

# Level 3 Technicals in Engineering 1145-530

Part of 1145-30, 1145-31 and 1145-32

November 2017 Version 1.0

**Guide to the examination**

## Who is this document for?

This document has been produced for centres who offer **City & Guilds Level 3 Technicals in Engineering**. It gives all of the essential details of the qualification's external assessment (exam) arrangements and has been produced to support the preparation of candidates to take the exam/s.

The document comprises four sections:

1. **Details of the exam.** This section gives details of the structure, length and timing of the exam.
2. **Content assessed by the exam.** This section gives a summary of the content that will be covered in each exam and information of how marks are allocated to the content.
3. **Guidance.** This section gives guidance on the language of the exam, the types of questions included and examples of these, and links to further resources to support teaching and exam preparation.
4. **Further information.** This section lists other sources of information about this qualification and City & Guilds Technical Qualifications.

# 1. Details of the exam

## External assessment

City & Guilds Technical qualifications have been developed to meet national policy changes designed to raise the rigour and robustness of vocational qualifications. These changes are being made to ensure our qualifications can meet the needs of employers and Higher Education. One of these changes is for the qualifications to have an increased emphasis on external assessment. This is why you will see an external exam in each of our Technical qualifications.

An external assessment is an assessment that is set and/or marked by the awarding organisation (ie externally). All City and Guilds Technical qualifications include an externally set and marked exam. This must be taken at the same time by all candidates who are registered on a particular qualification. We produce an exam timetable each year. This specifies the date and time of the exam so you can plan your delivery, revision and room bookings/PC allocation in plenty of time.

The purpose of this exam is to provide assurance that all candidates achieving the qualification have gained sufficient knowledge and understanding from their programme of study and that they can independently recall and draw their knowledge and understanding together in an integrated way. Whilst this may not be new to you, it is essential that your learners are well prepared and that they have time to revise, reflect and prepare for these exams. We have produced a Teaching, Learning, and Assessment guide that is you should refer to alongside the present document ([Teaching, Learning and Assessment Guide](#)). If a learner does not pass the exam at their first attempt, there is only one opportunity to resit the exam, so preparation is essential.

## Exam requirements of this qualification

- **Engineering** – Theory exam (3 hours).

The exam is graded and a candidate must achieve at least a Pass grade in order to be awarded the qualification. (In addition to the exam, a synoptic assignment must also be completed and passed.) You can find full details of the synoptic assignment in the *Qualification Handbook* and the *Synoptic Assessment Guide* – please see the link to the qualification page at the end of this document.

## When does the exam take place?

The exam is offered on two fixed dates in March or June. The exact dates will be published at the start of the academic year in the *Assessments and Exam Timetable* <http://www.cityandguilds.com/delivering-our-qualifications/exams-and-admin>.

At the start of the programme of study, in order to effectively plan teaching and exam preparation, centres should know when the exam will be taking place and allocate teaching time accordingly. Section 2 of this document gives a summary of the content that needs to be covered in order to prepare learners for the exam and full details of this are given in the *Qualification Handbook*.

## Form of exam

The exam for this qualification can be taken on paper (1145-530).

## Can candidates resit the exam?

Candidates may resit the exam once only. If a candidate fails the exam both on the first attempt and when resitting it, that candidate has failed the qualification and cannot achieve it in that academic year.

## How the exam is structured

Each exam has a total of 100 marks and is made up of:

- approximately 10-12 short answer questions
- 1 extended response question.

Short answer questions are used to confirm **breadth of knowledge and understanding**.

The extended response question is to allow candidates to demonstrate **higher level and integrated understanding** through written discussion, analysis and evaluation. This question also ensures the exam can differentiate between those learners who are 'just able' and those who are higher achieving.

More details about and examples of question types are given in Section 3 of this document.

## Assessment Objectives

The exams are based on the following set of assessment objectives (AOs). These are designed to allow the candidate's responses to be assessed across the following three categories of performance:

- **Recollection** of knowledge.
- **Understanding** of concepts, theories and processes.
- **Integrated application** of knowledge and understanding.

In full, the assessment objectives covered by the exam for this qualification are:

Assessment objective	Mark allocation (approx %)
<i>The candidate..</i>	
AO1 <b>Recalls knowledge</b> from across the breadth of the qualification	23%
AO2 <b>Demonstrates understanding</b> of concepts, theories and processes from a range of learning outcomes.	52%
AO4 <b>Applies knowledge, understanding and skills</b> from across the breadth of the qualification in an integrated and holistic way to achieve specified purposes.	25%

## **Booking and taking the exam**

All assessments for City & Guilds Technical Exams must be booked through Walled Garden. There is a deadline for booking exams, synoptic assessments and any other centre marked assessments, please refer to the time line to check these dates.

The exam must be taken under the supervision of an invigilator who is responsible for ensuring that it is conducted under controlled conditions. Full details of the conditions under which the exam must be taken can be found in the Joint Council for Qualifications (JCQ) document, [Instructions for Conducting Examinations \(ICE\)](#).

## **Special consideration**

Candidates who are unable to sit the exam owing to temporary injury, illness or other indisposition at the scheduled time may qualify for special consideration. This is a post-examination adjustment that can, in certain circumstances, be made to a candidate's final grade. The Joint Council for Qualifications' guide to the special consideration process can be found at [www.jcq.org.uk](http://www.jcq.org.uk).

To make a request for special consideration, please contact: [policy@cityandguilds.com](mailto:policy@cityandguilds.com)

## **Access arrangements**

Access arrangements are arrangements that allow candidates with particular requirements, disabilities or temporary illness to take assessments, where appropriate, using their normal way of working. The Joint Council for Qualifications document, *Access Arrangements and Reasonable Adjustments* gives full details and can be downloaded [here](#).

For further information and to apply for access arrangements please see:

[Access arrangements - When and how applications need to be made to City & Guilds](#)  
[Applying for access arrangements on the Walled Garden](#)

## 2. Content assessed by the exam

The exam assesses:

- **Unit 301: Engineering materials**
- **Unit 304: Manufacturing methods in engineering**
- **Unit 305: Engineering design**
- **Unit 306: Engineering mathematics and statistics**

The exam assesses a sample of the content of these units. This means that a single exam will **not** cover 100% of the unit content. The full range of content will be assessed over a number of examination series. Details of the coverage of a particular exam paper will **not** be released in advance of the exam itself. Centres should **not** make assumptions about what will be assessed by a particular exam based on what has been covered on previous occasions. In order to be fully prepared for the exam, learners **must** be ready to answer questions on **any** of the content outlined below.

The table below provides an overview of how the qualification's units are covered by the exam and the number of **marks** available per unit (ie **not** the number of *questions* per unit). In preparing candidates for the exam, we recommend that centres take note of the number of marks allocated to each unit and to assign teaching and preparation time accordingly.

In preparing candidates for the exam, centres should refer to the Qualification Handbook which gives full details of each unit/Learning Outcomes.

The following is a summary of only that qualification content which is assessed by the exam and **not** a summary of the full content of the qualification.

Unit	Learning outcome	Topics	Number of marks per unit
301 Engineering materials	L01 Identify the properties and characteristics of engineering materials	1.1 Properties and characteristics of engineering materials 1.2 Materials and their use in Engineering	2

	LO2 Understand metal heat treatment techniques and their effects on material structures	2.1 Heat Treatment Methods 2.2 Effect on materials structure	8
	LO3 Use testing methods to determine material properties	3.1 Mechanical testing methods 3.2 Carry out tests on materials 3.3 Analyse results of tests 3.4 Select materials to meet specification requirements	4
	LO4 Understand the basic principles of composite materials	4.1 Principles and components of composite materials 4.2 Pre-impregnated (pre-preg) materials 4.3 Dry fibre moulding 4.4 Use of adhesive and bonding materials	4
	LO5 Understand the basic principles of electronic materials	5.1 Conductive materials 5.2 Resistive and dielectric materials 5.3 Semi-conductor materials	5
304 Manufacturing methods in engineering	LO1 Understand manufacturing processes and techniques	1.1 Mechanical processes and techniques 1.2 Electrical processes and techniques 1.3 Electronics processes and techniques	2
	LO2 Understand production and automation systems	2.1 Scale of manufacture 2.2 Inspection methods 2.3 Measurement methods 2.4 Assembly and build methods 2.5 Component finishing and assembly protection methods. 2.6 Automation methods	6
	LO3 Understand advanced manufacturing techniques	3.1 Additive processes 3.2 Casting 3.3 Moulding & extrusion 3.4 Chemical	

		3.5 Cutting 3.6 High frequency techniques 3.7 Joining 3.8 Powder based	
	LO4 Understand process planning requirements	4.1 Production Planning 4.2 Management of materials	
	LO5 Understand quality control issues	5.1 Quality Concepts 5.2 Quality Improvement Strategies 5.3 Quality Tools and Techniques	4
305 Engineering design	LO1 Understand the process of developing a product design specification from a design brief	1.1 Terminology and definitions in the design process 1.2 Key elements of product design specifications 1.3 Key factors that are considered in development of a product design specification	2
	LO2 Develop a product design specification from a customer brief	2.1 Analysing a design brief 2.2 Design criteria	5
	LO3 Understand how engineering design solutions meet product design specifications	3.1 Idea generation 3.2 Evaluating design ideas 3.3 Methods of representing designs 3.4 Methods of testing designs	9
	LO4 Understand the effects of historic engineering design achievements	4.1 Significant engineering achievements of the 19th to 21st centuries	
	LO5 Produce 2D CAD drawings	5.1 Computer Aided Design 5.2 Produce 2D CAD drawings	

	LO6 Produce 3D CAD drawings	6.1 Produce 3D CAD drawings 6.2 Produce hard copies of CAD drawings	
306 Engineering mathematics and statistics	LO1 Apply principles of algebra	1.1 Algebraic functions 1.2 Indices 1.3 Exponentials and logarithms 1.4 Equations, functions and formulae 1.5 Practical engineering problems	7
	LO2 Apply principles of trigonometry	2.1 Trigonometric functions 2.2 Trigonometric identities and formulae 2.3 Graphs of trigonometric functions 2.4 Use of trigonometry to solve engineering problems	7
	LO3 Apply principles of calculus	3.1 Principles of differentiation 3.2 Principles of integration 3.3 Application of calculus to simple engineering problems	6
	LO4 Apply principles of complex numbers	4.1 Complex numbers 4.2 Mathematical operations using complex numbers 4.3 Graphical representation of complex numbers 4.4 Cartesian and polar forms 4.5 Application of complex numbers to simple engineering problems	4
	LO5 Apply statistical methods	5.1 Numerical measures 5.2 Probability 5.3 Normal distribution 5.4 Concepts of binomial distribution 5.5 Estimation 5.6 Graphs and diagrams 5.7 Failure rates and safety factors	

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Total marks for sections: 75 marks

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Integration across units\*: 25 marks

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**Total marks for exam: 100 Marks**

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\* *Integration across units*. These marks relate to Assessment Objective 4. These marks are awarded to differentiate between levels of performance by candidates taking the exam. The marks are given for how well a candidate has applied their knowledge, understanding and skills from across the units that make up the qualification in an integrated way to meet the requirements of the exam questions.

### 3. Guidance

#### Vocabulary of the exam: use of 'command' verbs

The exam questions are written using 'command' verbs. These are used to communicate to the candidate the type of answer required. Candidates should be familiarised with these as part of their exam preparation.

The following guidance has been produced on the main command verbs used in City & Guilds Technicals exams.

A more detailed version of this table, which also includes the command verbs used in the assignments is published in *City & Guilds Technical Qualifications Teaching, Learning and Assessment* guide.

Command verb	Explanation and guidance
<b>Analyse</b>	Study or examine a complex issue, subject, event, etc in detail to explain and interpret, elements, causes, characteristics etc
<b>Calculate</b>	Work out the answer to a problem using mathematical operations
<b>Compare</b> (...and contrast) (or <b>describe</b> the similarities/differences)	Consider and describe the similarities (and differences) between two or more features, systems, ideas, etc
<b>Define</b>	Give the meaning of, technical vocabulary, terms, etc.
<b>Describe</b>	Give a detailed written account of a system, feature, etc <b>(..the effect of...on...)</b> the impact, change that has resulted from a cause, event, etc <b>(..the process..)</b> give the steps, stages, etc
<b>Differentiate</b> between	Establish and relate the characteristic differences between two or more things, concepts, etc
<b>Discuss</b>	Talk/write about a topic in detail, considering the different issues, ideas, opinions related to it
<b>Distinguish</b> between	Recognise and describe the characteristic differences between two things, or make one thing seem different from another
<b>Evaluate</b>	Analyse and describe the success, quality, benefits, value, etc (of an end product, outcome, etc )
<b>Explain</b>	Make (a situation, idea, process, etc) clear or easier to understand by giving details <b>(..how..)</b> Give the stages or steps, etc in a process, including relationships, connections, etc between these and causes and effects.
<b>Give example(s) illustrate/</b>	Use examples or images to support, clarify or demonstrate, an explanation, argument, theory, etc

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<b>Give a rationale</b>	Provide a reason/reasons/basis for actions, decisions, beliefs, etc
<b>Identify</b>	Recognise a feature, usually from a document, image, etc and state what it is
<b>Justify</b>	Give reasons for, make a case for, account for, etc decisions, actions, conclusions, etc, in order to demonstrate why they suitable for or correct or meet the particular circumstances, context
<b>Label</b>	Add names or descriptions, indicating their positions, on an image, drawing, diagram, etc
<b>List</b>	Give as many answers, examples, etc as the question indicates (candidates are not required to write in full sentences)
<b>Name</b>	Give the (technical) name of something
<b>Propose</b>	Present a plan, strategy, etc (for consideration, discussion, acceptance, action, etc).
<b>Select</b>	Choose the best, most suitable, etc, by making careful decisions
<b>State</b>	Give the answer, clearly and definitely
<b>Summarise</b>	Give a brief statement of the main points (of something)

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## Question types

The following explains, and gives examples of, types of questions used in City & Guilds Technical exams. In preparing candidates to take the exam, it is recommended that you familiarise them with the requirements of each question type so that they can be effective and make best use of the time available when sitting the exam.

- An effective candidate will gauge the type and length of response required from the question and the number of marks available (which is given for each question on the exam paper).
- Short answer questions may not require candidates to write in complete sentences. Extended response questions will require a more developed response.
- Candidates should read the exam paper before attempting to answer the questions and should allocate time proportionate to the number of marks available for each question or section.

Question type:	Example question	Example question:
<p><b>Short answer questions (restricted response)</b> These are questions which require candidates to give a brief and concise written response. The number of marks available will correspond to the number of pieces of information/examples and the length of response required by the question.</p>	<p>Explain how annealing changes the properties of an aluminium alloy.</p>	<p>Annealing involves heating the alloy and holding it at temperature so that the grains in the metal grow. This makes the alloy softer and easier to work.</p>
<p><b>Structured Response Questions</b> These are questions that have more than one part (eg a), b), etc.). The overall question is made up of linked, short answer questions which move the candidate through the topic in a structured way. For example, the question will usually start with a 'recall'/'state'/'describe' question followed by an 'explain' to draw out understanding of the topic. They usually have a shared</p>	<p>a) State the mechanical property that has the ability of a material to absorb energy from an impact and plasticity deform without fracturing.</p> <p>b) State the word that means the potential to improve the resistance to penetration of a material by heat treatment.</p>	<p>a) Toughness.</p> <p>b) Hardenability.</p>

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introductory 'stem', and the number of marks may increase through the question.

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### **Extended response questions**

Extended response questions are those that require the candidate to write a longer written response using sentences and paragraphs. These usually require candidates to discuss, explain, etc. a topic in some detail. The question is often based on a short case study, scenario or other prompt. The level of detail should be gauged from the question and the number of marks available.

### **Example question**

A company is designing the frame of a new bicycle. Discuss which factors are most important when selecting a material for the frame. (12 marks)

### **Mark scheme**

Indicative content to include:

Examples of parts that may be included in the answer are:

- functional/performance requirements
- characteristics of the user
- mechanical and physical properties of the materials, including strength, toughness, density, corrosion resistance, etc
- cost (material, manufacturing, direct and indirect)
- selling price
- impact of relevant standards
- customer requirements (aesthetics, strength-to-weight ratio)
- manufacturing limitations and constraints, including tolerances
- scale of manufacture
- form of the material.

### **Band 1 (1 – 4 marks)**

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Basic - largely descriptive response based on recall and knowledge, stating a few related factors to be considered during the selection of the material. Some factors may be described in detail. Candidates at the top of this level may be characterised by showing understanding of the reasons for a few of the considerations.

#### **Example band 1 response**

The main important thing is the properties of the material. The material for the frame needs to be strong in compression and tough so that it does not fracture when it hits bumps or is dropped. It must be light and low density and have excellent corrosion resistance. This could be achieved by painting it or plastic coating it, or galvanising as these would all stop rusting and corrosion.

#### **Band 2 (5 – 8 marks)**

Clear - more detailed response, including a range of different factors to be considered when selecting the material. Shows knowledge and understanding of the reasons why many of the factors have to be considered. Candidates at the top of this level may be characterised by analysing a few considerations in depth and considering a broad range of factors, such as how customer preference material properties and manufacturing implications will affect the performance of a product.

#### **Example band 2 response**

The factors to be considered when selecting the material include:

- how the properties of the material match the needs of the application
- how the frame will be manufactured
- customers 'wants'.

The frame will need to have sufficient strength to support the weight of the user and be tough enough to resist impacts where the bike is rode on uneven surfaces. Ideally, the frame should also be lightweights – this could be achieved by using a material with a low density or reducing the amount of material needed due to a high strength to weight. The lighter the frame, the faster the bike will be able to go with the same power. The material should also be corrosion resistant, to ensure that the bike has an acceptable lifespan even if it gets wet due to rain.

The manufacturing method can limit the choice of material. For example, if the company only has moulding they would be limited to composites, and to use metals they may need some form of tube bending and joining process such as brazing or welding.

Customer wants will also affect the selection. For example, customers may want a specific colour – this can mean that the material may need to be suitable to be painted or a high-tech look. They may also have a maximum prize that they are prepared to pay.

### **Band 3 (9 – 12 marks)**

Detailed - very detailed responses, showing understanding of a wide variety of different factors to be considered when selecting the material. Most factors to be considered are evaluated, with substantiation and ranking of which are deemed more important, making recommendations and producing supporting conclusions. Candidates at the top of this level may be characterised by analysing and evaluating a broad range of considerations, some of which include conflicting requirements.

#### **Example band 3 response**

A wide variety of factors need to be considered when selecting the material:

- the needs of the application. This includes the type of bicycle; for example, a racing bike would be lighter than an off-road bike, to allow it to be faster whilst accepting that it would not be as robust. This also includes the size and weight of the rider, which will have an effect on both the strength needed from the material and the joining methods used to hold the parts of the from together
- the properties of the material. As well as the strength (discussed above), the frame of an off-road bike would need to be tough to resist bumps and corrosion resistant to prevent damage from rust or mud. However, the strength, toughness and corrosion resistance must be balanced against the cost. For example, for an off-road bike low carbon steel might be used, painted to reduce corrosion, as this is strong and costs much less than an aluminium alloy, which would be lighter but more expensive
- the scale of manufacture and the processes available. Different materials require different manufacturing processes. If a manufacturer does not have a process available (eg welding to join metal, or moulding for composites) it may not be cost-effective to buy that process just for a small quantity. For a large quantity, it may be much more cost effective to use an

automated manufacturing process (such as CNC cutting and robotic welding of metal frames) rather than use a manual process (such as moulding of composites).

Overall, the selection of the material will probably be a compromise between the cost (both of the material and for processing that material into a usable frame) and the properties required. The higher the selling price that the user is prepared to pay, the better the strength-to-weight ratio and other properties of the materials that are likely to be used.

## Examination technique

Candidates with a good understanding of the subject being assessed can often lose marks in exams because they lack experience or confidence in exams or awareness of how to maximise the time available to get the most out of the exam. Here is some suggested guidance for areas that could be covered in advance to help learners improve exam performance.

### Before the exam

Although candidates cannot plan the answers they will give in advance, exams for Technical qualifications do follow a common structure and format. In advance of taking the exam, candidates should:

- be familiar with the structure of the exam (ie number and type of questions).
- be aware of the amount of time they have in total to complete the exam.
- have a plan, based on the exam start and finish time for how long to spend on each question/section of the exam.
- be aware of how many marks are available for each question, how much they should expect to write for each question and allow most time for those questions which have the most marks available.

### At the start of the exam session

At the start of the exam, candidates:

- should carefully read through the instructions before answering any questions.
- may find it helpful, where possible, to mark or highlight key information such as command words and number of marks available on the question paper.
- identify questions which require an extended written answer and those questions where all or part of the question may be answered by giving bullets, lists etc rather than full sentences.

### Answering the questions

Candidates do not have to answer exam questions in any particular order. They may find it helpful to consider, for example:

- tackling first those questions which they find easiest. This should help them get into the 'flow' of the exam and help confidence by building up marks quickly and at the start of the exam.
- tackling the extended answer question at an early stage of the exam to make sure they spend sufficient time on it and do not run out of time at the end of the exam.

Candidates should avoid wasting time by repeating the question either in full or in part in their answer.

Candidates should **always** attempt every question, even questions where they may be less confident about the answer they are giving. Candidates should be discouraged however, from spending too long on any answer they are less sure about and providing answers that are longer and give more detail than should be necessary in the hope of picking up marks. This may mean they have less time to answer questions that they are better prepared to answer.

### Extended answer questions

Before writing out in full their answer to extended questions, candidates may find it helpful to identify the key requirements of the question and jot down a brief plan or outline of how they will answer it. This will help clarify their thinking and make sure that they don't get 'bogged down' or provide too much detail for one part of the question at the expense of others.

## **Towards the end of the exam**

Candidates should always set aside time at the end of the exam to read back through and review what they have written in order to make sure this is legible, makes sense and answers the question in full.

If a candidate finds they are running out of time to finish an answer towards the end of the exam, they should attempt to complete the answer in abbreviated or note form. Provided the content is clear and relevant, examiners will consider such answers and award marks where merited.

Further guidance on preparing candidates to take the exam is given in the City & Guilds publication, [Technical Qualifications, Teaching, Learning and Assessment](#) which can be downloaded free of charge from City & Guilds website.

## 4. Further information

For further information to support delivery and exam preparation for this qualification, centres should see:

### City & Guilds

Qualification homepage: [www.cityandguilds.com/qualifications-and-apprenticeships/engineering/mechanical/1145-technical-in-engineering#tab=information](http://www.cityandguilds.com/qualifications-and-apprenticeships/engineering/mechanical/1145-technical-in-engineering#tab=information) which includes:

- Qualification handbook
- Synoptic Assignment
- Sample assessments

Technical Qualifications, Resources and Support: [www.cityandguilds.com/techbac/technical-qualifications/resources-and-support](http://www.cityandguilds.com/techbac/technical-qualifications/resources-and-support)

### Joint Council for Qualifications

Instructions for Conducting Examinations: <http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations>