Realising potential

GCSE ENGINEERING

(8852)

Specification

For teaching from September 2017 onwards
For exams in 2019 onwards

Version 1.1 21 January 2019

Contents

Are you using the latest version of this specification?

- You will always find the most up-to-date version of this specification on our website at
- We will write to you if there are significant changes to the specification.

1 Introduction

1.1 Why choose AQA for GCSE Engineering

The sky's the limit. Engineering is an increasingly innovative and exciting area to work in. It affects every aspect of modern life – from skyscrapers to smart phones, cars to carrier bags.

Our new GCSE introduces students to a host of new technologies, helping them to gain practical skills and understanding to inspire a lifelong interest in engineering. It will particularly appeal to those who enjoy being creative, with an affinity for drawing, design, maths and problem-solving.

Whilst this is a new qualification, you'll see we've kept much of the popular content and topics that we know you like.

We've also maintained the clear structure to our assessment using a mixture of question styles, giving all your students the opportunity to demonstrate their knowledge and understanding.

You can find out about all our Engineering qualifications at aqa.org.uk/engineering

1.2 Support and resources to help you teach

We've worked with experienced teachers to provide you with a range of resources that will help you confidently plan, teach and prepare for exams.

1.2.1 Teaching resources

Visit aqa.org.uk/8852 to see all our teaching resources. They include:

- specimen papers and mark schemes to show the standards required and how your students' papers will be marked
- sample schemes of work to help you plan your course with confidence
- training courses to help you deliver AQA GCSE Engineering qualifications
- a phone and email based subject team to support you in the delivery of the specification

Preparing for exams

Visit aqa.org.uk/8852 for everything you need to prepare for our exams, including:

- sample papers and mark schemes for new courses
- Exampro: a searchable bank of past AQA exam questions
- example student answers with examiner commentaries.

Analyse your students' results with Enhanced Results Analysis (ERA)

Find out which questions were the most challenging, how the results compare to previous years and where your students need to improve. ERA, our free online results analysis tool, will help you see where to focus your teaching. Register at aqa.org.uk/era

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Wherever you are in your career, there's always something new to learn. As well as subject specific training, we offer a range of courses to help boost your skills.

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- Prepare for a new role with our leadership and management courses.

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Alternatively, you can call or email our subject team direct.

E: engineering@aqa.org.uk

T: 0161 957 3334

2 Specification at a glance

This qualification is linear. Linear means that students will sit all their exams and submit all their non-exam assessment at the end of the course.

2.1 Subject content

Core content

2.2 Assessments

Question paper: Externally assessed
What's assessed Sections 1–6 from the subject content. Though the 'Practical engineering skills' section will predominantly be assessed through the NEA, some questions in the written exam will relate to practical contexts and students will need to apply their understanding within these contexts.
How it's assessed • Written exam: 2 hours • 120 marks • 60% of GCSE
Questions • Multiple choice questions assessing breadth of knowledge. • Short answer questions assessing in depth knowledge, including calculations. • Multiple choice questions related to the application of practical engineering skills. • Extended response questions drawing together elements of the specification.

+

Non-exam assessment: Practical engineering
What's assessed • Application of skills, knowledge and understanding in a practical context. • Analysis and evaluation of evidence.
How it's assessed • A brief set by AQA released on 1 June in the first year of study. • 80 marks • 40% of GCSE
Questions Students produce: • engineering drawings or schematics to communicate a solution to the brief. • an engineering product that solves a problem.

3 Subject content

The subject content is split into six sections. This subject content should be taught within a range of realistic contexts based around the major themes in the specification. To gain the most from the specification, sections will benefit from being taught holistically. For example, the properties of particular materials could be taught in a practical environment.

The subject content is presented in three columns. The left-hand column contains the specification content that all students must cover, and that is assessed in the written papers and/or NEA. The central column gives additional information that teachers require to ensure that their students study the topic in appropriate depth and, where appropriate, gives teachers the parameters in which the subject will be assessed.

Students must also demonstrate mathematical knowledge and understanding, in relation to engineering. The right-hand column throughout this section illustrates where the maths skills and knowledge can be applied to the wider engineering content.

The mathematical skills and knowledge as required by the DfE, are set out in Appendix 1: Mathematical understanding (page 47) of this document.

Non-exam assessment (NEA) (page 26) outlines what students must produce for the NEA, and the marking criteria.

3.1 Engineering materials

3.1.1 Materials and their properties

Students should have knowledge and understanding of the following groups/classifications of engineering materials. Students should be able to identify these materials based on their physical appearances and the following properties:

- toughness/brittleness
- ductility
- malleability
- hardness
- strength and stiffness.

Students should also be able to demonstrate knowledge and understanding of the behavioural characteristics of each of these materials during handling/machining.

3.1.1.1 Metals and alloys

Subject content	Additional information	Mathematical understanding
Ferrous metals and alloys: • cast iron • low and high carbon steels • steel alloys (stainless steel). Non-ferrous metals and alloys: • aluminium • copper • lead • zinc • alloys (brass and bronze).	Students will not be expected to have practical experience of working with all of these metals/alloys but exam questions could refer to any of the properties listed. Students should also be able to demonstrate knowledge and understanding of how the mechanical properties of these metals can change through: • the addition of materials to form alloys • methods which affect the grain size (heating) • cold working • hardening and quenching • corrosion • addition/subtraction of carbon in steels.	

3.1.1.2 Polymers

Subject content	Additional information	Mathematical understanding
Thermoplastics: • ABS • acrylic • nylon • polycarbonate • polystyrene. Thermosetting polymers: • epoxy • polyester and melamine resins • polyurethanes • vulcanised rubber.	Students will not be expected to have practical experience of working with all of these polymers but exam questions could refer to any of the properties listed. The effects of heat on thermosets and thermoplastics.	

3.1.1.3 Composites

Subject content	Additional information	Mathematical understanding

• Fibre reinforced polymers (FRP):
  ◦ carbon-fibre reinforced polymer
  ◦ glass reinforced plastic (GRP).
• Plywood.
• Medium Density Fibre board (MDF).
• Oriented Strand Board (OSB).
• Structural concrete.
	Students will not be expected to have practical experience of working with all of these composites but exam questions could refer to any of the properties listed.
	
	Students should also be able to demonstrate knowledge and understanding of how the mechanical properties of these materials can change through the:
	• direction/alignment of reinforcement
	• matrix in which the reinforcement is placed
	• amount of reinforcement used
	• size and shape of reinforcement.	

3.1.1.4 Other materials

Subject content	Additional information	Mathematical understanding
• Timbers (structural grades). • Ceramics.	Students will not be expected to have practical experience of working with all of these materials but exam questions could refer to any of the properties listed.	

3.1.2 Material costs and supply

Students should have knowledge and understanding of the cost, availability, form and supply of the engineering materials listed in Materials and their properties (page 9).

Subject content	Additional information	Mathematical understanding
Cost, availability, form and supply of the metals, alloys, polymers, composites and other materials listed.	Students will be expected to know the comparative costs of different materials within and across these groups eg copper vs gold for use as electrical components or timber vs steel for structural components. Students will not be asked questions about specific aspects of individual materials in the exam, but they will be expected to demonstrate their understanding of the benefits to designers and manufacturers of having a choice of materials to work with. They will also be expected to provide and discuss at least three examples.	
Calculation of costs to manufacture/ produce items to inform the development of an engineered solution in industry.	Students will be expected to understand the following: • available stock sizes and supply • using economies of scale to reduce costs (price breaks based on quantity) • waste produced.	E1, E2, E3, E4, E5 M1.1, M1.2
The ability of engineering materials to be: • machined • treated • shaped • recycled.	Students will be expected to be familiar with these concepts in relation to the materials listed.	

3.1.3 Factors influencing design of solutions

Subject content	Additional information	Mathematical understanding
Energy production methods: • wind • solar • tidal • nuclear • fossil fuels • biomass.	Students will need to understand the benefits and drawbacks of each of the energy production methods listed including any possible environmental impact.	

Subject content	Additional information	Mathematical understanding
Engineered lifespans.	• Planned obsolescence. • Sealed parts. • Maintenance requirements.	
The need for and methods of maintenance of engineered products.	Students will be expected to understand the need for maintenance of engineered products to: • ensure safety in operation • enable efficiency of operation. They will also need to understand the reasons for the following types of maintenance work: • lubrication • avoiding corrosion • compensating for wear • End of Life (EOL), disposal and recovery of materials.	Measurement and tolerances M1.1, M1.2, M1.3
	Understand that statistics can be used to predict service intervals and expected lifetime of components.	M2.2, M2.4
Engineered solutions can be inhibited by the availability and forms of materials.	Cost is affected by the availability of materials, and using non-standard forms will increase cost.	M1.4
How user requirements affect material choice and manufacturing process.	Users requiring solutions that are higher strength or lower weight means choosing materials such as titanium or carbon fibre composites, and may require more specialist manufacturing processes.	M1.4

3.2 Engineering manufacturing processes

Students should have knowledge and understanding of the following manufacturing processes and techniques. They will be expected to demonstrate knowledge of:

- which process is appropriate for specific materials
- how these processes would be carried out.

Students will not be expected to have practical experience of using all of these processes but exam questions could refer to any of them.

3.2.1 Additive manufacturing

Subject content	Additional information	Mathematical understanding
• Fused deposition. • Sintering (for metals). • Rapid prototyping (for polymers).		

3.2.2 Material removal

Subject content	Additional information	Mathematical understanding
Cutting: • sawing • shearing • laser.		Calculation of cutting speeds M1.1
Turning: • cylindrical • tapered • boring.		Calculation of angles M1.6, M1.7
Milling: • face • slot.		
Drilling: • using a pillar drill • centre drilling in the lathe.		Calculation and selection of spindle speeds M2.3
Chemical etching: • PCB manufacture (alternative manufacturing methods will also be accepted).		

3.2.3 Shaping

Subject content	Additional information	Mathematical understanding
Shaping by forming and manipulation: • bending • folding • press forming • composite lay up • punching • stamping.		Calculation of: • angles • tolerances • pressure or force. M1.1, M1.2, M1.5, M1.6, E10

3.2.4 Casting and moulding

Subject content	Additional information	Mathematical understanding
• Pressure die casting. • Sand casting. • Injection moulding.		

3.2.5 Joining and assembly

Subject content	Additional information	Mathematical understanding
Permanent and temporary methods: • rivets • threaded fastenings • soldering (soft and hard) • brazing • welding.		

3.2.6 Heat and chemical treatment

Subject content	Additional information	Mathematical understanding
• Normalising. • Annealing. • Hardening. • Quenching.		

3.2.7 Surface finishing

Subject content	Additional information	Mathematical understanding
• Painting. • Dip coating. • Electroplating. • Galvanising. • Polishing.		

3.3 Systems

Students should have knowledge and understanding of the use and role of the following systems within engineering settings. Students should be:

- familiar with the function of the system building blocks specified in 'systems' below
- able to describe the way in which parts of a system can be divided into sub-systems.

Subject content	Additional information	Mathematical understanding
Systems descriptions	• system block diagrams (input, process and output) • schematic drawings • flow charts.	M1.3, M2.4

3.3.1 Mechanical systems

Subject content	Additional information	Mathematical understanding
• Linkages • Conversion of motion including rotary to reciprocating and linear to oscillating.		E14, E15
• Gear trains including chains and sprockets • Cams and followers (including the use of cams within an engine).		Ratio of simple gears and mechanical advantage
Pulleys (how pulleys can be used as a means of reducing effort when lifting loads or transferring power within a system).		M1.4, M3.2, M3.3
Bearings.		

3.3.2 Electrical systems

Subject content	Additional information	Mathematical understanding
Electrical systems comprising: • power supplies (mains and batteries) • input control devices (for example relays and switches) • output devices (motors, buzzers, bells, lamps and solenoids). The difference between Alternating and Direct Current.		M3.2, M3.3, M3.4, M4.1, M4.5 E12

3.3.3 Electronic systems

Subject content	Additional information	Mathematical understanding

Electronic systems comprising:
• inputs (for example light or temperature sensors)
• analogue and digital signals
• process devices:
  • timers
  • counters
  • comparators
  • logic (AND, OR and NOT).		

Programmable devices: microcontrollers eg peripheral interface controller (PIC) used to perform more complex operations or replace discrete process integrated circuits.		M3.1, M3.2
Interfacing components: drivers required for loads that process or programmable devices cannot supply (transistor, field-effect transistor (FET)).		
The use of analogue to digital conversion (ADC) in a programmable device.		

Subject content	Additional information	Mathematical understanding
Output components • LEDs • 7 segment display • buzzer • piezo sounder		
Discrete components within a circuit: • resistors (fixed and variable) • diodes (signal, rectifying) • capacitors (polarised and non-polarised).		E12, E13, M2.1, M2.3
Simple programming for monitoring and controlling processes: using flow charts for explanation, limited to three inputs and three outputs within an engineered system eg a pick and place machine used in the production of electronic circuits.		

3.3.4 Structural systems

Subject content	Additional information	Mathematical understanding
Students should know how simple imposed, dynamic (live) and static (dead) loads are applied and transmitted, including space frame and monocoque structures, leading to bending and torsion/buckling.		E11

3.3.5 Pneumatic systems

Subject content	Additional information	Mathematical understanding
The uses of and differences between pneumatic and hydraulic circuits. Exam questions may focus on the specific circuits and students may be expected to provide an example of when the different types of circuits could be used and why. Examples include: • robotics • process/factory automation • machinery.		E10

3.4 Testing and investigation

Students should have knowledge and understanding of a range of testing and investigation methods. They should be able to apply relevant mathematical calculations when engineering a solution.

3.4.1 Modelling and calculating

Subject content	Additional information	Mathematical understanding
Predicting performance in any of the systems referred to in Systems (page 16).	Students will be expected to use calculations, simulations and modelling either manually or with Computer Aided Design (CAD) to: • design and test electronic circuits • calculate hydraulic/pneumatic forces. Exam questions will not examine complex systems with more than four major component parts.	

Subject content	Additional information	Mathematical understanding
Calculate: • area • volume • stiffness • density • Young's Modulus • factors of safety • forces within/applied to a component or a system • conversion of load/extension to stress/strain (when investigating tensile strength of a material) • resistance in series and parallel, current or voltage.		E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15 M1.1, M1.2, M2.3, M2.4, M3.2, M3.3, M3.4, M4.1, M4.2, M4.3, M4.4, M4.5

3.4.2 Testing

Students will be expected to understand and utilise the following testing methods.

Subject content	Additional information	Mathematical understanding
Methods of testing and evaluating materials and structural behaviour under load, including determining tensile/compressive strength	Students will be expected to use calculations, simulations and modelling either manually or with Computer Aided Design (CAD) to: • design and test electronic circuits • calculate hydraulic/pneumatic forces. Exam questions will not examine complex systems with more than four major component parts.	M4.1, M4.2
Destructive and non-destructive testing.	The difference between these methods and the advantages of each.	
Testing control programs for programmable devices through modelling and enactment.		M2.3, M3.1
Modifying a program to improve performance.	Eg using a micro controller as part of an engineered solution. Changing parameters to adjust motor speed or sensor threshold ranges.	

Subject content	Additional information	Mathematical understanding
Quality control methods.	The use of quality control methods to ensure successful outcomes through the application of tolerances. Identifying and applying checks during the production process.	M1.4, M2.2

3.4.3 Aerodynamics

Subject content	Additional information	Mathematical understanding
Students will be expected to understand the following terms: • lift • drag • thrust.	Students may be asked about these terms within a context and they should be able to give an example (eg when refining the design of a compressed gas powered dragster). Any appropriate example will be acceptable.	

3.5 The impact of modern technologies

Students will be expected to understand the following and provide and discuss examples for each.

Subject content	Additional information	Mathematical understanding
The use of new and emerging technologies.	Students will be expected to demonstrate an understanding of their impact on: • production • society • the environment.	
The impact of engineering industries.	Students will be expected to demonstrate an understanding of the positive and negative impacts of engineering industries upon the social and economic infrastructure.	

3.6 Practical engineering skills

Students will be expected to draw on their knowledge and understanding of engineering to apply the following practical skills to a problem.

Subject content	Additional information	Mathematical understanding
Solve problems through a logical, systematic approach. Analyse and evaluate existing solutions to problems.	Use block diagrams and flowcharts.	M2.4
Produce and work to a series of engineering drawings or schematics.	**Both** mechanical and electrical/ electronic, which must be drawn using current conventions such as drawings in: • orthographic (3rd angle) • 3D representation (Isometric) • assembly • section view.	
Use CAD to assist in the creation of a solution. Use Computer Numerical Control (CNC)/Computer Aided Manufacture (CAM) in the manufacture of a solution.	• CAD in both 2D and 3D. • Examples of 2D being Circuit diagrams, PCB layout, orthographic views. • 3D being solid modelling, isometric views. • CAM can be 2D or 3D. • Laser cutting, vinyl cutting, PCB routing or hole drilling, turning. • Rapid prototyping, milling/ routing.	
Test materials and their structural behaviour under load in order to ascertain suitable material(s) for a chosen component.		
Produce and follow a production plan taking into account: materials, processes, time and safety.		
Predict performance using calculations and modelling.	Through systems modelling and data analysis. Iconic, analogue and symbolic modelling can be used. Calculations will form an important part of any symbolic modelling.	

Subject content	Additional information	Mathematical understanding
Select and safely use a range of appropriate: • materials • parts • components • tools • equipment. In order to manufacture a working solution.		
Select and use appropriate processes in order to manufacture a working solution.	Examples include: • measuring • marking • turning • milling • drilling • forming • bending • casting • joining • fastening • folding • shaping • finishing.	
Apply quality control methods and techniques during the manufacture of the solution.	These will be appropriate to the solution being manufactured. Methods and techniques should include: • working to necessary tolerances • demonstrating the ability to check tolerances through the use of tools (Vernier calipers, micrometers and depth gauges) • using software (CNC/CAM) to ensure that all parts/ components fit together allowing the solution to function.	M1.4

Subject content	Additional information	Mathematical understanding
Design a range of tests to assess the fitness for purpose and performance of a completed product.	Students should take into account how areas for improvement/ modification could be identified and consider alternative solutions.	

4 Scheme of assessment

Find past papers and mark schemes, and specimen papers for new courses, on our website at aqa.org.uk/pastpapers

This specification is designed to be taken over two years.

This is a linear qualification. In order to achieve the award, students must complete all assessments at the end of the course and in the same series.

GCSE exams and certification for this specification are available for the first time in May/June 2019 and then every May/June for the life of the specification.

All materials are available in English only.

Our GCSE exams in Engineering include questions that allow students to demonstrate their ability to:

- recall information
- draw together information from different areas of the specification
- apply their knowledge and understanding in practical and theoretical contexts.

4.1 Aims and learning outcomes

Courses based on this specification must encourage students to:

- engage in a range of intellectual and practical processes in order to solve problems through the production of engineered outcomes
- develop knowledge and understanding of materials, components and resources relating to engineering
- develop knowledge and understanding of engineering processes and be able to apply these where appropriate in order to produce a manufactured outcome
- draw on knowledge, skills and understanding of materials, processes and techniques in order to engineer products which provide a functioning solution in response to a given brief
- develop an understanding of how emerging technologies (in areas such as materials science, information technology (IT) and communications, energy, medicine and robotics) have changed and will continue to change the way in which engineered products are made and used
- develop an understanding of health and safety procedures and be able to carry out practical activities in a safe way
- develop an awareness and understanding of the impact of engineering on the environment and sustainable development
- develop skills, knowledge and understanding as a foundation for future learning and progression, in relation to engineering and other related disciplines
- apply their knowledge and understanding of mathematical concepts in an engineering related context.

4.2 Assessment objectives

Assessment objectives (AOs) are set by Ofqual and are the same across all GCSE Engineering specifications and all exam boards.

The exams and non-exam assessment will measure how students have achieved the following assessment objectives.

- AO1: Demonstrate knowledge and understanding of engineering principles and processes.
- AO2: Apply knowledge, understanding and skills in different contexts, including through the use of a range of tools, equipment, materials, components and manufacturing processes.
- AO3: Analyse and evaluate evidence in relation to a range of engineering contexts.

4.2.1 Assessment objective weightings for GCSE Engineering

Assessment objectives (AOs)	Component weightings (approx %)		Overall weighting (approx %)
	Written Paper	NEA	
AO1	25	0	25
AO2	20	30	50
AO3	15	10	25
Overall weighting of components	60	40	100

4.3 Assessment weightings

The marks awarded on the papers will be scaled to meet the weighting of the components. Students' final marks will be calculated by adding together the scaled marks for each component. Grade boundaries will be set using this total scaled mark. The scaling and total scaled marks are shown in the table below.

Component	Maximum raw mark	Scaling factor	Maximum scaled mark
Written paper	120	x1	120
NEA	80	x1	80
		Total scaled mark:	200

4.4 Non-exam assessment

Students will undertake a single 'design and make' activity, which will arise from investigating a brief set by AQA. AQA will release a new brief on 1 June in the academic year prior to the year in which the NEA should be submitted.

The brief will comprise a broad context and three examples of how the brief might be fulfilled. Schools/colleges and students are free to select one of the examples or devise their own solution to fulfil the brief. Further information on this is provided in section 4.4.2 (page 27).

This component will account for 40% of the students' overall mark. The NEA project in its entirety should take approximately 30 hours to complete and consist of a working prototype and a concise portfolio including sector-specific drawings and an evaluation of their product.

The portfolio will consist of an investigation into a context; analysis of the problem; relevant research to formulate a range of methods of solving the problem (including modelling); systems diagrams and sector-specific drawings; a final prototype that is fit for purpose, a test plan and a final evaluation.

Students are encouraged to investigate, analyse and evaluate throughout the portfolio and evidence all decisions made. If your school or college chooses to submit e-portfolios, it is advised to submit them either as a PowerPoint or PDF. Students are also advised not to use hyperlinks within their portfolio. Students should provide photographic evidence of the finished outcome along with evidence of the stages of making.

4.4.1 Setting the task

Students will be required to respond to a brief produced by AQA.

The brief will be issued to schools via e-AQA. The brief will change every year and will be released on 1 June in the year prior to the assessment being submitted.

Students must ensure they use the NEA brief for the year in which they will be entered for the exam (eg if a student is taking the exam in 2019, they should complete the NEA for 2019).

4.4.2 Taking the task

With reference to the brief, students will be expected to develop a solution that meets the needs of a user.

When working with the set brief, schools/colleges are free to refine it themselves in conjunction with the student, or to choose one of the provided examples.

Any project can have a wide variety of outcomes. These may vary between very simple solutions and the very complex.

Schools/colleges will need to consider the level of demand at this early stage. Setting too simple a task may restrict a student’s ability to satisfy the top mark band descriptors, whilst attempting an overly complex task may result in incomplete or non-functioning outcomes. It is important to match any task with the student’s known capabilities, allowing them to demonstrate what they can do, without needing additional support.

The examples provided are not compulsory and schools/colleges will need to use professional judgement when deciding how to offer the brief to students. In order to ensure students are free to be creative, they are able to either devise their own solution to the problem or select one of the examples given. There is no additional credit available for devising their own solution rather than choosing one of the examples provided.

When considering the specimen assessment materials for this specification, in the case of a litter pick, a very simple solution may consist of a simple pole (to prevent stooping) with a spike on the end to pierce the litter. Although this would satisfy some of the requirements, it has numerous disadvantages. There is, for example, no easy way to remove the pierced litter from the spike, it cannot grip differently shaped objects and lacks any ability to control the force required to pierce a range of materials. This solution would not be deemed to be demanding but could allow some students to access some marks. Areas in which students marks may be limited if they choose a simple solution are, for example, the use and explanation of multiple systems, the range of engineering drawings they produce and the range of materials they use to create their solution.

At the other end of the scale might be a more complex solution that is able to grip, possibly hold a small number of items, and is capable of releasing the litter when required, without anyone needing to handle the litter. A further enhancement might be the addition of a light to help locate litter or an indicator showing fully open or closed positions when operating a grip.

It is important to note that as the descriptors are progressive in nature only the most able will be able to satisfy the requirements of the top mark band completely.

AQA cannot approve product proposals but you should contact your subject adviser or email engineering@aqa.org.uk if you have any questions about the suitability of a proposal.

The marking criteria requires students to create a product that integrates different types of systems. Students are expected to produce and work to both mechanical and electrical/electronic drawings so their product should utilise both types of systems to produce an integrated product.

4.4.2.1 Evidence

Students must produce a written or digital design folder clearly evidencing how the assessment criteria have been met, together with photographic evidence of the final manufactured prototype outcome.

When presenting their evidence, students should organise their work in a way that explains and confirms the processes, materials, tools and equipment used. The evidence should contain all the information necessary to enable a competent and skilled third party to manufacture the product. This could take the form of:

- a manufacturing diary
- production plans that are appropriately annotated and, for the higher marks, self-documenting (an approach that identifies and explains different production methods as appropriate, alternative material possibilities and production methods, and the quality control methods that could be adopted). Annotation may include narrative text alongside photographs and flow charts
- evidence of the solution that is made clear in detailed photographs of the product.

The evidence submitted, when taken together should, for the higher marks, provide:

- a developed and well-planned annotated design with sufficient detail so that a fully working solution could be developed from the design
- a detailed explanation showing an understanding of what the problem involves and how the proposed solution meets the needs of the user
- explanations of where the user has to select appropriate settings (operator input), further explanations as to how the system functions as it was designed to do, and explanations of where systems may require the operator to make quality control judgments
- explanations of any specialised knowledge required to develop or understand a particular type of manufacturing system and explanation of processes used to produce outputs in a controlled manner
- a test plan which explains the purpose of the test
- evidence that the tests have been carried out with the results being documented
- any remedial action (if any was needed) that has been taken as a result of testing.

Students will not be expected to submit their practical outcome for moderation but should supply adequate evidence of their working solution (eg detailed photographic evidence).

4.4.2.2 Time limits

Students should spend approximately 30 hours on their NEA unless there are specific access requirements that should be considered. We expect students to be selective in their choice of material to include, and to manage their time appropriately.

4.4.3 Marking the task

Six criteria are produced for assessment. Each band should be viewed holistically when marking assessments. Students who produce no work for a criterion, or who produce work below that of GCSE standard, should be awarded a mark of zero.

The criteria should not be viewed as a linear process to be followed in a step-by-step manner. Rather, students should be encouraged to cross reference the criteria throughout, and assessors encouraged to award marks where they are deserved and can be evidenced.

4.4.4 Feedback

Students are free to revise and redraft a piece of work before submitting the final piece for assessment. You can review draft work and provide **generic feedback** to ensure that the work is appropriately focused. In providing generic feedback you **can**:

- provide feedback in oral and/or written form
- explain, if necessary, the context of the task
- give general advice on how the task could be approached
- advise on resources that could be used
- remind students of the key areas that should be covered in their project (problem-solving, drawings and conventions, applying systems technology and testing and evaluation)
- provide support if the student is not able to carry out sufficient work at one stage to enable them to progress to the next stage (if such support is given to students then this **must** be recorded on the *Canididate Record Form* and the student's mark should be adjusted accordingly).

In providing generic feedback you **cannot**:

- correct a student's work
- provide templates, model answers or writing frames
- provide specific guidance on how to solve the problem
- provide specific feedback to students on how to improve their projects to meet the requirements of the marking criteria
- provide feedback where a student has produced an incomplete stage and this is sufficient to allow progression to the next stage
- tell students what types of tests they should be completing as part of the Testing and Evaluation section.

Whilst students may be guided in general terms, the final outcome must remain their own. Advice can be used to evaluate progress to date. A clear distinction must be drawn between providing feedback to students as part of work in progress and reviewing work once it has been submitted by the student for final assessment. Once work is submitted for final assessment it cannot be revised. It is not acceptable for you to give, either to individual students or to groups, feedback and suggestions as to how the work may be improved in order to meet the marking criteria.

In accordance with the JCQ Instructions for conducting NEA, any support or feedback given to individual students ***which has not been provided to the class as a whole*** must be clearly recorded on the *Candidate Record Form* and the student's mark must be **appropriately adjusted** to represent the student's unaided achievement.

4.4.5 The use of provided programs

There may be circumstances where it is thought necessary to provide either a part or full solution to a section of the project for a student in order that they can progress with their project.

The use of CAD-CAM or CNC machining is a likely area. If the software provided automatically generates the machining, with no intermediate intervention by the student, then this is classed as a 'provided' program and should be treated in the same way as any other piece of work that is not produced by the student and not given any credit.

If the student edits the intermediate stage, by altering the G and M codes or by using an editing facility within the software, perhaps by changing the steps in the STL file then this should be given credit.

Students who have used a provided program can still gain marks for any machining that they complete based on the instructions generated by the program.

4.4.6 Assessment criteria

The assessment criteria for NEA are split into six sections as shown below.

4.4.6.1 Guidance on applying the marking criteria

Level of response marking instructions are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level.

Before you apply the mark scheme to a student's engineering product, review the product and annotate it and/or make notes on it to show the qualities that are being looked for. You can then apply the marking criteria.

Start at the lowest level of the marking criteria and use it as a ladder to see whether the product meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's product for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the product.

You can compare your student's product with the standardisation examples to determine if it is the same standard, better or worse.

When assigning a level you should look at the overall quality of the product. If the product covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the product to help decide the mark within the level, ie if the product is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

4.4.6.2 Problem solving - 15 marks

In this section students will be required to demonstrate their ability to analyse a given problem, imagine solutions to that problem, use a range of modelling techniques, produce a prototype and communicate their ideas clearly. Students should use sketches or modelling to show technical concepts and the initial steps in generating a functional solution. More detailed drawings/models using conventions should not be credited in this section, but rather in Drawings and Conventions (page 32) which deals directly with using sector-specific conventions.

Students should provide (as appropriate):

- a written description of the task that clearly defines what the problem is
- organised work that communicates ideas
- evidence of a completed prototype of the design solution.

Level/mark	Problem analysis	Problem solving	Modelling	Communicatin g	Production of a prototype
3 (11-15 marks)	The problem has been analysed thoroughly, resulting in a comprehensiv e and accurate description of the problem to be solved including consideration of relevant variables that may affect the engineered solution.	A range of alternative, well-explained methods of solving the problem is considered in detail. Choice is justified with reference to the demands of the problem resulting in an appropriate solution being selected and developed fully.	Excellent modelling is demonstrated using a range of techniques including 3D, graphical and mathematical. All aspects are well-explained and demonstrate that the final outcome should function as desired.	All information is consistently well-organised and presented in an appropriate format. All aspects of decision making are well conveyed.	A fully functioning and high quality prototype of the solution has been produced.
2 (6-10 marks)	The problem is accurately identified with most aspects of the problem having been analysed.	Consideration of other methods of solving the problem is limited to a single alternative suggestion with some detail, or a small number of methods that lack development. A mostly appropriate solution is chosen for further development.	Good modelling of several aspects of the development is demonstrated. Some drawings or records of other forms of modelling are annotated and it is clear from the drawings that the majority of ideas are workable.	Most information is organised and presented in an appropriate format. This conveys some aspects of decision making but not all choices are explained.	A functioning prototype with some non-critical flaws has been produced.

Level/mark	Problem analysis	Problem solving	Modelling	Communicatin g	Production of a prototype
1 (1-5 marks)	The problem is accurately identified but inconclusively analysed.	A single method of solving the problem is generated. Choices are stated but not followed through sufficiently to solve the problem.	Incomplete or partially effective modelling is demonstrated. An attempt at annotation of drawings/ modelling may have been made but it is not always clear from the descriptions or explanations that the ideas are workable.	Information is confused and not always presented in the most appropriate format. The reasoning behind why decisions were made is unclear.	A prototype that does not function adequately has been produced.
0	Nothing worthy of credit				

4.4.6.3 Drawings and conventions - 15 marks

In this section students will demonstrate their ability to develop illustrated design ideas that conform to sector-specific conventions, use CAD effectively and clearly annotate their drawings.

The drawings in this section could include:

- orthographic (including sectional views)
- isometric
- assembly
- schematics.

Students should provide (as appropriate):

- a development and explanation of a detailed, annotated design idea using appropriate engineering drawings
- drawings that comply with sector-specific standards and conventions
- detailed CAD drawings for presentation.

Level/mark	Development drawings	Computer aided design	Conventions	Annotation	Information
3 (11-15 marks)	Develops, justifies and evaluates a detailed and fully annotated solution that uses comprehensive and appropriate engineering drawings.	CAD has been used, with effect, to produce accurate drawings of complex parts and rendered 3D presentations.	Drawings consistently conform to sector-specific standards and conventions.	Drawings are annotated clearly, accurately and appropriately, and are easy to follow providing all required detail.	All information is consistently presented in a clear and logical manner that ensures understanding.
2 (6-10 marks)	Develops and partially evaluates an annotated solution using some engineering drawings.	CAD has been used to present adequate information of shape and size or the function of components to allow development to progress.	Drawings generally conform to sector-specific standards and conventions with occasional errors or omissions.	Drawings have annotation for most important features, but lack sufficient detail.	Most information is presented in a clear manner. Some detail may be missing or be confusing.
1 (1-5 marks)	Develops a solution using a limited range of engineering drawings.	CAD has been used to attempt to present a limited amount of simple information about shape or size.	Drawings use conventions to a very limited extent or inaccurately.	Drawings lack any annotation other than brief descriptions or labels.	Information is difficult to understand and lacks clarity.
0	Nothing worthy of credit				

4.4.6.4 Production planning - 15 marks

In this section students will demonstrate their ability to produce and follow a production plan and explain the stages of production, consider repeatability and use CNC, explain the quality control measures taken and consider health and safety.

Students should produce (as appropriate):

- a detailed production plan
- an explanation of each of the stages of production
- an explanation of the quality control techniques used to produce the product.

Level/mark	Producing and following a plan	Explaining the plan	Ensuring repeatability and using CNC	Sequencing and quality control	Health and Safety
3 (11-15 marks)	Produced and followed a detailed production plan, covering most aspects of production using information contained within engineering drawings or circuit diagrams.	A comprehensive and detailed explanation of all of the stages in the production of an engineered product is provided.	Planning includes detail related to the use of jigs/ fixtures to ensure repeatability. Detailed evidence that jigs or fixtures and/or CNC programming have been used.	Identifies all stages and explains the sequence of processes and the quality control techniques used to produce the product.	Comprehensively details the application of health and safety procedures in all processes.
2 (6-10 marks)	Produced and followed a simple production plan using information contained within engineering drawings or circuit diagrams.	A clear and detailed explanation of the main stages in the production of an engineered product is provided.	Evidence of the planned use of jigs, fixtures or CNC programming, to enable repeatable outcomes.	Identifies the main stages/ processes and an important quality control technique used to produce the product.	Details the application of health and safety procedures in the main processes.
1 (1-5 marks)	Followed a simple production plan using information contained within engineering drawings or circuit diagrams.	An outline plan that identifies limited aspects of production is provided.	Evidence of the use of a provided jig/ fixture or machining of a part on a CNC machine, using a provided program.	Identifies the main process(es) and mentions the need for quality control when producing the product.	Adheres to health and safety procedures.
0	Nothing worthy of credit				

4.4.6.5 Engineering skills used - 15 marks

In this section students will demonstrate their ability to use safely a range of materials and equipment and explain their choices, consider quality control and work to tolerances.

Students should produce (as appropriate):

- evidence of the selection and safe uses of appropriate materials, parts, components, tools and equipment required to make their product
- an explanation of the processes used
- evidence of the quality control measures taken.

Level/mark	Skill	Use of a range of processes and materials	Quality control and working to tolerances	Level of demand	Explanation of processes
3 (11-15 marks)	The outcome shows a high level of skill across a number of processes, with work completed accurately.	Used safely a wide range of appropriate: • materials • parts • components • processes • tools • equipment.	Applied the planned quality control to all stages of manufacture to make their product. The engineered product meets the tolerances stated.	Makes a complete, high-quality engineered product with a high level of demand.	Clear and detailed explanations of which alternative processes were considered, justifying why particular methods have been used.
2 (6-10 marks)	The outcome shows an acceptable level of skill across a number of processes, with most work completed accurately.	Used safely a small range of appropriate: • materials • parts • components • processes • tools • equipment.	Applied the planned quality control to a limited number of stages. The engineered product is made within some of the tolerances stated.	Makes an incomplete, high level of demand engineered product **or** a complete low level of demand product.	Simple explanations of why particular processes were used.
1 (1-5 marks)	The outcome shows a limited amount of skill with little work completed accurately.	Used safely a very limited range of: • materials • parts • components • processes • tools • equipment.	Applied quality control to a single stage. The engineered product is not made to any stated tolerances.	Makes an incomplete, low level of demand engineered product.	The processes that have been used are stated.

Level/mark	Skill	Use of a range of processes and materials	Quality control and working to tolerances	Level of demand	Explanation of processes
0	Nothing worthy of credit				

4.4.6.6 Applying Systems Technology - 10 marks

In this section students will demonstrate their ability to identify and explain the systems they have used and produce block diagrams to represent them.

Students should provide (as appropriate):

- representations of technological systems used in their product in diagrammatic form
- block diagrams with explanations of the systems operating within their product.

Level/mark	Application of systems technology	Explanations of systems technology
5 (9-10 marks)	Identifies and explains in detail two or more of the systems and technologies used in the engineered product to organise and control the function of the product.	Detailed block diagrams are produced for multiple systems with all sub-systems and feedback explained.
4 (7-8 marks)	Identifies and explains one or more systems technology used in the engineered product to organise and control the function of the product.	A complex block diagram for one or more systems with sub-systems or feedback explained.
3 (5-6 marks)	Explains in general terms a single systems technology used in the engineered product and how it operates.	A systems block diagram, including an explanation of each of the blocks as a system or shown diagrammatically with explanation.
2 (3-4 marks)	Displays a basic understanding of the systems technology used in the engineered product. Descriptions lack accuracy.	A linear systems block diagram where more than one operation is described.
1 (1-2 marks)	Shows a limited awareness of the systems technology used in the engineered product but descriptions lack any detail.	A simple systems block diagram is produced consisting of a single input/process/output operational structure.
0	Nothing worthy of credit	

4.4.6.7 Testing and Evaluating - 10 marks

In this section students will demonstrate their ability to undertake testing of their product and evaluate its effectiveness. They will also be expected to provide an honest evaluation of the product and make recommendations for improvements.

Students should provide (as appropriate):

- evidence of a range of appropriate testing of the product
- an analysis and evaluation of the completed product, with further explanation as to how and why it could be improved.

Teachers should note that evaluation is considered to be 'how well does the solution work and how could it be better?'.

Students should consider and asses how well the solution meets the requirements of the problem and how the solution could be improved if the problem were to be revisited.

Level/mark	Testing	Evaluating
5 (9-10 marks)	Undertaken detailed and objective testing of all aspects of the product using a variety of testing techniques to compare with a comprehensive specification. An explanation of how quality is maintained through testing, detailing methods that ensure the work is within tolerance.	A comprehensive analysis and evaluation of all aspects of the completed product, both systems operation and manufacture. Well-reasoned suggestions made for how and why possible improvements could be made.
4 (7-8 marks)	Undertaken appropriate testing of most aspects of the product and provided an informative comparison to the product specification. Quality control methods applied consistently to ensure all aspects of work are within tolerance.	A detailed analysis and evaluation of the completed product, explaining how and why either systems operation or manufacture could/needs to be improved.
3 (5-6 marks)	Undertaken a range of basic testing on the product using a variety of techniques comparing the results to the product specification. An explanation of the method used to ensure quality is maintained.	An analysis and evaluation of the completed product, explaining why it needs to be improved.
2 (3-4 marks)	Undertaken testing of limited aspects of the product with comparison to the product specification, using a single technique. Some quality issues addressed.	A limited analysis and evaluation of an aspect of the completed product, stating why it needs to be improved.

Level/mark	Testing	Evaluating
1 (1-2 marks)	Undertaken testing of a single aspect of the product with comparison to the product specification. Has a minimal awareness of quality issues.	Limited analysis and evaluation of an incomplete product.
0	Nothing worthy of credit	

5 Non-exam assessment administration

The non-exam assessment (NEA) for this specification is to engineer a product in response to a given brief.

Visit aqa.org.uk/8852 for detailed information about all aspects of NEA administration.

The head of the school or college is responsible for making sure that NEA is conducted in line with our instructions and Joint Council for Qualifications (JCQ) instructions.

5.1 Supervising and authenticating

To meet Ofqual's qualification and subject criteria:

- **students** must sign the *Candidate record form* (CRF) to confirm that the work submitted is their own and any additional help received has been recorded
- all **teachers** who have marked a student's work must sign the declaration of authentication on the CRF (this is to confirm that the work is solely that of the student concerned and was conducted under the conditions laid down by this specification)
- teachers must ensure that a CRF is attached to each student's work.

All practical work that is submitted for assessment must be completed under direct supervision. If a student needs to undertake some work that cannot be completed in school/college due to a lack of resources (for example, welding aluminium) no credit can be given for the work undertaken off site. You must ensure that you are familiar with the product before it is taken off site and also verify it after any off site work has been completed to ensure that the only work that has been completed off site is what has been discussed beforehand.

Students must have sufficient direct supervision for the written element to ensure that the work submitted can be confidently authenticated as their own. If a student receives additional assistance and this is acceptable within the guidelines for this specification, you should award a mark that represents the student's unaided achievement. Please make a note of the support the student received on the CRF and sign the authentication statement. If the statement is not signed, we cannot accept the student's work for assessment.

5.2 Avoiding malpractice

Please inform your students of the AQA regulations concerning malpractice. They must not:

- submit work that is not their own
- lend work to other students
- allow other students access to, or use of, their own independently sourced source material (they may lend their books to another student, but they must not plagiarise other students' research)
- include work copied directly from books, the internet or other sources without acknowledgement

- submit work that is word-processed by a third person without acknowledgement
- include inappropriate, offensive or obscene material.

These actions constitute malpractice and a penalty will be given (for example, disqualification).

If you identify malpractice **before** the student signs the declaration of authentication, you don't need to report it to us. Please deal with it in accordance with your school or college's internal procedures. We expect schools and colleges to treat such cases very seriously.

If you identify malpractice **after** the student has signed the declaration of authentication, the head of your school or college must submit full details of the case to us at the earliest opportunity. Please complete the form JCQ/M1, available from the JCQ website at jcq.org.uk

You must record details of any work which is not the student's own on the CRF or another appropriate place.

Consult your exams officer about these procedures.

5.3 Teacher standardisation

We'll provide support for using the marking criteria and developing appropriate tasks through teacher standardisation.

In the following situations teacher standardisation is essential. We'll send you an invitation to complete teacher standardisation if:

- moderation from the previous year indicates a serious misinterpretation of the requirements
- a significant adjustment was made to the marks in the previous year
- your school or college is new to this specification.

For further information about teacher standardisation visit aqa.org.uk/8852

For further support and advice please speak to your adviser. Email your subject team at engineering@aqa.org.uk for details of your adviser.

5.4 Internal standardisation

You must ensure that you have consistent marking standards for all students. One person must manage this process and they must sign the Centre declaration sheet to confirm that internal standardisation has taken place.

Internal standardisation may involve:

- all teachers marking sample pieces of work to identify differences in marking standards
- discussing any differences in marking at a training meeting for all teachers involved
- referring to reference and archive material such as previous work or examples from our teacher standardisation.

5.5 Commenting

To meet Ofqual's qualification and subject criteria, you must show clearly how marks have been awarded against the marking criteria in this specification.

Your comments will help the moderator see, as precisely as possible, where you think the students have met the marking criteria.

You must record your comments on the CRF.

5.6 Submitting marks

You must check that the correct marks are written on the CRF and that the total is correct.

The deadline for submitting the total mark for each student is given at aqa.org.uk/keydates

5.7 Factors affecting individual students

For advice and guidance about arrangements for any of your students, please email us as early as possible at eos@aqa.org.uk

Occasional absence: you should be able to accept the occasional absence of students by making sure they have the chance to make up what they have missed. You may organise an alternative supervised session for students who were absent at the time you originally arranged.

Lost work: if work is lost you must tell us how and when it was lost and who was responsible, using our special consideration online service at aqa.org.uk/eaqa

Extra help: where students need extra help which goes beyond normal learning support, please use the CRF to tell us so that this help can be taken into account during moderation.

Students who move schools: students who move from one school or college to another during the course sometimes need additional help to meet the requirements. How you deal with this depends on when the move takes place.

- If it happens early in the course, the new school or college should be responsible for the work.
- If it happens late in the course, it may be possible to arrange for the moderator to assess the work as a student who was 'educated elsewhere'.

5.8 Keeping students' work

Students' work must be kept under secure conditions from the time that it is marked, with CRFs attached. After the moderation period and the deadline for Enquiries about Results (or once any enquiry is resolved) you may return the work to students.

5.9 Moderation

You must send all your students' marks to us by the date given at aqa.org.uk/deadlines. You will be asked to send a sample of your students' NEA evidence to your moderator.

You must show clearly how marks have been awarded against the assessment criteria in this specification. Your comments must help the moderator see, as precisely as possible, where you think the students have met the assessment criteria. You must:

- record your comments on the Candidate Record Form (CRF)
- check that the correct marks are written on the CRF and that the total is correct.

The moderator re-marks a sample of the evidence and compares this with the marks you have provided to check whether any changes are needed to bring the marking in line with our agreed standards. Any changes to marks will normally keep your rank order but, where major inconsistencies are found, we reserve the right to change the rank order.

School and college consortia

If you're in a consortium of schools or colleges with joint teaching arrangements (where students from different schools and colleges have been taught together but entered through the school or college at which they are on roll), you must let us know by:

- filling in the *Application for Centre Consortium Arrangements for centre-assessed work*, which is available from the JCQ website jcq.org.uk
- appointing a consortium coordinator who can speak to us on behalf of all schools and colleges in the consortium. If there are different coordinators for different specifications, a copy of the form must be sent in for each specification.

We'll allocate the same moderator to all schools and colleges in the consortium and treat the students as a single group for moderation.

5.10 After moderation

We will return your students' work to you after the exams. You'll also receive a report when the results are issued, which will give feedback on the appropriateness of the tasks set, interpretation of the marking criteria and how students performed in general.

We'll give you the final marks when the results are issued.

To meet Ofqual requirements, as well as for awarding, archiving or standardising purposes, we may need to keep some of your students' work. We'll let you know if we need to do this.

6 General administration

You can find information about all aspects of administration, as well as all the forms you need, at aqa.org.uk/examsadmin

6.1 Entries and codes

You only need to make one entry for each qualification – this will cover all the question papers, non-exam assessment and certification.

Every specification is given a national discount (classification) code by the Department for Education (DfE), which indicates its subject area.

If a student takes two specifications with the same discount code:

- further and higher education providers are likely to take the view that they have only achieved one of the two qualifications
- only one of them will be counted for the purpose of the *School and College Performance tables* – the DfE's rules on 'early entry' will determine which one.

Please check this before your students start their course.

Qualification title	AQA entry code	DfE discount code
AQA GCSE in Engineering	8852	XA1

This specification complies with:

- Ofqual *General conditions of recognition* that apply to all regulated qualifications
- Ofqual GCSE qualification level conditions that apply to all GCSEs
- Ofqual GCSE subject level conditions that apply to all GCSEs in this subject
- all other relevant regulatory documents.

The Ofqual qualification accreditation number (QAN) is 603/0719/5.

6.2 Overlaps with other qualifications

There are no overlaps with any other AQA qualifications at this level.

6.3 Awarding grades and reporting results

The qualification will be graded on a nine-point scale: 1 to 9 – where 9 is the best grade.

Students who fail to reach the minimum standard grade for grade 1 will be recorded as U (unclassified) and will not receive a qualification certificate.

6.4 Resits and shelf life

Students can resit the qualification as many times as they wish, within the shelf life of the qualification.

6.5 Previous learning and prerequisites

There are no previous learning requirements. Any requirements for entry to a course based on this specification are at the discretion of schools and colleges.

6.6 Access to assessment: diversity and inclusion

General qualifications are designed to prepare students for a wide range of occupations and further study. Therefore our qualifications must assess a wide range of competences.

The subject criteria have been assessed to see if any of the skills or knowledge required present any possible difficulty to any students, whatever their ethnic background, religion, sex, age, disability or sexuality. Tests of specific competences were only included if they were important to the subject.

As members of the Joint Council for Qualifications (JCQ) we participate in the production of the JCQ document *Access Arrangements and Reasonable Adjustments: General and Vocational qualifications*. We follow these guidelines when assessing the needs of individual students who may require an access arrangement or reasonable adjustment. This document is published at jcq.org.uk

Students with disabilities and special needs

We're required by the Equality Act 2010 to make reasonable adjustments to remove or lessen any disadvantage that affects a disabled student.

We can make arrangements for disabled students and students with special needs to help them access the assessments, as long as the competences being tested aren't changed. Access arrangements must be agreed **before** the assessment. For example, a Braille paper would be a reasonable adjustment for a Braille reader.

To arrange access arrangements or reasonable adjustments, you can apply using the online service at aqa.org.uk/eaqa

Special consideration

We can give special consideration to students who have been disadvantaged at the time of the assessment through no fault of their own – for example a temporary illness, injury or serious problem such as family bereavement. We can only do this **after** the assessment.

Your exams officer should apply online for special consideration at aqa.org.uk/eaqa

For more information and advice visit aqa.org.uk/access or email accessarrangementsqueries@aqa.org.uk

6.7 Working with AQA for the first time

If your school or college hasn't previously offered our specifications, you need to register as an AQA centre. Find out how at aqa.org.uk/becomeacentre

6.8 Private candidates

This specification is not available to private candidates.

6.9 Use of calculators

Students may use a calculator in the examination. They must however ensure that their calculator meets the requirements as set out in the *JCQ Instructions for conducting examinations*. These instructions make it clear what the requirements are for calculators (what they must be) and what they are not (what they must not be). The instructions are regularly updated and can be found on the Joint Council for Qualifications website at www.jcq.org.uk.

7 Appendix 1: Mathematical understanding

A grasp of a range of mathematical concepts and skills is key to success in engineering. This section outlines the equations and mathematical skills students will be expected to recall and use within the exam. Not all of these equations and skills will be tested in every exam series but students may be asked to use any combination of equations and skills.

The mathematical content has been developed in order to support teaching of GCSE Engineering and should not be seen as an additional element. The skills in mathematics are not intended to be taught separately to the main content, but integrated into schemes of work. The skill groups are indicated in the subject content, using the references E1 (Equation 1), E2 (Equation 2) or M1 (Mathematical Skill 1), M2 (Mathematical Skill 2) etc.

Students should recognise, carry out calculations and be able to communicate using the following SI units: millimetres (mm), metres (m), kilograms (Kg), tonnes (T), newtons (N), volt (V), ohm (Ω); and the following SI multipliers: p, n, μ, m, k, M, G and T.

Students should also have knowledge and understanding of the following conversion of units:

- mm to cm
- cm to m
- litres to ml, to cm^3, and to mm^3
- kg to tonnes
- weight to mass.

7.1 Equations

Through their work in engineering, students will be expected to apply relevant knowledge, skills and understanding from Key Stage 3 and 4 courses in mathematics.

Equation number	Description	Equation
E1	Area of a rectangle	$A=L\times W$
E2	Volume of a cuboid	$V = L \times W \times H$
E3	Area of a circle	$Ac=\pi r^2$
E4	Volume of a cylinder	$Vc=Ac\times L$
E5	Area of a triangle	$At=½(B\times H)$
E6	Density = mass/volume	$\rho=m/v$
E7	Stress = force/cross-sectional area	$\sigma =F/A$
E8	Strain = change in length/original length	$\varepsilon=\delta l/l$
E9	Young's modulus = stress/strain	$E=\sigma/\varepsilon$

Equation number	Description	Equation
E10	Pressure = force/area	$P=F/A$
E11	Factor of safety = material strength/ yield stress	$FoS={}^{\sigma}y/L$
E12	Ohm's law: current = voltage/ resistance	$I=V/R$
E13	Series resistance	$R_t = R_1 + R_2$
E14	Ratio of simple gears: Gear ratio = Number of teeth on driven gear/ number of teeth on driver gear	
E15	Mechanical Advantage = load/effort	$MA=Fb/Fa$

7.2 Mathematical skills

7.2.1 M1 – Arithmetic and numerical computation

Mathematical skill number	Description of skill
M1.1	Recognise and use expressions in decimal form
M1.2	Recognise and use expressions in standard index form
M1.3	Perform calculations using time and cost
M1.4	Use ratios, fractions and percentages
M1.5	Calculate squares and square roots
M1.6	Calculate angles of a triangle using trigonometry
M1.7	Use Pythagoras' theorem

7.2.2 M2 – Handling data

Mathematical skill number	Description of skill
M2.1	use an appropriate number of significant figures
M2.2	find arithmetic means
M2.3	make order of magnitude calculations
M2.4	collection, organisation and presentation of data

7.2.3 M3 – Algebra

Mathematical skill number	Description of skill
M3.1	understand and use the symbols =, <, ≤, ≥, >, ±, α, ~
M3.2	change the subject of an equation

Mathematical skill number	Description of skill
M3.3	substitute numerical values into algebraic equations using appropriate units for physical quantities
M3.4	solve simple algebraic equations

7.2.4 M4 – Graphs

Mathematical skill number	Description of skill
M4.1	translate information between graphical and numeric form
M4.2	plot two variables from experimental or other data
M4.3	draw an appropriate trend line onto plotted data
M4.4	determine the slope of a graph
M4.5	interpret data presented in graphical form

Get help and support

Visit our website for information, guidance, support and resources at

You can talk directly to the Engineering subject team:

E: engineering@aqa.org.uk

T: 0161 957 3334