Engineering system in either:

a diagnostic testing or problem-solving

b robotics / process control system / or programming microcontrollers for inclusion in a domestic product. The second part of the assignment is intended to allow the learner to gain experience of the use of computers within engineering in a specific context. A selection of topics can be made available which will allow the learner to demonstrate their ability using suitable resources which are available and will ensure that the learner's experience forms a coherent part of their overall learning.

A learner who is following an automotive or electronic bias may benefit from undertaking work in diagnostics or using expert systems in problem-solving, whereas another learner interested in engineering manufacturing and assembly processes could complete Part 2 using robotics or a process control system.

When assessing Part 2 of the assignment, the various activities should be regarded as a whole, and judgments formed on the entirety of the evidence across the practical task. This is to allow a well-founded assignment that will compensate for any possible lack of access to particular specialised equipment. It will allow learners to gain access to maximum credit when working with different levels of facilities.

The assignment needs to reflect the applied nature of the qualification and should require the learner to work practically and to apply knowledge and skills gained both from this unit and from previous study of related units. It is essential that the learner applies knowledge and skills gained in the study of other units so that this assignment is not seen in isolation, and is to be regarded as a method of reinforcing their learning.

The assignment (Part 1 and Part 2) will take approximately 15 of the 60 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the learner will produce:

1. a written summary of the use of computers in engineering contexts. This should include references to the application, sector and advantages
2. a presentation which records the processes used and the testing, results and decisions made by the learner in completing either:
    a. records of diagnostic testing, identification of faults and component replacement
    b. a computer program used to control the robotic device or process control system and sensing devices used.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

Assignment structure

A suggested assignment structure, which would allow learners to meet the evidence requirements, may include the following steps:

Part 1 (All learners to complete)

- Produce a short written summary, with examples, of the uses of Computer Aided Engineering systems in modern engineering practice, including domestic products.
- Explain the advantages for manufacturers, users and those involved in designing or maintaining the systems.

Part 2 (Learner is to complete Part a or b)

a Diagnostic / expert system

- Refer to the centre-provided component specification and use a diagnostic system to identify system performance of the component, and any rectification, adjustment or modification required.
- Carry out the identified procedures.
- Test the rectified system against the performance specification and state:
    - how closely it matches the specification
    - any procedures followed or problems encountered.
- Record the testing carried out and explain why the method used was appropriate.
- Produce a presentation and transmit it electronically.

b Robotic / process control system / microcontroller programming

- Use the centre-provided task specification to produce a computer program which can be used as a basis of programming and controlling the provided process system, robotic device or microcontroller.
- Select and fit any required sensors.
- Using the developed file, transfer the data to the robotic device/process control system or microcontroller, and run and test the program.
- Compare the behaviour of the robotic device/process control system or microcontroller, with the task specification and state:
    - how closely it matches the specification
    - any procedures followed or problems encountered.
- Record the testing and modifications carried out and explain why these were necessary.
- Produce a presentation, and transmit it electronically.

Weighting of assessment criteria topics

Assessment criteria topic	Weighting	Marks
1. Understand the use of Computer Aided Engineering systems	25%	12
2. Plan, prepare, use and record Computer Aided Engineering processes	75%	36
Total	100%	48

Assessment grid

This statement of performance should be read in association with the assessment criteria for this unit. Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	Band 1	Band 2	Band 3
	The learner has:		
1. Understand the use of Computer Aided Engineering systems	**0 – 4 marks** Produced a basic summary that includes some brief information on the application and advantages of Computer Aided Engineering systems Relied predominantly on a single source of information	**5 – 8 marks** Produced an adequate summary that conveyed accurate useful information on the application and advantages of Computer Aided Engineering systems Obtained information from more than one source	**9 – 12 marks** Produced a comprehensive summary that converyed accurate and useful information showing a thorough understanding of the application and advantages of Computer Aided Engineering systems Obtained information from a range of sources and reached well-informed decisions after analysing research
2. Pan, prepare, use and record Computer Aided Engineering processes. 2.1 Part A: Diagnostic/ Expert system	**0 – 12 marks** Identified a fault Needed more than one attempt to rectify a fault Identified components and made general suggestions regarding rectification	**13 – 24 marks** Diagnosed simple faults Identified a procedure to rectify a fault Used an expert systems to assist with the identification and rectification procedures	**25 – 36 marks** Successfully diagnosed faults Followed a systematic approach including the use of expert systems to recognise and rectify a fault After following successful rectification procedures, tested the operation of the system, or suggested modification required

	Attempted to use electronic data transmission at a simple level	Used electronic data transmission effectively	Used a variety of electronic data transmission systems effectively
3. Pan, prepare, use and record Computer Aided Engineering processes. 3.1 Part b: Robotic/ process control system/ microcontroller programming	**0 – 12 marks** Used simple sensing devices Produced a basic solution (program) May have needed more than one attempt to produce a solution which meets the specification Attempted to use electronic data transmission at a simple level	**13 – 24 marks** Identified sensors which operate with limited accuracy Produced a working solution (program) allowing the system to operate using limited sensing and output devices Produced a solution which meets the specification in most respects Used electronic transmission effectively	**25 – 36 marks** Successfully utilised the properties of sensors for the specific applications Produces a successful working solution (program), allowing the system to respond to several requirements using sensing and output devices Produced a solution which meets the specification with precision and accuracy, whilst meeting quality standard requirements Used a variety of electronic data transmission systems effectively

Guidance for delivery

The use of computers occurs in many facets of engineering. Work undertaken in this unit should be linked to other work such as Level 2 Unit 2: Engineering design; Level 2 Unit 4: Producing engineering solutions; Level 2 Unit 6: Manufacturing engineering; or Level 2 Unit 7: Maintenance. This should be seen as part of an iterative process undertaken by engineers to ensure quality outcomes of their work. Using this method, learners will be exposed to new methods or processes and be able apply them in other situations. It is accepted that learners may program a device as part of the assessed task in this unit, but may complete its manufacture as a finished product as part of the work required for another unit. Equally, diagnostic testing undertaken in this unit may be used as an essential part of the processes required for successful repair of a system in Unit 7: Maintenance. Using electronic transmission of data will permeate the work of units concerned with many aspects of engineering including design, manufacture and maintenance.

Problem-solving and diagnostic testing can involve actual or simulated situations. The automotive sector should be able to provide local facilities or examples of routine diagnostic testing, although this technology is not limited to a single sector. Good use is also made of diagnostics in products such as inkjet or laser printers which use on-board diagnostics reliant on microprocessor-based microcontrollers.

Microcontrollers are central to systems which control the operation of heaters, pumps and indicators whilst receiving information from various sensors and switches. A wide range of domestic products including mobile phones, camcorders, conventional and microwave ovens rely on microcontroller technology. Other examples include domestic washing machines and dishwashers. Microcontrollers programmed as part of this unit can then be used in conjunction with work undertaken in Level 2 Unit 4: Producing engineering solutions or Unit 5: Construct electronic and electrical systems, where they can form the basis of a reactive or intelligent system.

Learners should be aware of the following aspects of industrial process control systems:

- the need for safety and interlocking guarding
- quality and inspection methods
- computer numerical control (CNC) methods used to control material removing and forming
- boiler control systems
- conveyors and transfer systems
- the use of vision systems.

For classroom teaching purposes, a combination of actual examples and teaching systems should be used. Several suitable teaching systems are included below. Using various robotic teaching systems will provide a high level of motivation and understanding in this context.

Increasing use is made of electronic communications systems in engineering and this should be reflected in the tasks learners undertake. Passing information as an e-mail or eDrawing will enable learners to communicate and work co-operatively.

The following are some resources that may facilitate or enhance the learning covered in this unit:

- Work placement or visits to commercial or college-based automotive servicing facilities.
- A selection of dismantled or display models which show the relationship of the microcontroller to other parts of domestic appliances.
- Software which can act as an 'expert system'. This needs to be accessible to learners. Several electronics packages exist, such as PCB-Wizard, Crocodile Technology and Electronics Workbench.
- CAM systems: any suitable system, either simple, eg using 2D software and linking to a cutter-plotter, or more complex involving a 3D package outputting STL files to cutting machines or rapid prototyping machines (this is not essential for this unit but would help integrate the work of this and other units).
- Actual or virtual industrial visits will help learners understand how industrial organisations are organised and how computer technologies are used.
- Microcontroller teaching systems. These are frequently based on the PIC microcontroller, simplified programming systems, eg PICaxe or PICbasic are used.
- Robotics teaching systems, eg Fischer technic robotics, Lego ® NXT Mindstorms, PICaxe robot.

Useful websites include:

- Economatics Education **www.economatics-education.co.uk**
- Lego Education **www.lego.com/eng/education/mindstorms**
- Picaxe **www.picaxe.co.uk**
- HowStuffWorks **www.howstuffworks.com**
- Wikipedia **http://en.wikipedia.org/wiki/Fuzzy_logic**
- Rotork **www.rotork.com**
- Bulldog **www.bulldogtools.co.uk**
- NEC Electronicks **www.necel.com/v_factory/en/index.html**
- Chain Reaction Bicycles **www.chainreactionbicycles.com**

Opportunities for applied learning

Sectors such as the chemical industry use automated process control systems widely. Visits to chemical companies and other manufacturing sectors will give learners an insight into the application of computer- based technologies.

Visits to plastics or electronics manufacturing companies will allow learners to understand how process control is used at all stages of manufacture from raw material through to component production and assembly by automated or robotic methods. Learners can operate similar systems providing opportunities for incorporating colour recognition systems, as well as temperature or level control. In mechanical engineering, the use of optical systems is now widespread and is used for ensuring traceability of components. This work integrates with Level 2 Unit 5: Construct electronic and electrical systems, and will enable learners to understand the importance of feedback in systems of this type and the importance of programmable systems.

Robotics forms an increasingly important part of manufacturing assembly processes and hazardous working environments. Learners should control modelled systems as a minimum in order to understand the technologies involved.

Modern automotive repair facilities make common use of diagnostic testing and maintenance operations using computer-based systems. Learners will be able to encounter such operations either during industrial placements or visits. This work links closely to Unit 7: Maintenance, where further opportunity can be taken to use expert systems or diagnostics.

Domestic equipment increasingly takes advantage of microprocessor technology. Learners need to be aware of these applications, which can be as diverse as systems which monitor the content of refrigerators, to vacuum cleaners which indicate when they need emptying. These intelligent products are becoming more integrated into everyday living.

What activities might be involved in this unit?

- Using a diagnostic system in maintenance operations for fault-finding and repair.
- Designing a control sequence for a robotic device or process control system.
- Testing and evaluating work against a specification.
- Using a computer-based system to communicate data.

Suggested prior learning

Engineering Principal Learning Level 1 Unit 3: Using Computer Aided Engineering.

Some experience of CAD-CAM and control system programming in KS3 Design and Technology, or in Level 2 Unit 5: Construct electronic and electrical systems.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone.

Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- exploring ideas using expert systems to assist them

Creative thinkers

- generating ideas when producing control programs
- trying out alternatives or new solutions when diagnosing or fault-finding

Reflective learners

- communicating their learning in relevant ways suitable for peers, supervisors or customers when dealing with process control systems

Team workers

- co-operating with others when working towards common goals, such as repairing or designing a system

Self-managers

- working towards goals, showing initiative, commitment and perseverance when undertaking a task which is complex, such as designing or fault-finding

Effective participators

- discussing issues of concern with others, and seeking resolution when needed so that projects make headway and are co-ordinated.

Level 2 Unit 4: Producing engineering solutions (ENG2U4)

What is this unit about?

The purpose of this unit is to provide learners with first hand practical experience of planning and producing engineering solutions whilst ensuring that Health, Safety and quality standards are applied throughout the process.

This unit will develop learners' understanding of the requirements of the Engineering industry. Learners will use hand, machine and computer controlled methods of manufacture. These methods are particularly important to the Engineering sector as they are relevant in a variety of industrial situations and environments, such as production, maintenance, installation and commissioning.

The Engineering sector also recognises the significance of preparing and following a production plan for both planning and quality assurance processes.
Activities will take place in the following contexts:

- Development: including the use of engineering drawings and the selection of suitable materials.
- Production: the production of parts and components using processes, tools and equipment safely and effectively.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. be able to plan and prepare engineering solutions
2. be able to use tools and equipment, and select parts, materials and components to achieve the solutions
3. know the Health and Safety and quality standards, and be able to apply them in the context of the process required for the solutions.

Assessment criteria

1. Plan and prepare for producing engineering solutions

The learner can:

1.1 examine a range of engineering materials and use the results to help prepare a production plan (IE2)

1.2 identify suitable standard components

1.3 produce a production plan for a single item using engineering drawings (EP3):

   a. organising time and resources, prioritising actions when producing a production plan (SM3)

   b. recording modifications required to the production plan (CT6).

2. Use tools and equipment, and select parts, materials and components to achieve the solutions

The learner can:

2.1 state the functions of parts and components including:
   a. mechanical
   b. pneumatic/hydraulic
   c. electrical/electronic

2.2 specify and use tools and equipment:
   a. hand tools for fabrication and assembly
   b. machine tools for shaping or cutting
   c. test equipment for fault-finding or ensuring quality

2.3 select and use materials, parts and components, working with a range of engineering materials

2.4 use a system to produce a single item which matches a product specification.

3. Apply Health and Safety and quality standards in the context of the process required for the solutions

The learner can:

3.1 apply Health and Safety procedures by:
   a. selecting suitable clothing and personal protective equipment (PPE) as necessary
   b. completing processes in accordance with risk assessments (SM4)

3.2 carry out quality checks by applying standards and specifying the use of test and measurement equipment (SM3)

3.3 evaluate the process of producing engineering solutions to inform future progress (RL5).

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 60 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

Learners will complete an assignment which reflects the main activities of the unit, in a context of development, production, maintenance, commissioning or installation of a single item. The assignment should involve the planning, production and assembly of an engineering component, and the recording and basic interpretation of consequent testing.

In this assignment, learners will produce a component or assembly from a prepared production plan including drawings. This is a normal requirement for many people working in different sectors of engineering, and being able to complete these processes will demonstrate the learner's ability to perform engineering operations.

When producing an item for this unit, the minimum requirement is to use two technologies from mechanical, pneumatic/hydraulic or electrical/electronic. The production of a mechanical component, eg suspension arm, or an assembly using standard components, eg electronic components and a printed circuit board or pneumatic components connected and fixed into position, will meet the requirements of this unit.

The assignment will take approximately 10 of the 60 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the learner will produce:

1. a production plan, indicating time allocation, and identifying materials, components and equipment, giving reasons for their selection
2. an engineering component or assembly according to the production plan
3. a brief report which includes records of testing, Health and Safety procedures, basic identification of reasons for any failures, modifications or alterations to the production plan, and an evaluation of the processes used to inform future progress.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

The learners will need to be provided with a component or system specification and a copy of the assignment set and the learner's evidence of its completion should be kept for moderation purposes. If it is not practical to keep the component or assembly, a photographic record should be kept, along with a signed statement verifying that it is the learner's own work.

Assignment structure

A suggested assignment structure, which would allow learners to meet the evidence requirements, may include the following steps:

- Using a centre provided component or system specification, produce a production plan which identifies the materials, components and equipment to be used. Include time allocation and prioritise actions.
- Produce the component following the production plan.
- Compare the component against the specification and explain:
    - how closely it matches the specification
    - any procedures followed or problems encountered in ensuring the component complied with the specification.
- Record any testing carried out and explain why the method used was appropriate and why any alterations or deviations from the production plan were required.
- Evaluate the processes used.
- Follow safe working practices, including the use of PPE.

Weighting of assessment criteria topics

Assessment criteria topic	Weighting	Marks
1. Plan and prepare for producing engineering solutions	25%	12
2. Use tools and equipment, and select parts, materials and components to achieve the solutions	62.5%	30
3. Apply Health and Safety and quality standards in the context of the process required for the solutions	12.5%	6
Total	100%	48

Assessment grid

This statement of performance should be read in association with the assessment criteria for this unit. Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	Band 1	Band 2	Band 3
	The learner has:		
1. Plan and prepare for producing engineering solutions	**0 – 4 marks** Relied predominantly on a single source of information when planning Considered choices of materials and components Produced a basic production plan, including basic time allocations Attempted to record any modifications	**5 – 8 marks** Obtained information from more than one source when planning Justified the selection of materials and identified components Produced an adequate production plan which includes most essential information, including time allocations and action priorities Recorded any modifications or alterations	**9 – 12 marks** Collected and used information from a variety of sources when planning Analysed information obtained from a range of sources, including examining the properties of materials and identifying suitable components to aid selection Worked proactively to produce a comprehensive production plan based on well-informed decisions; included realistic time allocations and action priorities Adequately justified any modifications or alterations required and suggested possible improvements

2. Use tools and equipment, and select parts, materials and components to achieve the solutions	**0 – 10 marks** Worked within wide tolerances to produce the component or assembly Completed work to partially meet the product specification Used a restricted range of materials, tools and components, and mentioned component and part functions	**11 – 20 marks** Produced an adequate component or assembly which meets basic quality standard requirements Completed work almost to schedule and closely adhered to the product specification Used a range of materials, tools and components, and described component and part functions	**21 – 30 marks** Produced a component or assembly with precision, which meets quality standard requirements Completed work to schedule and met the product specification Used a wide range of materials, hand and machine tools, test equipment and components accurately; explained component and part functions in detail
3. Apply Health and Safety and quality standards in the context of the process required for the solutions	**0 – 2 marks** Normally complied with Health and Safety procedures Carried out simple quality checks Produced a simple evaluation of the processes used	**3 – 4 marks** Complied with Health and Safety procedures at all times Used test procedures to ensure basic quality standards Evaluated the processes used to assess their suitability	**5 – 6 marks** Shown an active awareness of Health and Safety procedures and complied with them at all times; completed processes in accordance with risk assessments Checked work systematically; used test and measurement equipment to ensure specification requirements are fully met Evaluated the processes used to inform future progress

Guidance for delivery

This unit forms an essential part of linking the design aspect of Level 2 Unit 2: Engineering design, with the manufacturing of Level 2 Unit 6: Manufacturing engineering. In this unit, manufacturing will be confined to the production of a single item. This is central to this unit and needs to be very clear to learners. Manufacturing in quantity is dealt with in Level 2 Unit 6: Manufacturing engineering.

Undertaking this unit will provide opportunities for learners to gain new skills and knowledge, while integrating them with the content of previous learning. It will help learners understand the importance of planning and making the correct design decisions. Using an iterative process, ideas can be developed into reality for testing and evaluating, prior to manufacturing and marketing decisions being made.

This practical unit will give learners the opportunity to learn about, and gain experience of, producing engineering solutions in the context of development, production, maintenance, installation and commissioning. The activities will range from the use of engineering drawings and the selection of suitable materials, parts and components, to using processes, tools and equipment safely and effectively. The unit assumes that design work has been completed, and is concerned with the essential practical tasks which produce and maintain engineering products and systems. This does mean that to complete the unit, learners will need to be familiar with the content of Level 2 Unit 2: Engineering design. This could be achieved by co-teaching these two units.

To allow sufficient time for the learner to gain experience across a range of materials and processes, the unit is confined to the production or repair/maintenance or commissioning of single items. When producing items for this unit, the minimum requirement is to use any two systems from mechanical, pneumatic/hydraulic or electrical/electronic technologies.

Learners will need to be familiar with the general properties of the following materials:

- metals: ferrous, non-ferrous and alloys
- polymers: both thermoplastic and thermosetting
- composites and ceramics including carbon, reinforced plastics and sintered metals.

Learners will also need to be familiar with the standard components used in the related sector, such as:

- threaded fasteners
- electronic components
- pneumatic/hydraulic cylinders and valves.

Both individual and group tasks may be carried out by learners when working on this unit. Opportunities to use this unit to consolidate learning in associated units should be taken. These might include the building of an electronic system or the using of CAD-CAM equipment to produce a component with a complex profile. This approach will enable learners to make links between activities and form a wider understanding of engineering processes.

Whilst this unit is concerned with the production of a single component or equivalent simple assembly, such as an electronic circuit board, other related units such as Level 2 Unit 6: Manufacturing engineering, and Level 2 Unit 7: Maintenance, offer opportunities for repeating similar processes or extending the work of this unit. This cyclical process will enable learners to understand the similarities of engineering manufacturing processes, and will reinforce their learning as they review and adopt the activities previously undertaken in this unit.

Opportunities for applied learning

This unit is well suited to activities undertaken in the workplace, as well as in school or college. Where activities are carried out away from the normal supervision of school or college, it is important that the learner is fully inducted into Health and Safety procedures.

Learners will benefit from being teamed with experienced technicians, and will gain valuable insight and experience when engaged in repairing, commissioning or making and assembling engineering systems or products.

The learner should gain first hand practical experience of a wide range of manufacturing and engineering technologies.

By using hand, machine and computer controlled methods of manufacture, learners will be exposed to work which may be carried out in a variety of industrial situations and environments. The method of working adopted is important as learners need to understand the requirements of the engineering workplace and the significance of preparing and following a production plan, both in planning and quality assurance processes.

What activities might be involved in this unit?

- Using engineering processes to produce part of an engineering product or system.
- Performing quality checks.
- Recording work and tests carried out.

Suggested prior learning

- Level 2 Unit 2: Engineering design.
- Level 2 Unit 3: Engineering applications of computers.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone.

Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- identifying problems to resolve when producing an engineering product

Creative thinkers

- generating ideas and exploring possibilities when producing an engineering product

Reflective learners

- communicating their learning in relevant ways for different audiences when reporting on work or testing carried out

Team workers

- co-operating with others when working towards common goals in group projects

Self-managers

- working towards goals and showing initiative, commitment and perseverance when carrying out practical tasks

Effective participators

- proposing practical ways forward and breaking these down into manageable steps when either producing or repairing engineering items.

Level 2 Unit 5: Construct electronic and electrical systems (ENG2U5)

What is this unit about?

The purpose of this unit is to develop learners' understanding of basic electronic and electrical principles, and how electronic systems are used in engineering products. It will provide learners with the opportunity to use tools and equipment in order to construct electronic and electrical systems.

The study of this unit requires learners to recognise and use test equipment and follow fault-finding procedures on electronic and electrical systems. When constructing circuits, learners should plan the sequence of operations or locations of components and connections, build and test the circuit, review the results, and apply that learning to subsequent activities. The skills and knowledge they gain will have particular relevance for the Engineering industry in activities such as robotics construction or building electronic systems.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. be able to select and use electronic and electrical components and sub-systems
2. be able to construct electronic and electrical systems
3. be able to test and fault-find electronic and electrical systems.

Assessment criteria

1. Select and use electronic and electrical components and sub-systems

The learner can:

1.1 interpret and use circuit schematic and systems block diagrams and identify circuit components and symbols (IE4)

1.2 select power supplies including batteries and transformers

1.3 calculate and specify component values for:

- a. frequency rates
- b. voltage, current and resistance

1.4 explain the function of resistors, capacitors and semi-conductors

1.5 describe and use the characteristics of the following range of circuit types or their programming equivalents as system blocks:

- a. single transistor (as amplifier or switch)
- b. combinational logic
- c. timers, delays and latches
- d. pulse generators
- e. electro-mechanical control circuits including motors and solenoids

1.6 use light emitting devices such as LEDs, lamps and displays.

2. Construct electronic and electrical systems

The learner can:

2.1 explain the advantages of programmable devices and describe the programming process

2.2 follow wiring colour codes

2.3 use components, tools and equipment to construct electronic and electrical systems on printed circuit boards or by using prototyping systems, following circuit schematic and system block diagrams

2.4 follow safe working practices (SM4)

2.5 use programmable and electro-magnetic devices.

3. Test and fault-find electronic and electrical systems

The learner can:

3.1 use test equipment and follow fault-finding procedures including continuity, power, truth tables and expected values (IE4)

3.2 use tools and equipment to test and fault-find systems; be familiar with operation of the following and use them for testing:

- a. oscilloscope for frequency and voltage
- b. multimeter for voltage, current, resistance and continuity
- c. logic probe for logic levels.

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here.

Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 30 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

Learners will complete an assignment which requires them to produce and prove a circuit which contains the following minimum parts:

- one input device
- two interconnected process systems blocks
- one output device and any associated drive sub-system required.

Engineering manufacturers frequently require prototype circuits for use in research and development projects. In this assignment, learners could be asked to perform the role of development engineer and construct a working circuit for a specified task. They will need to be provided with a circuit diagram or systems block diagram, but will need to calculate some component values and plan before building the circuit.

This is a short 30 guided learning hour unit and the assignment needs to reflect this. The assignment will take approximately 8 of the 30 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the learner will produce:

1. a plan for the construction of a circuit, which includes any provided circuit or systems diagram(s), along with an explanation of circuit and component functions, and any calculations of component values
2. a constructed circuit which performs the function of a system
3. records of testing and fault-finding.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

Copies of the assignment set and the learner's evidence of its completion should be kept for moderation purposes. If it is not practical to keep the constructed circuit, a photographic record should be kept, along with a signed statement verifying that it is the learner's own work.

Assignment structure

A suggested assignment structure, which would allow learners to meet the evidence requirements, should involve the use of a given circuit diagram or systems block diagram, and may include the following steps:

- Plan for construction; include flowcharts, PCB layouts and calculations of component values where necessary.
- Make brief notes explaining the functions of components in the circuit.
- Construct a functioning system consisting of two or more interconnected process blocks, following safe working practice.
- Make a photographic record of the main stages of construction.
- Provide a record of testing results, including fault-finding procedures and equipment used.

Weighting of assessment criteria topics

Assessment criteria topic	Weighting	Marks
1. Select and use electronic and electrical components and sub-systems	25%	12
2. Construct electronic and electrical systems	50%	24
3. Test and fault-find electronic and electrical systems	25%	12
Total	100%	48

Assessment grid

This statement of performance should be read in association with the assessment criteria for this unit. Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	Band 1	Band 2	Band 3
	The learner has:		
1. Select and use electronic and electrical components and sub-systems	**0 – 4 marks** Attempt to use the simple circuit and systems diagrams; attempted to identify and use a few components Demonstrated a limited application of the functions and characteristics of sub-systems and components Calculated some component values	**5 – 8 marks** Used circuit and systems diagrams; identified and used a restricted range of components correctly Demonstrated several applications of the functions and characteristics of sub-systems and components Calculated and specified component values	**9 – 12 marks** Used comprehensive circuit and system diagrams; selected and used specific components for their characteristics and given reasons for this selection Demonstrated a wide application of the functions and characteristics of sub-systems and components Calculated and specified component values accurately
2. Construct electronic and electrical systems	**0 – 8 marks** Attempted to use diagrams for subsequent operations Needed more than one attempt to produce assemblies to the required standard	**9 – 16 marks** Used circuit and systems diagrams; identified and used a restricted range of components correctly Used a range of components to produce functioning assemblies which meet basic quality standards requirements	**17 – 24 marks** Independently used diagrams effectively for subsequent operations Used a range of components to produce accurate assemblies that meet quality standards with precision

	Made superficial reference to the use of programmable devices	Explained how programmable devices could be used	Explained how programmable devices could be used for the task including sample programming
	Used tools and equipment correctly most of the time, when constructing	Used tools and equipment correctly when constructing circuits; followed standard colour codes when constructing	Used tools and equipment correctly to construct a complete and fully functioning circuit, including the use of electromechanical devices where necessary
	Normally complied with Health and Safety requirements	Complied with Health and Safety requirements	Shown an active awareness of, and complied with, Health and Safety requirements
3. Test and fault-find electronic and electrical systems	**0 – 4 marks**	**5 – 8 marks**	**9 – 12 marks**
	Used a very limited range of test equipment to carry out simple checks; followed a pre-set fault-finding plan	Used a limited range of test equipment effectively to identify faults and check system performance	Demonstrated a planned and organised approach to testing, recording outcomes that ensured that the engineered system had been constructed to perform effectively and meet the specification

Guidance for delivery

As this is a 30 guided learning hour unit, it is important that adequate time is allocated for substantial practical activity when introducing components and their functions. Opportunities for extended practical work can be achieved by using this unit's content with work undertaken in Level 2 Unit 4: Producing engineering solutions, or Level 2 Unit 7: Maintenance. Devising work which links with the use of sensors and microcontrollers in Level 2 Unit 3: Engineering applications of computers, will also provide more experiential learning opportunities.

A systems approach should be adopted for the majority of the content of this unit. When teaching, frequent reference to sub-systems as building blocks in a design context will help strengthen the links between hardware and software solutions.

When completing this unit the learner will be working with low voltage circuits (<50 volts), and must follow safe working practices.

The function of components should include the following:

- resistors:
    - fixed
    - variable
    - thermistors
    - light-dependent
- capacitors:
    - polarised
    - non-polarised
- semi-conductors:
    - diodes
    - light emitting diodes
    - transistors bipolar
    - field effect
- integrated circuits:
    - logic
    - programmable
    - timers
    - operational
    - amplifiers.

Some functions may be taught by using software simulations so that learners do not spend time on repetitive operations such as changing components when prototyping. However, gaining experience with real components is an essential part of learning about their use in engineering systems.

Provided that the essentials are covered, the use of constructional kits adds considerably to the learning experience, allowing work to be carried out quickly and producing a high level of involvement for the learner.

A fundamental skill for learners to develop is the ability to interchange hardware and software sub-systems so that processes such as timing can be carried out, either by hardware construction or using software delays. Another example of this interchange ability could be in a light-seeking system where a system containing an operational amplifier could be used. Alternatively, software-based systems using information obtained from an analogue-to-digital converter linked to a sensor could be used for the same purpose.

Work carried out in this unit can be used as a basis for learning in other units. Opportunities should be identified to extend the learning, and to allow learners to apply the knowledge and understanding gained in this unit to other related activities such as designing or constructing engineering solutions. Examples of this might include the setting up and operation of simple Computer Aided Engineering processes where a microcontroller and associated sensors form the core of the system.

The following are some resources that may facilitate or enhance the learning covered in this unit:

- The Technology Enhancement Programme has a wide range of teaching resources which link to the content of this unit.
- Programmable systems are available from a number of educational suppliers including the popular PICaxe from Revolution Education.

- Programming software is available from Economatics (Education)-Logicator which builds on similar programmes used at Key Stage 3.
- LJ Group have several teaching systems which are focused on electronics.
- Circuit simulation software, eg Crocodile Technology and Circuit Wizard.

Opportunities for applied learning

The following activities provide opportunities for learners to apply the skills and knowledge gained in this unit.

- Building electronic systems. This could be closely linked with work undertaken in Level 2 Unit 4: Producing engineering solutions, which might involve sensing or motor control systems as part of automated control systems. This might also form a part of Level 2 Unit 3: Engineering applications of computers, when dealing with sensing in process control or robotics.
- Fault-finding simple electronic or electrical systems in Level 2 Unit 7: Maintenance.
- Incorporating learning into other more complex tasks involving maintenance or the building of control or instrumentation systems.
- Participating in engineering activities, including competitions requiring this level of electrical or electronic understanding and skill, eg the Toyota Technology Challenge, the 4x4 in Schools Technology Challenge or Greenpower.

What activities might be involved in this unit?

- Producing and testing a circuit.
- Working with circuits consisting of two or more interconnected process blocks.
- Selecting and using appropriate input sensors and output drivers.
- Producing evidence of planning and testing.

Suggested prior learning

Learners should be familiar with the concepts of simple electrical circuits and have some understanding of voltage and current. They should be able to manipulate simple formulae and use binary and indices.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone.

Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- carrying out research into component uses or circuit designs, evaluating the information and judging its relevance and value

Creative thinkers

- connecting own and others' ideas and experiences in inventive ways when designing and using systems blocks

Reflective learners

- inviting feedback and dealing positively with praise, setbacks and criticism when constructing or fault finding circuits
- assessing their own and others' achievements in project work, and identifying opportunities for improvement
- evaluating prototyped circuits to inform future progress

Team workers

- taking responsibility, showing confidence in themselves and contributing to group discussions when organising a small-scale production of circuit boards

Self-managers

- organising time and resources, prioritising actions when engaged in practical construction of circuits or undertaking assessed tasks

Effective participators

- discussing issues of concern with their teachers or peers, seeking resolution when considering possible solutions or rectification of mistakes.

Level 2 Unit 6: Manufacturing engineering (ENG2U6)

What is this unit about?

The purpose of this unit is to provide learners with an understanding of multiple production processes relevant to the engineering world. Learners will undertake a range of practical processes including production and resource planning, providing evidence of methods and processes used. They will also carry out quality control procedures by testing part completed and finished products or components.

This is a practical unit which allows the learner to replicate the methods used to produce a component or system on a quantity production basis, as well as using processes, tools and equipment safely and effectively. The emphasis on different engineering manufacturing processes is particularly important in order for learners to gain a broad understanding of the Engineering industry.

An important aspect of this unit is the emphasis on project planning and team working, including the use of people resources and ensuring that team members are using their skills and abilities in order to be most effective in the production process. Learners should be encouraged to both review their own work and get feedback from others. They should use the review and the feedback to improve their work.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. be able to plan and prepare for the production of multiple components
2. be able to perform manufacturing processes
3. know about Health and Safety and quality standards, and be able to apply them to manufacturing processes.

Assessment criteria

1. Plan and prepare for the production of multiple components

The learner can:

1.1 plan, and prepare for, sequences of processes or operations for multiple production, including:
   a. scheduling operations, eg by using Gantt charts (SM3)
   b. considering opportunities for automated processes to be used (CT5)
   c. preparing for multiple production by producing moulds, tools and jig/fixtures
   d. developing a production plan

1.2 understand the importance of setting up machines

1.3 recognise that machining operations can be carried out manually and using computer control

1.4 plan, contribute and work as a member of a team when preparing for the production of multiple components (TW1, 2).

2. Perform manufacturing processes

The learner can:

2.1 explain the use of computer numerical controlled (CNC) machines including programming methods

2.2 use engineering manufacturing processes

2.3 carry out machining operations manually and using computer control to produce components to specifications and tolerances

2.4 work in groups, adapting behaviour to suit a wide range of engineering manufacturing processes when producing multiple components (TW3).

3. Apply Health and Safety and quality standards to manufacturing processes

The learner can:

3.1 explain the importance of Health and Safety in an industrial workplace (RL6)

3.2 describe how quality control procedures are used when producing in quantity by:

- a. explaining how statistical methods are applied to testing
- b. devising test procedures
- c. evaluating procedures to inform future progress (RL5)

3.3 follow quality control procedures by:

- a. using test or measurement equipment
- b. using statistical methods when testing (IE2)

3.4 follow safety procedures when working in an industrial environment (SM4).

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 60 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

Learners will complete an assignment which involves the planning and production of an uncomplicated engineering product, using multiple production processes, and the recording of consequent testing. This method of assessment allows the learner to apply the knowledge and skills from the unit within a sector related context, as well as demonstrating team working skills.

In view of the need for multiple production, allowance must be made for learners to have access to sufficient resources. This may mean part of the assignment being phased to allow learners to have individual time allocation with specialised equipment.

If all, or part of, the evidence produced by a learner relates to outcomes produced as a result of working in a group, it must be clear which evidence is to be credited to the individual learner.

The assignment will take approximately 15 of the 60 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the learner will produce:

1. a production plan identifying manufacturing processes, equipment, materials and components, and Health and Safety risks and provision. The use of people resources and the possible use of automated processes should also be included
2. three examples of a finished product
3. records of methods, preparation (eg mould or jig production), testing and modifications to design or processes
4. a record of how production was divided in the team.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

Copies of the assignment set and the learner's evidence of its completion should be kept for moderation purposes. If it is not practical to keep the products, a photographic record should be kept, along with a signed statement verifying that it is the learner's own work.

Assignment structure

A suggested assignment structure, which would allow learners to meet the evidence requirements, may include the following steps:

- Using the provided product (component) specification, produce a production plan which identifies manufacturing processes, equipment materials and components, as well as Health and Safety considerations.
- In the plan, include how a group of four people could work together to produce the products, as well as the possible use of automated processes.
- Produce three examples of the product.
- Compare the three examples and explain:
    - how closely they match the specification
    - any procedures followed or problems encountered in ensuring the products were the same and that a consistent standard was achieved.
- Record any testing carried out and explain why the method used was appropriate.
- Explain how automated processes could have been used for two stages in the production of the product.
- Record any modifications made to the design or planned manufacturing processes and any rectification which was carried out.
- Explain how the work was divided and the responsibilities of each person.

The context of this assignment could be a scenario in which a manufacturer of small-scale engineering components needs to set up a flexible manufacturing operation. This must be capable of producing components of varying degrees of complexity in quantities ranging from twos or threes to fifty or more. The learner's task is to plan the production of three such items from the provided information and to organise a team of four people to carry out the work.

The assignment must be planned so that learners fully understand the relevance of the tasks they are completing and can comprehend how planning sequences of operations and the functioning of a team relates to the day-to-day operation of the manufacturing industry.

Weighting of assessment criteria topics

Assessment criteria topic	Weighting	Marks
1. Plan and prepare for the production of multiple component	25%	12
2. Perform manufacturing processes	62.5%	30
3. Apply Health and Safety and quality standards to manufacturing processes	12.5%	6
Total	100%	48

Assessment grid

Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	Band 1	Band 2	Band 3
	The learner has:		
1. Plan and prepare for the production of multiple components	**0 – 4 marks** Attempted the planning stage, including gathering information	**5 – 8 marks** Obtained information from more than one source and planned for a range of processes, including the selection of manual or automated processes	**9 – 12 marks** Collected and used information from a wide range of sources; evaluated planning issues and clearly considered manual and automated processes
	Produced a basic production plan which identified processes and included references to team working	Produced an adequate production plan which includes most essential information; included reference to the individual activities of each team member	Produced a comprehensive production plan based on informed decisions reached after analysing information, which enabled the group to work efficiently; recorded the task in detail including scheduling and roles of team members
	Mentioned the use of production aids such as moulds or jigs	Explained in detail how using production aids such as moulds or jigs will assist efficient manufacture	Prepared for production by producing accurate moulds, tools, jig or fixtures
	Recorded any modifications or alterations which resulted in improvement	Recorded any modifications or alterations required and suggested possible improvements	Recorded and justified any modifications or alterations required and suggested possible improvements

	Completed some tasks as a team member	Contributed to the team in several identifiable ways	Worked in a co-ordinated way with the team
2. Perform manufacturing processes	**0 – 10 marks** Used a restricted range of materials, tools and components Worked within wide tolerances to produce the component or a simple assembly; may have needed more than one attempt to produce items to the required standard Briefly described how CNC processes could be used Made a limited contribution to the efforts of the team when performing engineering operations	**11 – 20 marks** Used a range of materials, tools and components Produced adequate components or assemblies which meet basic quality standard requirements; all tasks were completed Explained how CNC machines could be used Contributed to the success of the team when performing engineering operations	**21 – 30 marks** Used a wide range of materials, tools and components Produced components or assemblies with precision which meet quality standard requirements; work was completed to schedule Explained in detail how CNC machines could be used and programmed Showed elements of leadership or made an outstanding contribution to the success of the team when performing engineering operations
3. Apply Health and Safety and quality standards to manufacturing processes	**0 – 2 marks** Normally complied with Health and Safety procedures	**3 – 4 marks** Complied with Health and Safety procedures and explained the importance of Health and Safety in relation to specific processes	**5 – 6 marks** Showed awareness of Health and Safety issues and complied with procedures and explained the importance of Health and Safety in relation to a range of processes

	Used test and measurement equipment at a minimal level to carry out checks	Used test and measurement equipment effectively to ensure basic quality standards were reached or maintained	Worked systematically using test and measurement equipment to ensure specification requirements were fully met
	Described a test procedure for quantity production with limited accuracy; carried out and recorded simple quality checks	Described test procedures for quantity production; used and recorded test procedures to ensure basic quality standards	Described and devised test procedures for quantity production; used and recorded test procedures, including using statistical methods, to ensure quality standards

Guidance for delivery

This unit builds on the experiences of Level 2 Unit 4: Producing engineering solutions, but requires the learner to consider quantity production and to build on their experiences of making single items. It also relies on work carried out in Level 2 Unit 2: Engineering design, and can contribute to work in Level 2 Unit 3: Engineering applications of computers. It allows an opportunity to further develop the content of Level 2 Unit 5: Construct electronic and electrical systems.

Industrial practice and group working

In order that learners gain the widest experience possible, within the constraints of time and available resources, it is expected that several approaches to learning will be necessary. Some time should be spent on looking at industrial practice so that there is a context for the learner's individual work. There should be the opportunity for collective working, with each learner playing a part in groups producing components or sub-assemblies prior to final assembly work.

Learners need to gain first hand experience of a number of suitable processes in order to have a comprehensive understanding of planning and quality control procedures. Whilst it is possible to reproduce many of the processes outlined in the unit in school or college facilities, it is important that industrial visits are used to contribute to the learner's overall appreciation of the scale and diversity of engineering manufacturing.

Preparation and programming

Learners need to gain experience in the procedures required for the preparation of engineering manufacturing operations. Setting and adjusting machine tools and the programming of CNC machines for simple operations form an essential part of the work. At a minimum level this should include using CNC-controlled cutters – knife or laser – to produce 2D components. More advanced learners will need the opportunity to perform operations such as using 3D machining to produce moulds for casting or plastics forming.

Using other resources

An essential part of this unit is an understanding of commercial manufacturing operations. Whilst this experience is best gained from visits to actual manufacturing plants, either as a conducted tour or by placement, this is not always possible or practical.

The web links below will provide a starting point for learners to gain a wider understanding of the scope, diversity and complexity of modern engineering manufacturing. Examples include mechanical products such as motorcycles using high technology casting, forming and machining processes and the use of modern materials in a traditional product, such as bicycles.

- How everyday things are made **http://manufacturing.stanford.edu/hetm.html**
- Triumph Motorcycles UK **www.triumph.co.uk**
- Rotork Controls **www.rotork.com**
- Bulldog Controls **www.bulldogtools.co.uk**
- NEC Electronics Virtual Factory Tour **www.necel.com/v_factory/en/index.html**
- Chain Reaction Bicycles **www.chainreactionbicycles.com**

Opportunities for applied learning

This unit is intended to enable the learner to understand processes used for multiple production. The learner will undertake planning procedures and will need to make decisions to enable effective multiple production. This is a practical unit which allows the learner to replicate the methods used to produce a component or system on a quantity production basis, as well as using processes, tools and equipment safely and effectively.

The learner should be aware of, and have access to, a wide range of the following processes:

- electronic circuit board production
- plastics forming and injection moulding processes
- producing shaped components using press and form tools
- assembling mechanical or electrical/electronic systems or sub-systems
- joining by gluing, soldering, welding or press fit
- applying finishes by painting, coating or plating.

Every opportunity should be taken for learners to experience the reality and organisation of an industrial environment through appropriate visits and placements.

It is important that learners are able to build on previous experiences gained whilst completing other units which share similar content, or which provide relevant skills and knowledge. Examples of these might be the use of computer controlled systems from Level 2 Unit 3: Engineering applications of computers, or assembly skills or making skills from Level 2 Unit 4: Producing engineering solutions.

What activities might be involved in this unit?

- Producing production plans.
- Producing limited numbers of similar products or components.
- Carrying out quality control procedures including details of testing.
- Working as a member of a team.

Suggested prior learning

- Level 2 Unit 3: Engineering applications of computers.
- Level 2 Unit 4: Producing engineering solutions.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone.

Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- identifying problems to resolve when planning manufacturing operations

Creative thinkers

- adapting ideas as circumstances change, considering alternative methods or materials when organising manufacturing operations

Reflective learners

- assessing themselves and others when considering how a group of people can work together as an effective team

Team workers

- working in teams, co-operating with others, reaching agreements, taking responsibility and providing constructive support and feedback to others as part of working together on common tasks

Self-managers

- organising their time, prioritising their actions and working towards goals, in order to ensure effective production processes

Effective participators

- proposing practical ways forward, breaking these down into manageable steps when planning or ensuring quality of production.

Level 2 Unit 7: Maintenance (ENG2U7)

What is this unit about?

The purpose of this unit is for learners to understand the importance of engineering maintenance, and also to develop the practical ability to carry out the removal and replacement of worn or damaged components. Learners should also be able to recognise the need for routine maintenance by using simple diagnostic techniques and statistical data.

Skills and techniques used in this unit will allow the learner to work with confidence in other units, reflect on past experience, and transfer their skills from one sector to another. This is an important aspect of the unit as many sectors are engaged in maintenance operations and will adopt similar strategies to carry out the work.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS) and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. be able to describe and evaluate the operation of a simple maintenance system
2. be able to complete and record maintenance procedures.

Assessment criteria

1. Describe and evaluate the operation of a maintenance system

The learner can:

1.1 explain the use of policies relating to controlling risks to Health and Safety in terms of:
   a. Health and Safety procedures in the workplace (SM4)
   b. the use of personal protective equipment (PPE)
   c. identifying the responsibility for Health and Safety and for reporting Health and Safety matters and realising the importance of personal conduct
   d. identifying the hazards that may exist in a workplace

1.2 describe, interpret and use sources of technical information (IE4)

1.3 source technical information and data to support maintenance activities (IE2)

1.4 explain the importance of planned maintenance and shutdown operations (IE6)

1.5 document simple maintenance operations

1.6 explain and record component failure using statistical data

1.7 report problems or issues to the relevant person(s) promptly

1.8 explain the importance of ensuring maintenance operations are correctly carried out.

2. Complete and record maintenance procedures

The learner can:

2.1 use aural, visual and functional methods to carry out examination procedures

2.2 follow correct procedures for removal and replacement of worn or damaged components

2.3 select correct tools, equipment and materials for different types of engineering maintenance procedures

2.4 demonstrate the use of PPE when carrying out maintenance operations

2.5 conform to safe working practices (SM4)

2.6 remove and replace components to manufacturers' specifications

2.7 demonstrate the use of simple diagnostic procedures (IE3)

2.8 use investigative procedures to determine causes of failure (CT5)

2.9 select and use tools and materials for carrying out maintenance operations, and devise simple maintenance procedures

2.10 complete documentation to record the maintenance operations carried out.

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 30 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

Assessment will consist of a practical assignment which should be carried out under controlled conditions as specified by City & Guilds. Although the detailed requirements will be provided separately to centres, the minimum requirement is that centres will ensure the authentication of the learner's work by one or more of the following methods:

- direct supervision
- the completion of a work log by the learner
- secure identification of the learner's contribution to practical activity identified by photographic evidence and observation.

The assignment will take approximately 6 of the 30 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the learner will produce:

1. a maintenance schedule for one system or item of equipment
2. evidence of the identification of faults
3. a completed service sheet for repair and/or service work carried out
4. a record of Health and Safety precautions and/or manufacturers' procedures followed
5. an evaluation of the effectiveness of the maintenance schedule, and the precautions and procedures specified.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

Assignment structure

The assignment should ideally be related to work-related practice and should allow the learner to:

- demonstrate an understanding of Health and Safety and required working practices
- show their ability to follow instructions and complete maintenance tasks
- record any procedures followed, including a copy of a maintenance schedule
- explain any Health and Safety requirements
- select and use tools and equipment
- carry out a simple fault-finding task and report the findings
- evaluate their work, comparing the effectiveness of the maintenance schedule with the reliability of the system.

An example of an assignment is provided related to computer maintenance. Centres can produce similar tasks ensuring suitability for focus sector repair activities.

Example assignment

Maintenance operations are completed on a routine basis in the Engineering industry. Using the instructions provided:

- find at least one fault on a computer system
- carry out any other required operation, eg updating the operating system or installing software or memory upgrade
- report any faults discovered and complete a service sheet for the work carried out
- explain how statistical information and maintenance systems can be used to ensure efficient and reliable working of engineering systems
- record any Health and Safety precautions or manufacturers' procedures followed
- explain the possible consequences of not completing this or related maintenance operations.

Weighting of assessment criteria topics

Assessment criteria topic	Weighting	Marks
1. Describe and evaluate the operation of a maintenance system	37.5%	18
2. Complete and record maintenance procedures	62.5%	30
Total	100%	48

Assessment grid

This statement of performance should be read in association with the assessment criteria for this unit.

Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	**Band 1**	**Band 2**	**Band 3**
	The learner has:		
1. Describe and evaluate the operation of a maintenance script	**0 – 6 marks** Attempted to explain Health and Safety procedures Used data sheets or followed simple instructions Carried out simple record keeping of maintenance operations Briefly described a maintenance schedule Recorded component failures	**7 – 12 marks** Explained the reasons for Health and Safety procedures in shutdown and maintenance operations Used technical information and data sheets Understood the need to collect maintenance data and produced records Explained the need to have maintenance schedules which include planned shutdown Recorded component failure using statistical methods	**13 – 18 marks** Clearly explained the reasons for Health and Safety procedures in shutdown and maintenance operations Used a range of available sources for identifying and interpreting the correct technical information Explained why detailed, accurate maintenance records are kept and produced accurate records Fully explained and understood the need to have maintenance schedules which include planned shutdowns Used statistical data to explain and record component failure

2. Complete and record maintenance procedures	**0 – 10 marks**	**11 – 20 marks**	**21 – 30 marks**
	Attempted to follow instructions and tried to complete a task to manufacturers' specification	Followed manufacturers' instructions to enable completion of a task to manufacturer's specification	Produced sets of instructions for removing or replacing components; devised service procedures suitable for preventative maintenance measures
	Identified a simple fault	Identified a range of faults using diagnostics	Carried out inspections and identified faults using a variety of methods including diagnostics; suggested possible rectification procedures to meet manufacturers' standards
	Worked in a responsible manner, carrying out basic procedures	Worked in a sensible and responsible manner; completed routine tasks, reporting problems or issues promptly	Worked in an appropriate, sensible and responsible manner most of the time; completed routine tasks confidently and reported any problems or unexpected issues
	Worked safely with a range of tools and equipment	Selected and worked safely with tools, equipment and materials	Justified any decisions regarding the selection and safe use of tools, equipment or materials used
	Used PPE as required	Routinely used PPE when working on maintenance operations	Worked safely using appropriate PPE at all times. Worked reliably on tasks and co-operated with others

Guidance for delivery

Some operations carried out by learners in this unit will require skills gained by completing other units, for example through working with diagnostics in Level 2 Unit 3: Engineering applications of computers, or the use of tools and equipment in Level 2 Unit 4: Producing engineering solutions. The development of these skills is important within the Engineering industry as they can be applied across a range of Engineering sectors, including:

- mechanical engineering and production
- specialised motor vehicle engineering
- aircraft and marine engineering
- electrical and electronic engineering maintenance.

Opportunities should be devised which produce an exciting, stimulating and challenging programme within the selected area, using a range of tools and equipment in line with current industrial practices.

The following are some suggestions of suitable tasks to be undertaken in this unit.

Mechanical engineering and production maintenance

These tasks could include the removal, replacement and adjustment of belts, pulleys, gears, bearings, levels and rollers.

Specialised motor vehicle, aircraft and marine engineering maintenance

These tasks could include the removal, replacement and adjustment of engine, transmission, chassis or electrical components, and the adjustment of clearances, gaps, levels, belts, pulleys, chains, bearings and replacement components.

Electrical and electronic engineering maintenance

This could include the maintenance of industrial or residential installation components, motors, computer hardware and software, and radio or television components. Example tasks might be:

- the removal and replacement of computer hardware and configuring for operator use
- the removal and replacement of circuit boards for inspection and checking failures.

The following are some resources that may facilitate or enhance the learning covered in this unit:

- CD interactive material, eg CDX, Digital Press.
- www.howstuffworks.com
- Selection of manufacturers' manuals and instruction books.

Opportunities for applied learning

There is ample opportunity within the maintenance areas of various Engineering sectors for learners to gain experience of maintenance activities. Maintenance can be carried out alongside production or in a dedicated environment such as automotive servicing or electronic and computer repair.

As maintenance activities are often carried out in conjunction with other engineering processes, this unit can be taught alongside other units so that there is a natural flow of information and experience between activities. This would allow the learner opportunity for review and to implement learning in differing contexts.

Additionally, learners may work on group projects which require setting and adjusting operations to be carried out, such as go-karting challenges, robotic competitions or mileage marathons.

What activities might be involved in this unit?

- Using PPE.
- Identifying risks and maintaining Health and Safety in a working environment.
- Planning work and carrying out maintenance activities.
- Reporting on activities and findings.
- Investigating and diagnosing causes of failures.
- Using statistical data and researching information.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone.

Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- explaining ways of deciding which areas of the machines and equipment need to be maintained
- explaining ways of planning and organising relevant maintenance procedures
- explaining ways of maintaining machines and equipment

Creative thinkers

- trying out cost-effective, efficient and eco-friendly methods of maintenance

Reflective learners

- evaluating their maintenance procedures for reliability and efficiency

Team workers

- working in a team to plan routine maintenance for machines and equipment
- communicating with their team to feedback on maintenance outcomes

Self-managers

- working within a timescale that meets the needs of others
- prioritising work for effective maintenance

Effective participators

- proposing practical ways of problem-solving using data and diagnostic abilities.

Level 2 Unit 8: Innovation, enterprise and technological advance (ENG2U8)

What is this unit about?

The purpose of this unit is to provide learners with an understanding of the concepts of innovation and development of ideas within engineering. The unit is concerned with the process of taking design and technological innovations into the marketplace, and will encourage learners to recognise the importance of new innovations to the Engineering industry.

Learners will also explore commercial issues and the environmental and social impacts of innovation, enterprise and advance. This will relate in particular to sustainability which is of importance to companies and nations.

Learners must both review their own work and get feedback from others. They should use the review and the feedback to improve their work.

This unit, alongside the others within the Level 2 Principal Learning in Engineering, has been designed to allow learners the opportunity to develop a range of Personal, Learning and Thinking Skills (PLTS), and to demonstrate these on more than one occasion. This approach will allow them to build towards a full range of PLTS.

Learning outcomes

The learner will:

1. know about innovation and the impact of technology
2. understand design, research and development
3. understand enterprise in the world of engineering.

Assessment criteria

1. Innovation and the impact of technology

The learner can:

1.1 describe the benefits that innovation and creativity bring to engineering through enterprise and inventions

1.2 describe the advantages that any of the following bring to the process of innovation:
   a. new developments in materials and processes on products
   b. research and product development
   c. modernisation and competitive advantage
   d. outsourcing
   e. entrepreneurs
   f. managers

1.3 explain the environmental and social impacts of engineering, and the sustainability of resources, such as (IE3, 5):
   a. increases and shift in global demand
   b. the depletion of fossil fuels and natural resources
   c. energy and resource efficient technologies
   d. renewable energy technologies

1.4 describe the effects of engineering technologies in the home, workplace and built environment (IE5)

1.5 carry out research and investigation into the environmental and social impacts of engineering (IE2) (CT1).

2. Design, research and development

The learner can:

2.1 describe the role that research and development play when designing and developing products, considering the need for (CT1):
   a. conceptual modelling using expert systems and software tools
   b. establishing design principles and dealing with design problems
   c. ensuring reliability and trial testing

2.2 explain how engineering design resolves the problems posed by conflicting requirements such as (IE4):
   a. accommodating economic, material and manufacturing process constraints
   b. the relationship between function and appeal
   c. legal and moral considerations
   d. planned development and accidental breakthrough

2.3 apply simple research and development techniques in the design and development of products (IE2).

3. Enterprise in the world of engineering

The learner can:

3.1 explain how innovation and enterprise are influenced by (IE4):
   a. profiting from ideas
   b. competition
   c. supply and demand

3.2 describe the methods used to protect new ideas, including patents, copyright and trademarks

3.3 evaluate the role of market forces in innovation and enterprise (IE4)

3.4 carry out research into ways of protecting ideas and raising finance through loans, grants and flotations (IE2) (CT1).

Where the assessment criteria show a direct link to an area of the PLTS framework, it is referenced here. Further information on PLTS is available in Section 3.1 of this specification and also within this unit in the section on Personal, Learning and Thinking Skills.

Guided learning hours

It is recommended that a minimum of 60 guided learning hours be spent on this unit.

Assessment

This unit is assessed through a centre set and marked assignment. Internal assessments are subject to moderation by City & Guilds.

Learners will produce a report in which they analyse an existing product, evaluating its effectiveness whilst taking into account the constraints which the designers and developers face. There is a need to research specific and generic issues and to make clear how the product fulfils generic needs.

The assignment should allow learners to describe the innovation process and provide a balanced view point when discussing the environmental impact of the idea. The wider issues such as management or business aspects can be drawn from the learner's wider experience of studying this unit.

The learner will complete an assignment, which will take approximately 15 of the 60 guided learning hours available for this unit. The learner should work under controlled conditions in accordance with the guidance in Section 4.4 of this specification, and evidence should be kept for moderation purposes.

Evidence requirements

The learner must produce evidence of achievement of the assessment criteria. In the assignment, the learner will produce:

1. a report describing the influences of innovation, enterprise and technological advance on a selected product, to include:
    a. a research plan
    b. research findings
    c. an evaluation of the impact and effectiveness of the innovation on the product.

In order to attain a high mark in this unit, learners must address all of the above. It may, however, be possible to achieve a pass mark without producing every one of the evidence requirements. A table showing how the assessment criteria topics are weighted is included below, and learners should be shown this in order that they understand how the final mark is determined.

Assignment structure

A suggested assignment structure, which would allow learners to meet the evidence requirements, may include the following steps.

Learners will need to:

- plan and carry out research
- use their findings to explain:
    - the reasons for developing the product
    - how well the product addresses the need to minimise environmental effects the management of a typical engineering innovation or development
    - how effective the product is at resolving a problem
    - some possible business implications of the development, including protecting new ideas, raising finance and market forces
- evaluate the sustainability, effectiveness and possible commercial success of the innovation on the product.

Weighting of assessment criteria topics

Assessment criteria topic	Weighting	Marks
1. Innovation and the impact of technology	37.5%	18
2. Design, research and development	25%	12
3. Enterprise in the world of engineering	37.5%	18
Total	100%	48

Assessment grid

This statement of performance should be read in association with the assessment criteria for this unit.

Please note that the descriptions in this marking grid relate to the top of each band. Further guidance on using marking grids is available in the Assessment section of this specification.

Assessment criteria topic	Band 1	Band 2	Band 3
	The learner has:		
1. Innovation and the impact of technology	**0 – 6 marks** Stated the benefits of innovation and creativity on the product design	**7 – 12 marks** Described the benefits of innovation and creativity on the product design	**13 – 18 marks** Explained how innovation and creativity improved the design and manufacture of the product
	Briefly outlined a few factors which aided the innovation process	Described how factors have aided the innovation process	Explained how a comprehensive range of factors have aided the innovation process
	Carried out basic research and listed social and environmental impacts of the product	Carried out appropriate research and described social and environmental impacts of the product or its development	Carried out extensive, appropriate research and fully described the social and environmental impacts of issues connected with the product development or operation of the product
	Listed impacts of the product technology on the home, workplace or built environment	Described the impacts of the product technology on the home, workplace or built environment	Explained how the product and its associated technologies will affect the home, workplace or built environment

2. Design, research and development	**0 – 4 marks**	**5 – 8 marks**	**9 – 12 marks**
	Briefly stated the role of design, research and development	Described the role of design, research and development, including one example of design decisions	Analysed the role of design, research and development, including examples of design decisions
	Highlighted a possible design conflict	Described how a design requirement conflicted with another	Explained how conflicts between different design requirements were resolved and how this affected the final product
	Applied basic research and development techniques	Applied appropriate research and development techniques	Applied a wide range of appropriate research and development techniques
3. Enterprise in the world of engineering	**0 – 6 marks**	**7 – 12 marks**	**13 – 18 marks**
	Stated basic influences on innovation and enterprise	Described the main influences on innovation and enterprise	Explained short and long term influences on innovation and enterprise
	Stated how ideas need to be protected	Briefly described how ideas could be protected and products marketed	Described in detail how ideas could be protected and products marketed
	Briefly mentioned market forces	Shown some understanding of the influence of market forces on the life of the product	Described in detail how market forces feed into business planning
	Stated a means of raising finance applicable to the product	Described various approaches to raising finance for the product	Explained how finance could be raised to support aspects of the development or marketing of the product

Guidance for delivery

This unit has substantial links to all other Level 2 units and may be regarded as having an integrating function. This unit will give learners the opportunity to learn about the development of new ideas and the use of new technologies in a way that considers the impact on the environment. Concepts such as the influence of market competition and forces, as well as fashion, on the innovative process could be developed through integrating the teaching of this unit with other Level 2 units such as Unit 2: Engineering design; Unit 4: Producing engineering solutions; or Unit 6: Manufacturing engineering. By co-teaching with these units, many of the ideas developed by this unit can be further explored.

Learners could investigate the work of successful entrepreneurs such as Clive Sinclair or James Dyson by examining relevant case studies.

The opportunity to visit local engineering businesses, research establishments, university departments or science parks linked to universities will also enable learners to gain a wider understanding of the importance of innovation, enterprise and technological advance.

The following are some resources that may facilitate or enhance the learning covered in this unit:

- Biographies of inventors such as Clive Sinclair
- National Academy of Engineering **www.nae.edu/nae/naehome.nsf**
- UK Skills **www.ukskills.org.uk**
- Lucid Group **www.lucidinnovation.com**
- Solar Navigator **www.solarnavigator.net**
- Earth Trends **www.earthtrends.wri.org**
- National Energy Action **www.nea.org.uk**
- Practical Action **www.practicalaction.org**
- Centre for Alternative Technology **www.cat.org.uk**
- Alternative Energy **www.alternative-energy.co.uk**
- Technology Enhancement Programme **www.tep.org.uk**
- Intellectual Property Office **www.ipo.gov.uk**
- http//:learning.channel4.com/sites/clipbank

Opportunities for applied learning

Learners will benefit from exploring the influences new technologies have on their everyday life in the home, at school or college, or during their work experience. They may wish to analyse how these technological changes have influenced the implementation of new design ideas. Part of the work undertaken in this unit should allow learners to use techniques such as brain-storming in order to develop creative, innovative ideas.

Links made with local engineering companies will enable realistic projects to be set where engineering professionals can help with the evaluation of proposals put forward by learners.

Learners could use products developed for other Level 2 units and present them in an innovative and challenging way. Other learners, teachers or employers could then give them feedback on aspects of their design proposal and its feasibility.

Examples of good practice to illustrate real-world applications of the underlying principles and issues around the concepts developed by this unit should be used. Employers could be invited to the school or college to give a presentation which includes real-world examples of innovation and ideas protection, as well as the challenges faced when conducting business in a sustainable fashion.

What activities might be involved in this unit?

- Visiting engineering centres to look at how industry deals with the need to innovate or maintain sustainability.
- Talking to engineers about design and innovation.
- Carrying out a project or case study about innovation or sustainability issues.
- Producing presentations to demonstrate the effect that modern engineering is going to have on society in the future.
- Assessing the effect of engineering technologies in the home, workplace and built environment.

Personal, Learning and Thinking Skills

The list below is indicative of the way this unit supports the development of PLTS, as opposed to the achievement of PLTS that are possible through the assessment. The unit supports the development of more PLTS than are covered through the assessment criteria alone.
Alternative approaches could be selected.

The learner could develop PLTS by:

Independent enquirers

- evaluating the relevance of information obtained as a part of the research process

Creative thinkers

- considering the best way to present information in order to suit audience requirements

Reflective learners

- assessing their own contributions to group research and discussion forums

Team workers

- providing constructive support and feedback to others

Self-managers

- prioritising areas of product research
- organising their time to focus on the effect of market conditions and consumer demand on energy consumption, development in processes and materials

Effective participators

- proposing improvements to research activities
- contributing to analytical discussions on the effects of enterprise and developing technology on product design.

4 Assessment

4.1 Aims

Principal Learning courses based on this specification should encourage learners to:

1 develop a broad understanding and knowledge of the Engineering industries
2 develop skills in the broad context of the Engineering industries
3 understand the contribution engineering makes to modern life
4 apply:
  4.1 Functional Skills at Level 2 in Mathematics, English and ICT
  4.2 transferable Personal, Learning and Thinking Skills (PLTS) in independent enquiry, creative thinking, reflective learning, team working, self-managing and effective participation
  4.3 investigative and project management skills through a Principal Learning project
  4.4 skills gained through work experience
5 learn through experience of applying knowledge and skills to tasks or contexts including those that have the characteristics of real work eg the minimum 10 days' work experience, including
  5.1 planning and reflecting on their experience
  5.2 drawing out and articulating lessons learnt
  5.3 applying their learning to new activities or situations.

4.2 National criteria

This Principal Learning Engineering specification complies with the following:

- Criteria for the specialised Principal Learning qualifications in engineering at levels 1, 2 and 3 (published QCA November 2006)
- Criteria for the accreditation of Principal Learning qualifications at levels 1, 2 and 3 (published QCA April 2007)

4.3 Prior learning

There are no prior learning requirements.

4.4 Internal assessment

Internally assessed units will comply with the Joint Council for Qualifications Instructions for conducting coursework/portfolios – please see JCQ website:
http://www.jcq.org.uk

Task setting

Clear guidance, with exemplars of suitable internal assessment, is available to all centres in order to ensure that suitable tasks are set. City & Guilds will give guidance on task setting and the moderator will review a selection of proposed tasks to check that they are suitable at the early advisory visits.

The teacher at a centre with overall responsibility for internal standardisation is also responsible for the standardisation of task setting.

Guidance is provided on the total amount of time that a task should take, on the amount of time that specific activities within a task should take and on the form of supervision expected.

Control criteria for tasks

The internally assessed assignments are to be taken under controlled conditions and the forms of evidence required in each unit will drive the controls needed. Where specific guidance is required, it will be found in the assessment section of the unit concerned. The following controls should be in place where appropriate for individual tasks.

Activity – A video or DVD recording of the activity, or a witness testimony describing the activity, will be necessary as evidence of ephemeral work.

Research of relevant sources of material – A bibliography or list of sources eg museums, businesses, organisations, websites will provide evidence of research. The teacher may also question learners on their research and submit signed notes from these questions as evidence.

Record of interviews with business, industry or third party representatives – Transcripts or audio recordings (if permitted by the individual concerned), or the learner's own record of the interview and evidence of permission or observation or witness statement by an observer may be used as evidence of interactions with learners.

Outcome or Production – Where this is produced over time, it is possible that the teacher may not supervise the whole of the process, however, sufficient supervision must take place to ensure that the material for assessment is the unaided work of the learner. Photographs, recordings and witness testimony can also be utilised to confirm that the work belongs to an individual learner.

Practical assignment – These must be conducted under supervision and the outcome should be submitted for moderation if possible.

Portfolio of evidence – This must be submitted for moderation.

The above controls are summarised for reference in the following table.

Form of evidence	Method of control								
	Video/DVD recording	Photographs	Witness statement	Bibliography list of sources	Signed notes evidencing questions asked by teacher	Transcript of audio recording	Learner's own record	Supervision	Submission of artefact or product
Activity	1		2						
Research of relevant sources of material				1	2				
Record of interviews with business, industry or third party representatives			2 with learner's own record			1 with evidence of permission	2 with witness statement		
Outcome or production	2	2	2			2		1*	1*
Practical assignment	2	2	2			2		1*	1 if possible
Portfolio or evidence									1*

Please note:

Control methods rated 1 are the most preferable type to be used. Those rated 2 may be used if employing the favoured method is not practical, or as a way of providing additional evidence of the learner having met the assessment criteria.

* Where the number 1 is followed by an asterisk, this indicates that any other control method may accompany but not substitute the use of this method.

Guidance by the teacher

The work assessed must be solely that of the learner. Any assistance given to an individual learner which is beyond that given to the group as a whole must be recorded.

Unfair practice

At the start of the course, the supervising teacher is responsible for informing learners of the City & Guilds Regulations concerning malpractice. Learners must not take part in any unfair practice in

the preparation of work to be submitted for assessment, and must understand that to present material copied directly from books or other sources, without acknowledgement, will be regarded as deliberate deception. Centres must report suspected malpractice to City & Guilds.

Applying the assessment grid

When assessing learners' work, teachers/assessors should consider the level of attainment demonstrated in four broad areas within the demands and context of the specific unit being assessed:

- the depth and breadth of understanding
- the level of skills
- the level of synthesis, analysis and evaluation
- the level of independence and originality.

In the assessment grid for each unit, mark ranges are specified for each assessment criteria topic. When assessing a learner's work, teachers/assessors should use their professional judgement to identify for each assessment criteria topic, the mark band description within which that work falls and then the mark within that range that best describes the depth and quality of the work.

To achieve the higher mark bands, learners should show greater depth and breadth of understanding, higher level skills, higher levels of synthesis, analysis and evaluation and higher levels of independence and originality as required in the assessment criteria. Work that clearly meets all the requirements of the mark band description should be awarded the maximum mark identified.

Aspects of the work that might fall short of meeting, in full, the description but which do not, in the judgement of the teacher/assessor, sufficiently influence the overall level of achievement to merit the work being assigned to a lower mark band, will reduce the mark awarded within the identified range available. This can be expressed as identifying the 'best-fit' approach, where the areas of strength in the work submitted by the learner can be allowed to compensate for weaknesses in other areas.

Assessors will use archived exemplars as they become available as a reference point. By comparing their own learners' work with archive work which has an assessment commentary attached, the assessor will be able to position the work either on a higher or lower point.

Assessment of group work

Group work is a useful way of obtaining information for some activities but it is important that individual learners meet the assessment criteria requirements. Teachers/assessors assessing the evidence will need to be convinced of its individual authenticity. Questioning can be used in order to clarify the validity, authenticity and sufficiency of evidence and, under these circumstances, the teacher/assessor may wish to include a dated witness statement detailing this evidence. It is expected that the use of such statements will be kept to a minimum, so that they constitute a very minor part of the submitted evidence.

Annotation of written/photographic evidence can also be used to detail an individual's contribution.

It is recognised that there can be instances where learners are required to carry out tasks as part of a group and that group-working skills are an integral part of the assessment requirements. In such cases this general guidance on group work will be superseded by the specific requirements and instructions of the individual unit(s).

Internal standardisation of marking

The centre is required to standardise the assessment across different teachers and teaching groups, within and across units, to ensure that all work at the centre has been judged against the same standards. If two or more teachers are involved in marking units, one teacher must be designated as responsible for internal standardisation.

Common pieces of work must be marked on a trial basis and differences between assessments discussed at a training session in which all teachers involved must participate.

The teacher responsible for standardising the marking must ensure that the training includes the use of reference and archive materials such as work from a previous year or examples provided by City & Guilds.

4.5 Supervision and authentication of internally assessed work

The Head of Centre is responsible to City & Guilds for ensuring that internally assessed work is conducted in accordance with City & Guilds instructions and JCQ instructions.

City & Guilds requires:

- learners to sign the record form to confirm that the work submitted is their own, and
- teachers/assessors to confirm on the record form that the work assessed is solely that of the learner concerned and was conducted under the conditions laid down by the specification
- the teacher/assessor responsible for internal standardisation also to sign the Centre Declaration Sheet (CDS) to confirm that internal standardisation has taken place and that the work presented is that of the learners named. If only one teacher has undertaken the marking, that person must sign this form.

The completed record form must be attached to each learner's work and the Centre Declaration Sheet must be sent to the moderator. Failure to sign either or both the record form and the CDS may delay the processing of the learners' results.

The teacher should be sufficiently aware of the learner's standard and level of work to appreciate if the work submitted is beyond the ability of the learner.

In most centres teachers are familiar with learners' work through class and assignments. Where this is not the case, teachers should make sure that all internally assessed work is completed under direct supervision or controls listed in Section 4.4.

In all cases, some direct supervision is necessary to ensure that the work submitted can be confidently authenticated as the learner's own. If it is believed that a learner has received additional assistance and this is acceptable within the guidelines for the internally assessed units, the teacher/assessor should award a mark which represents the learner's unaided achievement. The authentication statement should be signed and information given on the relevant form.

If the teacher/assessor is unable to sign the authentication statement for a particular learner, then the learner's work cannot be accepted for assessment.

4.6 Malpractice

Teachers should inform learners of the JCQ Regulations concerning malpractice. Learners must not:

- submit work which is not their own
- lend work to other learners
- allow other learners access to, or the use of, their own independently-sourced material (this does not mean that learners may not lend their books to another learner, but learners should be prevented from plagiarising other learners' research)
- include work copied directly from books, the Internet or other sources without acknowledgement or an attribution
- submit work typed or word processed by a third person without acknowledgement.

These actions constitute malpractice, for which a penalty (eg disqualification from the examination) will be applied.

If malpractice is suspected, the Examinations Officer should be consulted about the procedure to be followed.

Where suspected malpractice in internally assessed work is identified by a centre after the learner has signed the declaration of authentication, the Head of Centre must submit full details of the case to City & Guilds at the earliest opportunity. The form, JQM/M1, should be used. Copies of the form can be found on the JCQ website:
http://www.jcq.org.uk

Malpractice in internally assessed work discovered prior to the learner signing the declaration of authentication need not be reported to City & Guilds, but should be dealt with in accordance with the centre's internal procedures. City & Guilds would expect centres to treat such cases very seriously. Details of any work which is not the learner's own must be recorded on the cover sheet or other appropriate place.

4.7 Moderation

City & Guilds will ensure that in centres where learners from more than one centre are taught and assessed together, a single moderator for each Principal Learning qualification will be appointed subject to consideration of workload.
Moderation of internally assessed work will take place in two stages and the same moderator will be responsible for each.

Stage 1 – a visit from a moderator representing City & Guilds at a fairly early stage during the delivery of Principal Learning

The moderator will inspect some work and check such matters as:

- task setting against assessment criteria
- understanding of controlled conditions
- taking and marking of internal assessments
- arrangements for internal standardisation
- coverage of PLTS
- coverage of Applied Learning.

The moderator will give advice, feedback and guidance on each of the above. Stage 1 will be seen as a technical advisory visit and will cover the Principal Learning units.

Stage 2 – a check by the moderator on the taking and marking of samples of Principal Learning units

Internally assessed work will normally be reviewed at the centre but may be sent to the moderator. The samples to be moderated will be agreed with the centre for each identified unit in accordance with the moderation procedures. During the moderation visit, the moderator will normally assess samples of work with the teacher and discuss the standards in order to ensure that they are in line with the national standards for this qualification. If necessary, further samples may be requested and adjustments may be applied to the centre's marks. Mark adjustments will normally preserve the centre's order of merit, but if major discrepancies are discovered, City & Guilds reserves the right to alter the order of merit.

Centre marks for all units must be submitted to City & Guilds and to the moderator by the specified deadline. Claiming and moderation of internal assessment is only available in the summer term.

Further details will be given in moderation procedures documentation to be issued by City & Guilds.

4.8 Post-moderation procedures

On publication of the results for Principal Learning units, City & Guilds will provide centres with details of the final marks for the internally assessed units.

The learners' work will be returned to the centre after moderation has taken place. The centre will receive a report with, or soon after, despatch of published results giving feedback on the appropriateness of the task set, the accuracy of the assessments, and the reasons for any adjustment to the marks.

City & Guilds reserves the right to retain some learners' work for archive or standardising purposes.

4.9 Retaining evidence and re-using marks

The centre must retain the work of all learners for each internally assessed unit, with record forms attached, under secure conditions, from the time it is assessed, to allow for the possibility of an enquiry about results. The work may be returned to learners after the deadline for enquiries about results. If an enquiry about a result has been made, the work must remain under secure conditions in case it is required by City & Guilds.

4.10 External assessment

The external assessments will be timetabled twice a year, in January and June, and the dates will be published at the start of the academic year.

4.11 Factors affecting individual learners

Teachers should be able to accommodate the occasional absence of learners by ensuring that the opportunity is given for them to make up missed assessments. If work is lost, City & Guilds should be notified immediately of the date of the loss, how it occurred, and who was responsible for the loss. Centres should use the JCQ form, JCQ/LCW, to inform City & Guilds Candidate Support of the circumstances.

Learners who move from one centre to another during the course may require individual attention. Possible courses of action depend on the stage at which the move takes place. If the move occurs early in the course, the new centre should take responsibility for assessment. If it occurs late in the course it may be possible to arrange for the moderator to assess the work through the 'Educated Elsewhere' procedure. Centres should contact City & Guilds at the earliest possible stage for advice about appropriate arrangements in individual cases.

5 Administration

5.1 Availability of Principal Learning units

All internally assessed Principal Learning units for this specification are available once a year only, commencing in June 2013. External assessments will be timetabled twice a year, in January and June, and the dates will be published at the start of the academic year.

5.2 Centre registration

Centres wishing to prepare learners for this specification should apply for approval to offer Principal Learning before teaching begins. Completed application forms should be submitted to your local City & Guilds Regional Office. Further details of the approval process are available on the website at: **www.cityandguilds.com**

5.3 Centre requirements

Resources
Centres must have access to sufficient equipment in the centre or in other centres within the consortium to ensure that learners have the opportunity to cover all the practical activities. Any requirement for specialised equipment is to be found in the description of the units themselves.

Health and safety
The importance of safe working practice and the demands of the Health and Safety at Work Act 1974 must be stressed to all learners. Learners have responsibilities for maintaining the safety of others as well as their own. Anyone behaving in an unsafe fashion must be stopped and a suitable warning given by the teacher responsible.

It is essential that all learners acquire habits required to promote health and safety in the workplace and that their learning avoids potentially unpleasant or dangerous consequences.

Centre staff
Centre staff should be technically competent in all the areas for which they are delivering education and training and/or should also have relevant experience of providing the necessary practical training.

Continuing Professional Development (CPD)
Centres are expected to support their staff in ensuring that their knowledge and skills in the vocational area remain current and take account of any national or legislative developments.

5.4 Quality assurance

Internal quality assurance

Registered centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre registration by City & Guilds and the centre's and/or consortium's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance.

National standards and rigorous quality assurance are maintained by the use of:

- City & Guilds external examinations
- City & Guilds externally set briefs or assignments
- internal quality assurance
- City & Guilds external moderation.

To meet the quality assurance criteria for this qualification, the centre must ensure that the following procedures are followed:

- the setting of appropriate tasks (see Section 4.4)
- the application of appropriate control of tasks (see Section 4.4)
- training in the use of the assessment grid (see Section 4.4)
- completion by the person responsible for internal standardisation of the Centre

Declaration Sheet to confirm that internal standardisation has taken place (see Sections 4.4 and 4.5)

- the completion by learners and teachers/assessors of the record form for each learner's work (see Section 4.5).

External quality assurance

External quality assurance is provided by the two stage moderation system described in Section 4.7. External moderation of internally assessed work is carried out to ensure that assessment is valid and reliable, and that there is good assessment practice in centres and that national standards are maintained.

In order to carry out their quality assurance role, external moderators must have appropriate teaching and vocational knowledge and expertise. City & Guilds will appoint external moderators and will ensure that they attend regular training and development meetings designed to keep them up-to-date, to ensure standardisation of all assessments and to share good practice.

External moderators:

- provide advice and support to staff in centres
- ensure the quality and consistency of assessments within and between centres and over time by the use of systematic sampling
- regularly visit centres to ensure that they continue to meet the centre registration requirements of City & Guilds
- provide feedback to centres and to City & Guilds.

In order to monitor compliance with JCQ requirements, particularly for administering external tests, JCQ inspectors will regularly visit centres.

City & Guilds requires the Head of Centre to:

1 facilitate any inspection of the Centre which is undertaken on behalf of City & Guilds
2 make secure arrangements to receive, check and keep examination material secure at all times, maintain the security of City & Guilds confidential material from receipt to the time when it is no longer confidential and keep scripts secure from the time they are collected from the candidates to their despatch to City & Guilds.

5.5 Irregularities

Centres must inform City & Guilds of any irregularity, including any candidate who arrives late for a test. For detailed instructions please refer to the current JCQ Instructions for Conducting Examinations which is available to view or to download from the JCQ's website:
http://www.jcq.org.uk

5.6 Awarding grades and reporting results

The Level 2 Engineering Principal Learning will be reported on a four grade scale: A*, A, B and C. Learners who fail to reach the minimum standard for grade C will be recorded as U (Unclassified) and will not receive a qualification certificate.

5.7 Enquiries about results

The services available for enquiries about results include a clerical check, re-mark of external assessments and re-moderation of internally assessed work. Requests must be submitted within the specified period after the publication of results for individual assessments.
In cases where a post-results enquiry reveals inaccurate assessment, the result may be confirmed, raised or lowered.

For further details of enquiries about results services, please consult the current version of the JCQ Post-Results Services booklet.

5.8 Re-sits and shelf-life of unit results

Unit results remain available to count towards certification, whether or not they have already been used, as long as the specification is still valid.

Learners may re-sit a unit any number of times within the shelf-life of the specification. The best result for each unit will count towards the final qualification.

Learners will be graded on the basis of the work submitted for assessment.

5.9 Access arrangements and special consideration

We have taken note of the provisions of equalities legislation in developing and administering this specification.

We follow the guidelines in the Joint Council for Qualifications (JCQ) document: Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examination GCSE, GCE, GNVQ, AEA, Entry Level, Basic Skills & Key Skills Access Arrangements and Special Consideration. This is published on the JCQ website:

http://www.jcq.org.uk/access_arrangements/

Access arrangements

We can make arrangements so that learners with disabilities, special educational needs and temporary injuries can access the assessment. These arrangements must be made before the examination. For example, we can produce a Braille paper for a learner with visual impairment.

Special consideration

We can give special consideration to learners who have had a temporary illness, injury or indisposition at the time of the examination. Where we do this, it is given after the examination.

Applications for either access arrangements or special consideration should be submitted to City & Guilds by the Examinations Officer at the centre.

5.10 Language of examinations

We will provide units for this specification in English only.

5.11 Qualification titles

The qualification based on this specification is:

City & Guilds Level 2 Principal Learning in Engineering.

Appendix 1 Other issues

European Dimension

City & Guilds has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen units.

Environmental Education

City & Guilds 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 units.

Avoidance of Bias

City & Guilds has taken great care in the preparation of this specification and specimen units to avoid bias of any kind.