GCE AS/A LEVEL

WJEC GCE AS/A Level in

DESIGN AND TECHNOLOGY

APPROVED BY QUALIFICATIONS WALES

SAMPLE ASSESSMENT MATERIALS

Teaching from 2017

This Qualifications Wales regulated qualification is not available to centres in England.

For teaching from 2017
For award from 2018

GCE AS AND A LEVEL DESIGN AND TECHNOLOGY

ENGINEERING DESIGN

SAMPLE ASSESSMENT MATERIALS

Contents

Candidate Name	Centre Number					Candidate Number				
						0				

GCE AS DESIGN AND TECHNOLOGY

UNIT 1

ENGINEERING DESIGN

SAMPLE ASSESSMENT MATERIALS

2 Hours

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator.

INSTRUCTIONS FOR CANDIDATES

Answer ALL questions.

Write your name, centre number and candidate number in spaces at the top of this page.

Write your answers in the spaces provided in this booklet.

Use black ink or black ball-point pen.

Do not use pencil or gel pen.

Do not use correction fluid.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part question. You are advised to divide your time accordingly.

The total number of marks available is 80.

You are reminded of the need for good English and orderly, clear presentation in your answers. The quality of your written communication, including appropriate use of punctuation and grammar, will be assessed in your answer to question 5.

Q1. (a) Describe two ways in which the development of computer aided design (CAD) has been beneficial to the designer. [2]

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(b) Explain how computer numerical control (CNC) machines influence high volume production. [2]

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(c) Discuss the impact of:

(i) rapid prototyping on product development; [2]

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(ii) digital processing on product development. [2]

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Q2. (a)(i) Explain the purpose of safety symbols in a workshop environment. [2]

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(ii) Explain the meaning of each coloured symbol shown below. [2]

Blue circle with white edge

Yellow triangle with black edge

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(b) Shown below is a soldering iron.

Write four safety precautions that should be carried out by the user of the soldering iron. [4]

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Q3. (a) Products such as DVD players, mobile phones and computers are often developed as a result of technology push. Explain the meaning of 'technology push'. [2]

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(b) Discuss the effect that market pull has had on the development of a specified named product. [6]

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Q4. The image below of is of a traditional mountain bike.

The bike frame structure illustrated is subjected to both static and dynamic forces.

Evaluate how the traditional mountain bike has been designed in order to withstand the impact of these static and dynamic forces. [8]

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Q5. Describe the work of Jonathan Ive and discuss who has influenced his design style/thinking and how this influence has been reflected in his products. [8]

Marks will be awarded for the content of the answer and the quality of written communication.

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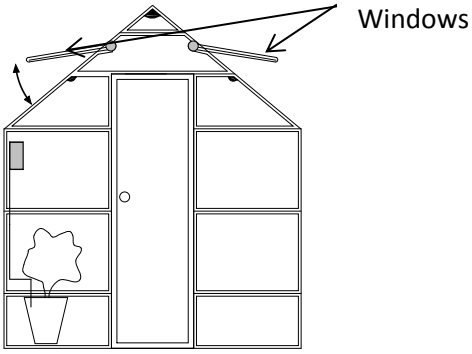
Q6. The greenhouse shown below is to be fitted with an automatic temperature control system that ensures:

- windows open if the temperature inside rises above 40^0C
- windows close again if the temperature inside drops below 34^0C.

You have been asked to contribute to the design of a window opening system for the greenhouse. The temperature is controlled by a temperature sensing component and an automated mechanical device that opens and closes a window.



(a) Analyse the information given and in the space below write four justified specification points that would need to be included when designing the product. [8]

Point 1: .....

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Justification: .....

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Point 2: .....

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Justification: .....

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Point 3: .....

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Justification: .....

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Point 4: .....

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Justification: .....

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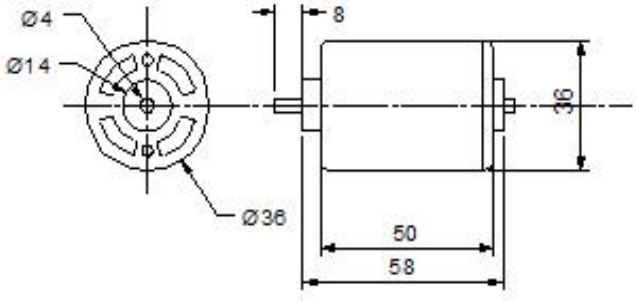
(b) The window opening system has three main parts:

- an electronic temperature sensing circuit
- a motor controlled by the temperature sensing circuit
- a mechanical device, operated by the motor, to open and close a window.

(i) In the box below, draw a detailed block diagram explaining the requirements for the temperature sensing circuit. [8]

(ii) In the box below, draw a detailed and labelled diagram of a suitable mechanical system that can be used to open and close a window. [8]

(c) The motor shown below will need to be protected from the moisture and humidity that can be anticipated within the greenhouse



In the box below, design a protective housing for the motor. Your design must include:

(i) constructional details

(ii) a proposed method of fixing it to the greenhouse

(iii) named material(s) from which the housing will be made. [8]

(d) Designers have to consider the issue of sustainability in the design of products such as the greenhouse temperature control system. Describe in detail how sustainability issues can be addressed when designing new products. [8]

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For continuation only.

MARK SCHEME

Guidance for examiners

Positive marking

It should be remembered that learners are writing under examination conditions and credit should be given for what the learner writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

Banded mark schemes

For band marked questions mark schemes are in two parts, the indicative content and the assessment grid.

The indicative content suggests the range of issues which may be included in the learner's answers. It can be used to assess the quality of the learner's response. Indicative content is **not** intended to be exhaustive and learners **do not** have to include all the indicative content to reach the highest level of the mark scheme.

In order to reach the highest levels of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that it contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

In Design and Technology, each question addresses one assessment objective: either AO3 or AO4. The assessment grid sub-divides the total mark to allocate for a question. These are shown in bands in the mark scheme. For each question, descriptors will indicate the different skills and qualities at the appropriate level.

Examiners should first read and place a tick in the learner's answer/s to indicate the evidence that is being assessed in that question; the mark scheme can then be applied. This is done as a two stage process.

Stage 1 – Deciding on the band

Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptors for that band. If the descriptors at the lowest band are satisfied, examiners should move up to the next band and repeat this process for each band until the descriptors match the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content.

Examiners should not seek to mark learners down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

GCE AS Design and Technology (Engineering Design)

MARK SCHEME

Question 1

		AO3	AO4	Mark
(a)	Describe two ways in which the development of computer aided design (CAD) has been beneficial to the designer.		✓	2
	*Answers that demonstrate an understanding of CAD should be awarded up to **2** marks based on:* • Advantages of electronic storage, space saving • Automatic dimensioning • Ability to copy and paste • Enables visualisation from any angle • Easy to edit • Orthographic drawings can be automatically generated • Images can be rendered in different colours or materials • Parts can be easily exported for CAM and rapid prototyping • Proposals can be sent electronically resulting in reduced lead in times **Guidance to markers** *No answer or an incorrect answer* ***0 marks*** *A simple response for example:* CAD drawings can be stored electronically and sent by email. ***1 mark*** *A more developed response for example:* CAD can save a considerable amount of space through electronic storage and proposals can be sent electronically in order to reduce lead in times. ***2 marks***			
(b)	Explain how computer numerical control (CNC) machines influence high volume production.		✓	2
	*Answers that demonstrate an understanding of CNC machines should be awarded up to **2** marks based on:* • Very fast cycle times • Complex shapes can be produced easily in large quantities • Very accurate • Improved consistency and high quality outcomes. Human error can be eliminated • Very fast set-up / change over times • Reduced need for jigs and fixtures • Reduced labour • Quality control and quality assurance can be built in **Guidance to markers** *No answer or an incorrect answer* ***0 marks*** *A simple response for example:* Using CNC machines can improve consistency and parts can be produced quickly. ***1 mark*** *A more developed response for example:* Using CNC machines can improve consistency as human error can be eliminated. Complex parts can be quickly produced in large quantities at reduced cost. ***2 marks***			

(c)	Discuss the impact of: (i) rapid prototyping on product development; (ii) digital processing on product development.		✓	2 x 2

*Answers that demonstrate an understanding of rapid prototyping and digital processing should be awarded up to **2** marks each based on:*
Rapid prototyping includes a wide range of techniques that will enable a prototype to be generated directly from a CAD drawing. Files are usually post processed as STL files and then turned into a solid model using one of a number of different techniques. Candidates could make reference to:

- Contour Modelling
- Fused Deposition Modelling
- Selective Laser Sintering
- Stereo lithography
- Continuous Liquid Interface Production

Digital processing enables the rapid and accurate production of design concepts in order that they can be visualised by potential clients prior to large scale production. Ideas can be quickly shared with others on a global basis and faults can be eradicated prior to manufacture.

Award up to two marks each for part (i) and part (ii) if an appropriate response is fully evaluated.

Guidance to markers

(i) *No answer or an incorrect answer* ***0 marks***
A basic response for example: Rapid prototyping can speed up product development and give clients the opportunity to provide feedback about the product. ***1 mark***
A developed response for example: Rapid prototyping can speed up product development as an accurate prototype can be produced very quickly from a CAD drawing, giving potential clients the opportunity to visualise the product and to provide feedback so that modifications can be made prior to production. ***2 marks***

(ii) *No answer or an incorrect answer* ***0 marks***
A basic response for example: Digital processing allows ideas to be shared by designers working in different parts of the world. ***1 mark***
A developed response for example: Digital processing enables ideas to be shared quickly with others on a global basis so that proposed modifications can be made and sent by return. The time taken between the development of initial ideas and manufacture is significantly reduced. ***2 marks***

	Total	**8**

Question 2

		AO3	AO4	Mark
(a)	(i) Explain the purpose of safety symbols in a workshop environment.		✓	2
	*Answers that demonstrate an understanding of safety symbols in a workshop environment should be awarded up to **2** marks based on:* Safety symbols are one of the main means of communicating health and safety information or issues related to possible risk. Safety symbols must be used whenever a hazard or danger cannot be avoided adequately or reduced in another way. **Guidance to markers** *No answer or an incorrect answer* ***0 marks*** *A basic response for example:* Safety symbols are used to communicate a hazard or issue. ***1 mark*** *A developed response for example:* Safety symbols are used to communicate a hazard/issue. The different coloured symbols make reference to the severity of hazard or issue ahead. ***2 marks***			
	(ii) Explain the meaning of each coloured symbol shown below: Blue circle with white edge. Yellow triangle with black edge.		✓	2
	*Answers that demonstrate an understanding of safety signage should be awarded up to **1** mark for each correct response:* **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Description for blue sign.* Blue circular signs with a white contrast are MANDATORY signs you follow. ***1 mark*** *Description for yellow sign.* Yellow equilateral signs with black contrast are WARNING signs indicating a danger exist within the environment. High Voltage, laser, danger flammable material. ***1 mark***			
(b)	Write four safety precautions that should be carried out by the user of the soldering iron.		✓	4
	Answers that demonstrate an understanding of the safety precautions when using a soldering iron should be awarded up to 1 mark for each precaution to a total of 4 marks based on: Always wear safety glasses when soldering. Make sure circuit isn't live. Always put the soldering iron back in its stand when not in use. Make sure that the stand is weighted enough or attached to the worktable so that it doesn't topple over. Never place a hot soldering iron on the work surface. Never leave flammable items (such as paper) near the soldering iron. Make sure the soldering iron is unplugged when not in use. Keep the cleaning sponge wet during use. Use fume extraction during soldering.			
			Total	**8**

Question 3

		AO3	AO4	Mark
(a)	Products such as DVD players, mobile phones and computers are often developed as a result of technology push. Explain the meaning of 'technology push'.		✓	2
	*Answers that demonstrate an understanding of technology push should be awarded up to **2** marks based on:* Technology push is the term applied to a process where new advances in science and technology are used in the development of products which improve upon those which previously existed. For example laser systems developed for use in radar systems during WW2 have subsequently been applied to a range of products such as CD and DVD players and are used in eye surgery. **Guidance to markers** *No answer or an incorrect answer* ***0 marks*** *Basic response with limited understanding of technology push* ***1 mark*** Technology push is when a product has undergone a change because of advances in technology. *Developed response with good understanding of technology push.* ***2 marks*** Technology push is where advances in technology have an effect on the final design of a product. For example, the design of a mobile phone has changed because of developments in hardware and software.			
(b)	Discuss the effect that market pull has had on the development of a specified named product.		✓	6
	*Answers that demonstrate an understanding of market pull should be awarded up to **6** marks based on:* • Market pull is the term used to describe how the influence for the development for new and improved products comes from the needs and demands of the consumer. • Dyson has developed products to meet the needs of consumers by carefully analysing their requirements. • The Air Multiplier was developed using existing technology in response to consumer demand for a more efficient product. • As a result of market pull, products are developed which meet the requirements of specific clients. • The products often use existing technology but applied in different situations in order to solve problems. • The products themselves are likely to have a long life cycle and will often be manufactured to a high standard. Award half marks from the range below if a specified product has not been selected. Products could include, for example, the Dyson Air Multiplier or the Sony PS4. • *No response or irrelevant answer* ***0 marks*** • *Brief description of the impact on a selected product* ***1 – 2 marks*** • *Good description of the impact on a selected product* ***3 – 4 marks*** • *Detailed description of the impact on a selected product* ***5 – 6 marks***			
			Total	**8**

Question 4

		AO3	AO4	Mark
	Evaluate how the traditional mountain bike has been designed in order to withstand the impact of these static and dynamic forces.	✓		8

Candidates are required to appraise and/or make judgements about how the bike has been designed to withstand static and dynamic forces.
Answers that demonstrate an understanding of static and dynamic forces should be awarded up to 8 marks based on:
Forces acting on the structure include tension, compression, torsion and shear. A full response would need to give consideration as to how the different parts of the bicycle have been designed to withstand these forces. This could include reference to triangulation in the frame and an understanding that different parts can act as either struts or ties as the dynamic forces change. In order to ensure against structural failure a factor of safety must also be applied to the design, candidates may also make reference to stress analysis and factors related to fatigue and creep.

- *Little or no understanding* ***0 marks***
- *Basic appraisal and/or judgements of how bike withstands either static or dynamic forces* ***1-2 marks***
- *Satisfactory appraisal and/or judgements of how bike withstands either static or dynamic forces* ***3-4 marks***
- *Good appraisal and/or judgements of how bike withstands both static and dynamic forces* ***5-6 marks***
- *Very good appraisal and/or judgements of how bike withstands both static and dynamic forces* ***7-8 marks***

Exemplar answers
The bicycle has been designed using the principle of triangulation to produce a strong structure [1 mark]. Triangular forms allow for the forces to be transferred through the frame [1 mark]. The material itself has been selected to withstand the forces of tension, compression, torsion and shear that can be anticipated as the frame is subjected to dynamic changes during its use under different conditions in different environments [1 mark]. The wall thickness also improves the final strength and ability of the frame to withstand the forces [1 mark]. In addition to material selection, careful consideration will have been given to the joints that have been used and the method by which they are held together [1 mark]. The joints will have been designed to withstand the dynamic and static forces and are often over designed [1mark]. In traditional bicycles made from mild steel these joints are brazed as this method of joining is less brittle than welding and is able to withstand the anticipated vibration [1 mark]. Aluminium frames are often just welded but to be able withstand the applied forces the tubes are often oversized and some extra strengthening is added at the joints. [1 mark]. The other issue with welded frames is that the whole frame will need heat treatment to strength the final frame [1 mark]. A factor of safety will also have been applied to the design to ensure that it will not fail under any conditions [1 mark].

	Total	**8**

Question 5

		AO3	AO4	Mark
	Describe the work of Jonathan Ive and discuss who has influenced his design style/thinking and how this influence has been reflected in his products.		✓	8

- Sir Jonathan Ive is a British industrial designer who is currently the Chief Design Officer (CDO) of Apple Inc.
- He oversees the Apple Industrial Design Group and also provides leadership and direction for Human Interface software teams across the company.
- Ive is the designer of many of Apple's products, including the MacBook Pro, iMac, MacBook Air, Mac mini, iPod, iPod Touch, iPhone, iPad, iPad Mini, Apple Watch and iOS.
- The style that Ive uses in many of his products is reminiscent of the minimalistic, unobtrusive, functional products that were designed by Dieter Rams for the German company Braun.
- Follows Rams: 10 principles of good design as his design philosophy.
- Modern day legend not known by public yet a leader in the design field.
- Likes to use translucent colours in blocks with little if any texture. e.g. The first apple computer screen. Bondi Blue.
- Trend of using two or three main colours a typical style adopted by apple.
- First designer to use the internal workings of a product as a feature/ selling point. Early iMacs showed the circuit boards and internal electronics.
- Minimalistic / simplistic forms. His style is to keep the design simple and clutter free. iPods for example initially just had simple switches on their face
- Tropical colours /names – locations. His first translucent computers use tropical colours such as reds, purples, greens etc. these colours are still used in modern day products.
- Metallic forms and shades / chrome.
- Elegant form, geometric shapes. Products are slim line in nature often very simple geometric forms such as rectangles or squares. His products simple in design yet sophisticated. iPad iPod etc.
- Control wheel / touch screen for ease of use. Interconnectivity of products. Like his products to be able to be simple to use but with a touch of elegance is his philosophy. First generation iPod. Simplicity is the key not only in his designs but also in the function of his products. If it is not needed why use it or have it?
- He spent a great deal of time working with his team on the iPhone asking himself whether or not he needed an LED light to show the iPhone was being charged. His attention to detail and desire to not accept the obvious means that his products are always evolving.
- Ive refined the iPod, brought out smaller, slimmer and coloured versions, and eventually added video and games.
- With the arrival of the iPhone in 2007, they single-handedly created a market for countless smartphone apps.

Guidance to markers

Candidates will be expected to make reference to specific products or design style/thinking.
Only 1 mark can be awarded with respect to his history or present role.

No answer or incorrect, no evidence of understanding. ***0 marks***

Level 1 ***1-2 marks***

- The candidate has a simplistic knowledge of the issues associated with the question.
- Limited use of terminology and technical language.
- The candidate has limited knowledge in relation to the context.
- The candidate will express basic ideas clearly, if not always fluently. Answers may deviate from the question or not be relevant.
- Grammar, punctuation and spelling may be weak, impacting on effective communication.

Level 2 ***3-4 marks***

- The candidate has a basic understanding of the issues associated with the question.
- Satisfactory use of terminology and technical language.
- The candidate has some general knowledge of the form and function of products, trends and styles in relation to the context.
- The candidate will express straightforward ideas clearly, if not always fluently. Answers may deviate from the question or be weakly presented.
- There may be some errors of grammar, punctuation and spelling but is still able to communicate the issues.

Level 3 ***5-6 marks***

- The candidate demonstrates a clear understanding of the issues associated with the question.
- Good use of terminology and technical language.
- The candidate has demonstrated knowledge of the form and function of products, trends and styles associated to the context.
- The candidate will express moderately complex ideas clearly and fluently, through well linked sentences and paragraphs. Answers will be generally relevant and structured.
- There may be occasional errors of grammar, punctuation and spelling.

Level 4 ***7-8 marks***

- The candidate demonstrates an ability to take into account a wide range of factors and has a clear understanding of the associated issues.
- Very good use of terminology and technical language.
- The candidate has developed a detailed knowledge of the form and function of a products, trends and styles associated to the context.
- The candidate will express complex ideas extremely fluently. Sentences and paragraphs will follow on from each other smoothly and logically. Answers will be consistently relevant and structured.
- There will be few, if any, errors of grammar, punctuation and spelling.

Total	**8**

Question 6

		AO3	AO4	Mark
(a)	You have been asked to contribute to the design of a window opening system for the greenhouse. The temperature is controlled by a temperature sensing component and an automated mechanical device that opens and closes a window. Analyse the information given and in the space below write four justified specification points that would need to be included when designing the product.	✓		8
	Award up to two marks for each point if it has been fully justified (up to four points). Points could include: • The product should be maintenance free with an appropriate operational life [1mark] so that it is cost effective to the consumer [1mark]. • The product should comply with BSI and ISO safety standards [1mark] so that it is safe in operation and complies with regulations [1mark]. • The window opening device should activate when the temperature rises above 40^0C and close again if the temperature falls below 34^0C [1 mark] as these are the parameters provided [1 mark]. • Materials used should be suitable for the environment [1mark] and be able to withstand heat and corrosion [1mark]. • The device should be straightforward to install [1mark] and be easy to set up and operate. [1mark]. **Guidance to markers** Irrelevant or no specification point ***0 mark*** A relevant point that that has not been justified ***1 mark*** A relevant point that that has been appropriately justified ***2 marks***			
(b)	(i) In the box below, draw a detailed block diagram explaining the requirements for the temperature sensing circuit.		✓	8
	Detailed block diagram is required. The diagram should include: Suitable input block ***2 marks*** Suitable process block ***2 marks*** Appropriate output block ***2 marks*** Appropriate sensing system that will detect the position of the window and provide feedback. ***2 marks*** **Guidance to markers** Within each block there should be a description of a suitable process to make the circuit work, for example, in the case of the input block: *Simple description* ***1 mark*** The circuit will need to have a temperature sensor. *Detailed description* ***2 marks*** The circuit will need to have a sensor that will be able to measure the temperature. This could be a thermistor.			

	(ii) In the box below, draw a detailed and labelled diagram of a suitable mechanical system that can be used to open and close a window.		✓	8
	The question requires a detailed diagram of a system that would open and close a window. Details should include: • all components correctly identified/named. May include a linear actuator, rack and pinion gear system, a simple or compound gear train or a pulley system; • reference to positional control and the need to reverse the device to close the window. **Guidance to markers** Mechanical diagram that has little detail or supporting annotation. ***1 - 2 marks*** Mechanical diagram with some supporting annotation that is broadly relevant to the design. ***3 - 4 marks*** Mechanical diagram with supporting annotation, relevant to the design and demonstrates a clear understanding of the problem. ***5 - 6 marks*** Detailed mechanical diagram, labelled with supporting annotation that is clearly relevant to the design and demonstrates a thorough understanding of the problem. ***7 - 8 marks***			

(c)	In the box below, design a protective housing for the motor. Your design must include: (i) constructional details (ii) a proposed method of fixing it to the greenhouse (iii) named material(s) from which the housing will be made.		✓	8
	Candidates' designs could be in a 2D or 3D form. The design should show: • how the protective housing is constructed (suitably rigid) • that the housing is of a suitable size/shape to accommodate the motor • consideration of cable management – how these enter the housing • consideration of how the design allows the motor to drive the mechanism – e.g. a spindle passes out through the housing, or there is a slot in the housing to allow the mechanism to enter/move • the motor fixing – secure either to the greenhouse or to the housing • how the housing is fixed to the greenhouse (this could be by fixing it to the motor, if the motor itself is attached directly to the greenhouse) • details of suitable materials, e.g. acrylic vacuum-formed shell, chrome plated mild steel screws etc. **Guidance to markers – the design includes:** simple constructional details and some supporting annotation, but with little or no fixing details shown and no suitable materials identified ***1-2 marks*** mostly suitable constructional details with supporting annotation that is relevant to the context, some fixing details shown and generally suitable material(s) identified **3-4** ***marks*** well communicated, suitable constructional details with supporting annotation relevant to the context, detailed consideration of fixing arrangements and suitable material(s) identified ***5-6 marks*** clearly communicated, entirely suitable constructional details with thorough annotation relevant to the context, detailed consideration of highly-appropriate fixing arrangements and suitable material(s) identified ***7-8 marks***			

(d)	Designers have to consider the issue of sustainability in the design of such products as the greenhouse temperature control system. Describe in detail how sustainability issues can be addressed when designing new products.		✓	8
	Candidates may make reference to the 6Rs for sustainability, the need to design for disassembly and upcycling. Candidates should not be penalised if they do not relate their answer to the greenhouse context as this is a more generic part of the question. Look for answers that are about the use of reclaimed materials, components, ease of disassembly, reference to recyclability of material within the product, packaging etc. • Incorrect/no answer ***0 marks*** • Brief description of issues the designer may consider, but with little reference to sustainability ***1 - 2 marks*** • More detailed description of issues the designer may consider, with some reference to sustainability ***3 - 4 marks*** • Structured description of issues the designer may consider, with mostly relevant reasons why these issues are important for sustainability ***5 - 6 marks*** • Structured and detailed description of issues the designer may consider, with clear and relevant reasons why these issues are important for sustainability ***7 - 8 marks*** *Responses could include:* The product may be manufactured from reclaimed materials which have minimum impact on the environment during processing [1 mark]. Recycling logos which identify the specific material from which each part has been made may be incorporated during manufacture [1 mark]. The product may be designed so that it can easily be disassembled in order that it can be recycled when no longer required [1 mark]. The consumer should be supplied with written and graphic instructions which provide information about how the product can be maintained and how it should be safely disposed of when it is no longer required [1 mark]. The numbers of fixings that hold the product together can be reduced to a minimum - clip fittings may be built in during, for example, the injection moulding process [1 mark]. In order to reduce the carbon footprint materials used in production could be obtained from local sources [1 mark]. Transportation costs may be reduced if the product retails locally, or the packaging has been designed to that as many products as possible can be stacked/transported in a single journey [1 mark]. Packaging is used sparingly - only where essential in order to protect the product from damage. [1 mark].			
			Total	**40**

Candidate Name	Centre Number					Candidate Number				
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GCE A LEVEL DESIGN AND TECHNOLOGY

UNIT 3

ENGINEERING DESIGN

SAMPLE ASSESSMENT MATERIALS

2 hours 30 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator.

INSTRUCTIONS FOR CANDIDATES

Answer ALL questions.

Write your name, centre number and candidate number in spaces at the top of this page.

Write your answers in the spaces provided in this booklet.

Use black ink or black ball-point pen.

Do not use pencil or gel pen.

Do not use correction fluid.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part question. You are advised to divide your time accordingly.

The total number of marks available is 100.

You are reminded of the need for good English and orderly, clear presentation in your answers. The quality of your written communication, including appropriate use of punctuation and grammar, will be assessed in your answer to question 10.

Q1. A student is to use the soldering iron shown below to populate a printed circuit board in a school workshop.

(a) Describe three health and safety considerations when using the soldering iron to populate the printed circuit board safely and effectively. 3 x [1]

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(b) The student needs to fit two printed circuit board pillars to hold the circuit inside the product.

Produce a five step risk assessment for the student when using the equipment shown to make two 5mm holes in the corners of the printed circuit board. 5 x [1]

Stage 1:…….

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Stage 2:…….

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Stage 3:…….

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Stage 4:…….

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Stage 5:…….

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Q2. The product pictured below shows information including the CE mark.

(a) Explain the meaning of the CE mark included on this product. [2]

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(b) Explain how the manufacturer of this product achieves the CE mark. [2]

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(c) Describe two benefits for the consumer of purchasing this product which includes the CE mark. 2 x [2]

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Q3. A concept electronic device has been designed to allow restaurant customers to select from a variety of dishes on the menu, order food and make payments wirelessly.

(a) The concept is intended to be innovative, stylish and minimalistic. Explain how this has been achieved. [2]

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(b) Before producing design ideas, a research team was assembled to investigate anthropometric data of the target market.

Describe the type of information that this research would provide and explain how this information would be of value to the designer. [4]

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(c) Explain the main advantages to the designer of using computer aided design (CAD) and computer aided manufacture (CAM) during the development of the device. [6]

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Q4. A new cordless rechargeable drill below has been designed to revitalise an older existing product.

Existing cordless drill

New cordless drill

(a) State a suitable scale of production for a cordless drill and explain why this is a suitable scale of production in this case. [4]

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(b) The new cordless drill has been designed to have a built-in rechargeable battery, whereas the existing model is supplied with two removable batteries. Explain the implications of this change, for both the manufacturer and the end-user. [8]

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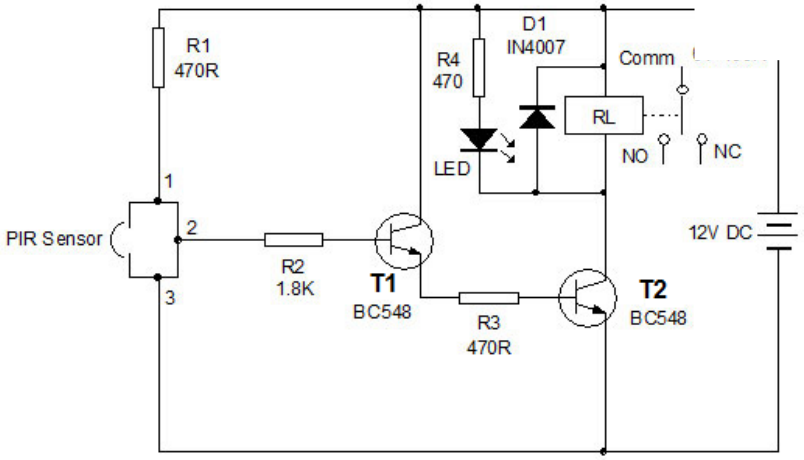
Q5. An automatic door opens when a sensor detects that someone is approaching. A 12 volt sensing system is used to trigger a 240volt motorised mechanism to open and close the doors.

(a) Study the electronic circuit diagram below.



(i) Describe how the input to this system functions. [2]

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(ii) Explain the reason for the components labelled 'T1' and 'T2'. [2]

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(iii) Explain, using notes and sketches, how you would add a 240volt power supply and motor to the circuit above to control the doors. [4]

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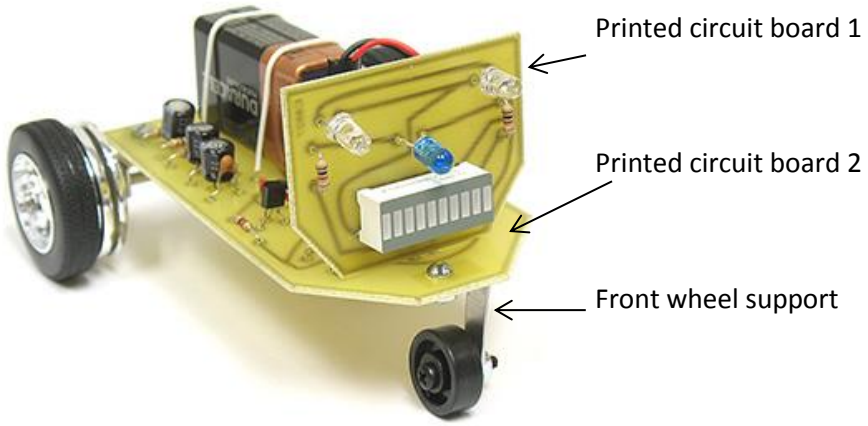
6. The robot shown below has been designed and made in a school workshop.



(a) (i) Evaluate the characteristics of printed circuit board (PCB) that makes it suitable for the main material for the robot. [4]

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(ii) Evaluate the suitability of acid-etching to produce the finished PCB. [4]

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Q7. (a) A modern calculator has been designed to appeal to new businesses.

A block diagram approach is often used when designing control systems.

In the space below complete a block diagram for the control system of the calculator and explain how this block diagram will support the designer to develop the control system for the calculator. [5]

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(b) The movable crane shown in the picture below is used to help technicians remove engines from cars.

(i) Describe the main forces acting on the named parts of the crane, when it is supporting the weight of an engine as shown in the picture [3]

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(ii) A technician extends the boom to its full length to lift an engine out of a car, and then moves the crane away from the front of the car so that the engine can be worked on.

Explain the effects that extending the boom and moving the loaded crane have on the forces acting upon the crane. [4]

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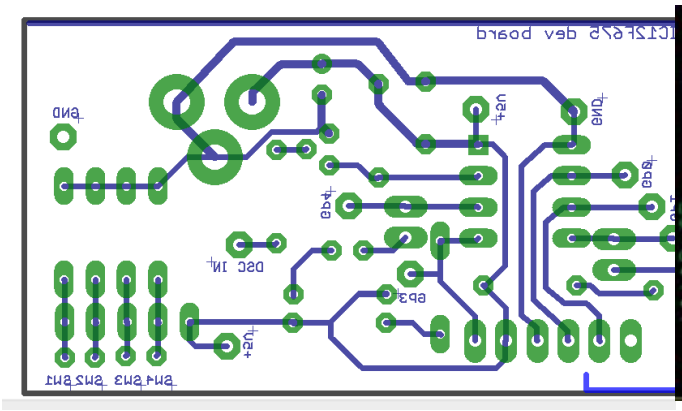
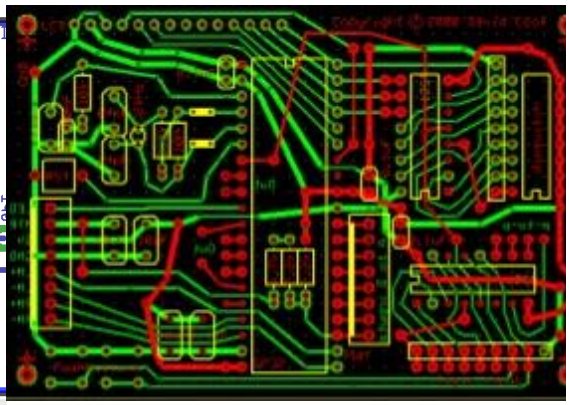
Q8. The images below show a printed circuit board (PCB) being designed using CAD.



CAD drawing A



CAD drawing B

(a) Explain why there are differently shaped green symbols in CAD drawing A and why CAD drawing B shows different coloured layers within the PCB. [4]

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(b) The image above shows PCBs being constructed using reflow soldering. Explain the stages involved in reflow soldering and the benefits to the manufacturer of using this method for constructing PCBs. [8]

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Q9. The angle-poise lamp shown below is considered a design classic.

(a) Identify two features of the lamp and discuss how they contribute towards making the lamp a design classic. 2 x [2]

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(b) Using the products shown below, discuss how historical influences can be seen in current product developments. [4]

	
Pocket Radio 1958	Apple range over time

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Q10. Design for maintenance can be a positive step taken by designers to reduce the environmental footprint of a product.

Analyse how designers consider issues such as maintenance, the environment and planned obsolescence on a solar lighting product that would be found in a garden or an open-air setting. [12]

Marks will be awarded for the content of the answer and the quality of written communication.

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For continuation only.

MARK SCHEME

Guidance for examiners

Positive marking

It should be remembered that learners are writing under examination conditions and credit should be given for what the learner writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Marks should not be deducted for a less than perfect answer if it satisfies the criteria of the mark scheme.

For questions that are objective or points-based the mark scheme should be applied precisely. Marks should be awarded as indicated and no further subdivision made.

Banded mark schemes

For band marked questions mark schemes are in two parts, the indicative content and the assessment grid.

The indicative content suggests the range of issues which may be included in the learner's answers. It can be used to assess the quality of the learner's response. Indicative content is **not** intended to be exhaustive and learners **do not** have to include all the indicative content to reach the highest level of the mark scheme.

In order to reach the highest levels of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that it contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

In Design and Technology, each question addresses one assessment objective: either AO3 or AO4. The assessment grid sub-divides the total mark to allocate for a question. These are shown in bands in the mark scheme. For each question, descriptors will indicate the different skills and qualities at the appropriate level.

Examiners should first read and place a tick in the learner's answer/s to indicate the evidence that is being assessed in that question; the mark scheme can then be applied. This is done as a two stage process.

Stage 1 – Deciding on the band

Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptors for that band. If the descriptors at the lowest band are satisfied, examiners should move up to the next band and repeat this process for each band until the descriptors match the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content.

Examiners should not seek to mark learners down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Design and Technology (Engineering Design)

MARK SCHEME

Question 1

		AO3	AO4	Mark
(a)	Describe three health and safety considerations when using the soldering iron to populate the printed circuit board safely and effectively.		✓	3
	*Answers that demonstrate an understanding of the health and safety issues of soldering should be awarded **1** mark for each consideration based on:* Clear identification of an appropriate health and safety consideration. Reduce the risk of burns by keeping the soldering iron in the holder when not in use. Candidates must identify health and safety considerations which may include: • Holding soldering iron correctly using handle and not touching tip • Using a well-ventilated area or extraction / avoid fumes inhalation • Use rosin-free / lead free solder **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Brief description of a health and safety consideration* ***1 mark*** *(1 mark for each consideration and description identified from above)*			
(b)	Produce a five step risk assessment for the student when using the equipment shown to make two 5mm holes in the corners of the printed circuit board.		✓	5
	*Answers that demonstrate an understanding of a five step risk assessment should be awarded **1** mark for each step based on:* Clear identification of correct risk assessment stage in the correct order: 1. Identify the risk or hazard that may cause harm. 1 2. Identify who may be at risk or harmed and how this may occur. 1 3. Assess the risks and take action, this may include steps to reduce the risks. 1 4. Record findings using appropriate documentation. 1 5. Review risks assessment regularly, especially if changes occur. 1 **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Brief description of a health and safety consideration* ***1 mark*** *(1 mark for each step identified in the correct order from above)*			
		Total		**8**

Question 2

		AO3	AO4	Mark
(a)	Explain the meaning of the CE mark included on this product.		✓	2
	Answers that demonstrate an understanding of the CE mark should be awarded up to 2 marks based on: French phrase "Conformité Européene" which literally means "European Conformity". This means the product is fit for purpose in the European market. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* CE mark means the product is fit for European market. ***1 mark*** *More detailed response* The letters "CE" are the abbreviation of the French phrase "Conformité Européene" which literally means "European Conformity". This means the product is fit for purpose in the European market. ***2 marks***			
(b)	Explain how the manufacturer of this product achieves the CE mark.		✓	2
	*Answers that demonstrate an understanding of the CE mark should be awarded up to **2** marks based on:* The manufacturer submits product for testing. Ensures product complies with all applicable European Directives and Regulations. Once successful, the product may bear the CE logo. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* CE mark is awarded once testing has been successful. ***1 mark*** *More detailed response* The manufacturer must submit the product for testing to ensure that the product complies with all applicable European Directives and Regulations. Once successful, the product may bear the CE logo. ***2 marks***			
(c)	Describe two benefits for the consumer of purchasing this product which includes the CE mark.		✓	4
	*Answers that demonstrate an understanding of the benefits for the consumer of including the CE mark on a product should be awarded up to **2** marks for each benefit based on:* • Consumers will know that manufacturers have checked that these products meet EU safety, health or environmental requirements. • Reassurance of a product's compliance with EU legislation. • Allows the free movement of products within the European market which might promote competition and lower purchase prices for consumers • The consumer is assured of the product's standard as a result of this approval. Consumers will know that the product is safe, fit for purpose and meets the applicable rules and regulations for this type of product. **Guidance to markers** *Incorrect / no answer* ***0 marks*** Simplistic or basic response The consumer knows that the product is safe for use. ***1 mark*** More detailed response The consumer is assured of the product's standard as a result of this approval. Consumers will know that the product is safe, fit for purpose and meets the applicable rules and regulations for this type of product. ***2 marks***			
		Total		**8**

Question 3

		AO3	AO4	Mark
(a)	The concept is intended to be innovative, stylish and minimalistic. Explain how this has been achieved.		✓	2
	*Answers that demonstrate an understanding of the stylish and minimalistic concept should be awarded up to **2** marks based on:* The concept looks very sophisticated in shape with a very elegant form. There are no buttons, so using touch-sensitive screen technology provides a clutter free interface for the user. Simple interfacing using wireless technology, contactless payments or ability to insert credit/debit cards into device. Small, slim line and pocket size product easy to carry for waiter / waitress to hand to customers. Similar to smart phones / tablet devices, similar 'style' in terms of aesthetics and also intended use. No tactile buttons, one large screen to view restaurant information reducing / minimising need for other items like menu, bill, receipt, etc. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* The concept is thin / slim and the screen is touch-sensitive. ***1 mark*** *More detailed response* The concept looks sophisticated in shape with an elegant form. There are no buttons, so using touch-sensitive screen technology provides a clutter free interface for the user. ***2 marks***			
(b)	Describe the type of information that this research would provide and explain how this information would be of value to the designer.		✓	4
	*Answers that demonstrate an understanding of the information provided and how this would be of value to a designer should be awarded up to **4** marks based on:* The information would provide numerical data on details of the body sizes / finger & hand measurements of the target market and help ensure the designer develops a product that is an appropriate size to suit the target market. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* The information provides details of body sizes of the target market. ***1 mark*** *Some detail addressing both aspects of the question* The information provides details of body sizes of the target market, so the designer can make sure the device is the right size. ***2 marks*** *Detailed response, possibly focussing more on one aspect of the question than the other* The information would be numerical data based on the size / measurements of hands / fingers of the target market so the designer can make sure the device is the right size. ***3 marks*** *A clear and detailed response addressing all aspects of the question* The information would be numerical data based on the size / measurements of hands / fingers of the target market so the designer can ensure the device is an appropriate size to suit, for example, the 95th percentile in the population. ***4 marks***			

(c)	Explain the main advantages to the designer of using computer aided design (CAD) and computer aided manufacture (CAM) during the development of the device.		✓	6
	*Answers that demonstrate an understanding of the benefits of using CAD and CAM during development should be awarded up to **6** marks based on:* • CAD can speed up the development process for the device as drawings and calculations can be produced and amended with ease. • CAD can be used to test ideas and to develop proposals by modifying ideas as required – often on-screen without having to go to the cost (or time) of producing a physical prototype. • CAD/CAM can be used to generate (via CNC) rapid prototypes where it is important to have physical models to test. • CAD can be used to provide clients with details of proposals / visuals so they can check proposals meet needs and expectations. • CAD files can be emailed – increasing efficiency during development if design and manufacturing facilities are not in the same location. • CAD files can be saved and accessed at different times / locations so many people (experts) can contribute to the work. **Guidance to markers** *Incorrect/no answer* ***0 marks*** *Brief explanation of the benefits of CAD and/or CAM to the designer during the development of the device.* ***1 - 2 marks*** *Satisfactory explanation of the benefits of CAD and CAM to the designer during the development of the device.* ***3 - 4 marks*** *Detailed explanation of the benefits of CAD and CAM to the designer during the development of the device.* ***5 - 6 marks***			
		Total		**12**

Question 4

		AO3	AO4	Mark
(a)	State a suitable scale of production for a cordless drill and explain why this is a suitable scale of production in this case.		✓	4

*Answers that demonstrate an understanding of a suitable scale of production for a cordless drill should be awarded up to **4** marks:*

Guidance to markers

Incorrect / no answer ***0 marks***

The most suitable scale of production is mass production ***1 mark***

Note – do not credit any other scales of production (for 1 mark) but if the explanation of suitability includes features that would also apply to mass production, credit may be given for that aspect of the response.

Mass production is the most suitable scale of production because:

Simplistic or basic response

Cordless drills are sold in thousands so no other scale of production could keep up with potential demand. ***1 mark***

More detailed response

Cordless drills are functional products that are often bought on price. A company making cordless drills using another scale of production, e.g. batch production, would need to sell the product at a high price and would not be competitive. ***2 marks***

Clear and detailed response

Cordless drills are functional products that are often bought on price. Mass production enables a company to benefit from economies of scale, and therefore to price their drill competitively. A drill is not a product that needs frequent updating, so the set-up costs for mass production can be spread over a long production run. ***3 marks***

(b)	The new cordless drill has been designed to have a built-in rechargeable battery, whereas the existing model is supplied with two removable batteries. Explain the implications of this change, for both the manufacturer and the end-user.		✓	8

*Answers that demonstrate an understanding of the implications of changing the design to include a built-in battery should be awarded up to **8** marks based on:*

Implications for the manufacturer

- There is no need to provide two batteries with the drill (case/packaging could be smaller).
- There is no need to provide a separate dock for charging the battery
- The design of the drill does not need to incorporate an 'off the shelf' battery shape (in the picture it is evident that this has allowed the manufacturer to design a more elegant handle).
- The position of the battery (and therefore its weight) is closer to the main body of the drill so the manufacturer has a better opportunity to consider the overall 'balance' of the drill in use.
- The manufacturer can specify a battery size/shape that uses up all the available space in the handle, maximising its output.
- The drill would need to be produced in high enough volumes to justify the design/production of a bespoke battery, otherwise costs could be very high.
- The manufacturer may be able to restrict the availability of batteries on the aftermarket (for maintenance and replacement) and make more profit from this aspect of the business.

Implications for the end user

- The drill may be more comfortable to use than the existing design,

where the weight of the battery acts at the base of the handle.

- There is less risk of improper charging of the battery (e.g. using the wrong docking station/charger).
- There is no need to store the separate battery and docking station.
- There is no opportunity to swap batteries over if one becomes discharged during extended operation.
- The user may have to charge the battery more often, with possible implications for longevity. (The candidate may explain this in terms of the end user being comfortable to start work with a partially discharged battery knowing they can easily swap over if it becomes exhausted in use. Without that opportunity, the end user might want to make sure the battery is fully charged before every task.)
- The end user may have to buy a replacement battery from the manufacturer, which could be more expensive than an off the shelf battery.
- The end user may have to take the drill to an authorised repairer to have the battery changed, which would add to cost (and possible inconvenience).

There is no requirement for the candidate to identify the same number of implications for the manufacturer and the end user, but to achieve a mark within band 3 or band 4 there should be a reasonable balance between the two. Do not credit the same point twice, e.g. *'the manufacturer can charge more for the battery'* and *'the battery will be more expensive for the customer'.*

Guidance to markers

No answer or no relevant issues described or discussed	0
• Basic description of the main issues associated with the question. • Little understanding of the implications of changing the design to include a built-in rechargeable battery, for either the manufacturer or the end user. • Limited use of terminology and technical language.	1-2
• Satisfactory explanation of the main issues associated with the question. • Some understanding of the main implications of changing the design to include a built-in rechargeable battery, for both the manufacturer and the end user, but possibly with a greater focus on one of these. • Satisfactory use of terminology and technical language.	3-4
• Good explanation of the issues associated with the question. • Clear understanding of the implications of changing the design to include a built-in rechargeable battery, for both the manufacturer and the end user. • Good use of terminology and technical language.	5-6
• Very good explanation of the issues associated with the question. • Clear and detailed understanding of the implications of changing the design to include a built-in rechargeable battery, for both the manufacturer and the end user. • Very good use of terminology and technical language.	7-8

Total	**12**

Question 5

		AO3	AO4	Mark
(a)(i)	Describe how the input to this system functions.		✓	2
	Answers that demonstrate an understanding of how the input functions should be awarded up to 2 marks based on: Infrared sensor (PIR sensor) has two sensing slots. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a *positive differential* change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are detected. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* A passive infrared sensor (PIR sensor) is an electronic sensor that measures infrared (IR) light from objects passing / near and uses this to switch on a device. ***1 mark*** More detailed response A passive infrared sensor (PIR sensor) has two sensing slots. When the sensor is idle, both slots detect the same amount of IR, the ambient amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a *positive differential* change between the two halves. When the warm body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are detected. ***2 marks***			
(ii)	Explain the reason for the components labelled 'T1' and 'T2'.		✓	2
	*Answers that demonstrate an understanding of transistors should be awarded up to **2** marks based on:* The two transistors are placed in a darlington pair arrangement. They activate the relay switch once the PIR sensor is triggered. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* T1 and T2 are transistors. Together they act as the 'process' and switch the load on. ***1 mark*** *More detailed response* The T1 and T2 are transistors placed in a darlington pair arrangement. They activate the relay switch once the PIR sensor is triggered. ***2 marks***			

(iii)	Explain using notes and sketches, how you would add a 240volt power supply and motor to the circuit above to control the doors.		✓	4
	*Answers that demonstrate an understanding of adding a power supply and motor to the circuit should be awarded up to **4** marks based on:* The relay has three connections. 1. The COM (common) needs to be connected to the +240V supply. 2. The NO (normally open) is connected to one side of the motor. 3. The NC (normally closed) is left free because this is when the relay is not magnetised (or off). 4. The motor symbol needs to be drawn correctly, with the +240V and -240V at either end. A mixture of sketches and text can be expected where candidates may draw on the circuit provided or redraft part of the circuit to show the 240V and motor. Annotations / explanations should support responses. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* One correct convention / connection only. Very little technical understanding applied. ***1 mark*** *Some detail* Two correct conventions / connections evident. Some technical knowledge applied correctly. ***2 marks*** *A detailed response* Three correct conventions / connections evident. Technical knowledge applied well to add a 240V supply and motor to the existing circuit diagram. ***3 marks*** *A clear and detailed response* Three correct conventions /connections evident to use the relay to activate a 240V power supply. A motor with diode is also drawn / added correctly. ***4 marks***			
			Total	**8**

Question 6

		AO3	AO4	Mark
(a)(i)	Evaluate the characteristics of printed circuit board (PCB) that makes it suitable for the main material for the robot.	✓		[4]
	Candidates are required to appraise and/or make judgements about why the PCB is a suitable material for the robot. The printed circuit board is used to make the body of robot because it is a lightweight and rigid material [1]. These two characteristics are essential for the robot because electronic circuits should not flex in case they affect current/ voltage flowing through the components [1] and the robot will need to be lightweight because the power source will lose energy if there is unnecessary weight [1]. Printed circuit board is easy to cut and shape and easy to drill for the components and fixings [1]. PCB board is specifically designed to produce conductive tracks for electronic circuits and is a quick and effective way of producing complex circuits diagrams [1]. **Guidance to markers** *Little or no understanding* ***0 marks*** *Basic appraisal and/or judgements of the suitability of PCB board for the body of the robot.* ***1 mark*** *Satisfactory appraisal and/or judgements of the suitability of PCB board for the body of the robot.* ***2 marks*** *Good appraisal and/or judgements of the suitability of PCB board for the body of the robot* ***3 marks*** *Very good appraisal and/or judgements of the suitability of PCB board for the body of the robot.* ***4 marks***			
(ii)	Evaluate the suitability of acid-etching to produce the finished PCB.	✓		[4]
	Candidates are required to appraise and/or make judgements about why acid-etching is a suitable production method for the PCB. Acid etching is quick and simple subtractive method of producing printed circuit boards for electronic components [1]. The process allows for complex circuits to be produced effectively [1]. The finished circuit once etched is easily cleaned and requires no further treatment [1]. It makes mass production cheaper than manually created boards [1]. Acid etching allows for more than one circuit to be produced at the same time [1]. Circuits can be very compact - the etched tracks replace wires and leads [1]. **Guidance to markers** *Little or no understanding* ***0 marks*** *Basic appraisal and/or judgements of the suitability of acid etching to produce PCBs.* ***1 mark*** *Satisfactory appraisal and/or judgements of the suitability of acid etching to produce PCBs.* ***2 marks*** *Good appraisal and/or judgements of the suitability of acid etching to produce PCBs.* ***3 marks*** *Very good appraisal and/or judgements of the suitability of acid etching to produce PCBs.* ***4 marks***			
			Total	**8**

Question 7

		AO3	AO4	Mark
(a)	In the space below complete a block diagram for the control system of the calculator and explain how this block diagram will support the designer to develop the control system for the calculator.		✓	5
	Guidance to markers *Up to 3 marks are available for a clear block diagram which identifies the three stages of input, process and output (1 mark for each stage). Up to 2 marks are available for a written response which demonstrates understanding of how this block diagram will support the designer to develop the control system, based on:* the block diagram breaks the control system down into smaller sub systems which can be dealt with in isolation by the designer, simplifying a complex system into multiple smaller ones. *Incorrect / no answer* ***0 marks*** *Correct response for each input/process/output* ***1 mark (x3)*** Input – process - output Key pad microprocessor LCD screen *Simplistic or basic response* The block diagram splits the system into smaller parts. ***1 mark*** *More detailed response* The block diagram breaks the control system down into smaller sub systems which can be dealt with in isolation by the designer, simplifying a complex system into multiple smaller ones. ***2 marks***			
(b)(i)	Describe the main forces acting on the named parts of the crane, when it is supporting the weight of an engine as shown in the picture		✓	3
	Guidance to markers *Incorrect / no answer* ***0 marks*** *Correctly described force for each of the named parts* ***1 mark*** *Award 0 marks for describing the force on any other parts of the crane* The extendable boom has a bending force acting upon it, due to the weight of the engine. ***1 mark*** The hydraulic ram has a compression/compressive force acting on it as the extendable boom is pressing down on the ram. ***1 mark*** The support has a tension/tensile force acting on it as the weight of the engine is trying to tip the boom in an anticlockwise direction. ***1 mark***			
(ii)	Explain the effects that extending the boom and moving the loaded crane have on the forces acting upon the crane.		✓	4
	Guidance to markers *Up to 2 marks are available for a developed response relating to both the effects of extending the boom and effects of moving the crane. In the mark scheme the effects are clearly separated into 'extending the boom' and 'moving the crane'. Candidates' responses may integrate these into a single paragraph. Look for reference to relevant points wherever they appear in the response as there is no requirement for candidates to structure their answer to reflect the mark scheme.* *Answers that demonstrate an understanding of the effect that lengthening the extendable boom has on both the boom itself and the hydraulic ram should be awarded up to **2** marks based on:* The boom experiences more bending and the hydraulic ram experiences more compression as the extendable boom is lengthened. **Guidance to markers** *Incorrect / no answer* ***0 marks***			

	Simplistic or basic response Extending the boom means that the bending force on it becomes greater as the weight of the engine acts further away from the support. ***1 mark*** *More detailed response* Extending the boom means that the bending force on it becomes greater as the weight of the engine acts further away from the point at which the hydraulic ram attaches to the boom. The compression force on the hydraulic ram is increased as there is a greater turning moment about the pivot point of the boom. ***2 marks*** *Answers that demonstrate an understanding of the effect of moving the crane should be awarded up to **2** marks based on:* The forces are static when the crane is still, however, when it is moved the forces become dynamic and different parts of the crane experience changes in forces. **Guidance to markers** *Incorrect / no answer* ***0 marks*** *Simplistic or basic response* The forces change as the crane is moved because they are no longer static. ***1 mark*** *More detailed response* The forces are static when the crane is still, however, when it is moved the forces become dynamic because the main load is suspended on a chain and it may swing front to back and/or side to side as the crane is moved away from the front of the car. ***2 marks***	
		Total 12

Question 8

		AO3	AO4	Mark
(a)	Explain why there are differently shaped green symbols in CAD drawing A and why CAD drawing B shows different coloured layers within the PCB.		✓	4

*Answers that demonstrate an understanding of the why there are differently shaped green symbols in the CAD drawing A should be awarded up to **2** marks and why CAD drawing B shows different coloured layers should be awarded up to **2** marks based on:*

The green symbols are PCB pads. This is where components will be soldered to the PCB. Different components have different size legs and different configurations so spaces and pads vary to cater for the components.

The different coloured layers show how double-sided PCBs are produced and the different colours are used to distinguish between the different sides.

Guidance to markers

Drawing A

Incorrect / no answer ***0 marks***

Simplistic or basic response

The green shapes are pads to solder different components. ***1 mark***

More detailed response

The green symbols are PCB pads. This is where components will be soldered to the PCB. Different components have different size legs and different configurations so spaces and pads vary to cater for the components. ***2 marks***

Drawing B

Incorrect / no answer ***0 marks***

Simplistic or basic response

The different coloured layers represent different sets of tracks on the PCB. ***1 mark***

More detailed response

The different coloured layers show how double-sided PCB are produced and the different colours are used to distinguish between the different sides of the PCB. ***2 marks***

(b)	The image above shows PCBs being constructed using reflow soldering. Explain in detail the stages involved in reflow soldering and the benefits to the manufacturer of using this method for constructing PCBs.		✓	8

Answers that demonstrate a clear understanding of the stages of reflow soldering and the benefits to the manufacturer.

Guidance to markers

Candidates may respond by explaining the relevant stages of the reflow soldering process and identifying a benefit of each stage to the manufacturer. Alternatively, they may explain the whole process of reflow soldering then move on consider the benefits of the process. Either of these approaches is acceptable – look for a reasonably balanced response between process and benefits and award a maximum of four marks if only one aspect is addressed in the response.

Reflow soldering – the main stages in the process are:

- Solder paste positioned onto PCB pads.
- Components are then added onto the solder paste.
- The solder paste is then heated and bonds the component to the PCB.
- PCBs are then cooled so that components are bonded to the PCB effectively.

Benefits to the manufacturer include:

- All / many components are positioned and passed through the heater soldering them into position at the same time. This is very efficient and increases productivity.
- Quality is high and consistent due to automation (pick and place machinery placing components in the correct positions repeatedly).
- Process is suitable for mass production / repeatability is exact due to little or no human involvement.
- More efficient (time and energy) than soldering by hand.
- Once set up, the costs of running this method are low when spread across PCBs produced in great volume.
  Very little waste created as reflow soldering uses the exact amount of solder paste required.

No answer or no relevant issues described or discussed	0
• Basic description of the main issues associated with the question. • Little understanding of the process of reflow soldering or the benefits to the manufacturer of using this method of construction for PCBs. • Limited use of terminology and technical language.	1-2
• Satisfactory explanation of the main issues associated with the question. • Some understanding of the process of reflow soldering and the benefits to the manufacturer of using this method of construction for PCBs. • Satisfactory use of terminology and technical language.	3-4
• Good explanation of the issues associated with the question. • Clear understanding of the process of reflow soldering and the benefits to the manufacturer of using this method of construction for PCBs. • Good use of terminology and technical language.	5-6
• Very good explanation of the issues associated with the question. • Clear and detailed understanding of the process of reflow soldering or the benefits to the manufacturer of using this method of construction for PCBs. • Very good use of terminology and technical language.	7-8

Total	**12**

Question 9

		AO3	AO4	Mark
(a)	Identify two features of the lamp and discuss how they contribute towards making the lamp a design classic.	✓		4

*Answers that demonstrate an understanding of the key features of the lamp that makes it a design classic should be awarded up to **2** marks based on:*
A design based on the human arm where a series of springs, cranks and levers combine to create a balanced and easily adjustable lighting platform evident in lamps since 1934 to today. The use of a subtle two tier base to provide additional weight without obtrusiveness. The two parallel bars used to create tension in the lower half of the lamp, allowing the desired position to be maintained. The use of springs to counteract each other and prevent movement. The symbolic lamp shade, able to rotate / adjust as desired.
The cable is neatly fitted within the structure.

Guidance to markers
Incorrect / no answer ***0 marks***
Simplistic or basic response
The shape of the lamp with the ability to be adjusted to a variety of different heights / positions. ***1 mark***
More detailed response
A design based on the human arm where a series of springs, cranks and levers combine to create a balanced and easily adjustable lighting platform evident in lamps since 1934 to today. ***2 marks***

		AO3	AO4	Mark
(b)	Using the products shown below, discuss how historical influences can be seen in current product developments.	✓		4

*Answers that demonstrate an understanding of the historical influences seen in current product developments should be awarded up to **4** marks based on:*

Guidance to markers
Incorrect / no answer ***0 marks***
Brief description with little detail in the historical influences
The Apple iPod/watch range reflects the same shapes as the Braun radio with circles, squares and rectangles. ***1 mark***
Brief description with some explanation of the historical influences
The Apple iPod reflects the use of geometric shapes in much the same way as the Braun radio. The overall size, shape and proportions are very similar clearly linked to Braun's product produced sixty years ago. ***2 marks***

Some detailed descriptions and analysis of historical influences
The Apple iPod/watch range has clear similarities with the Braun Radio from 1958. The overall rectangular shape has been maintained, giving a clean, crisp and minimalistic feel. The iPod retains the circular selector feature which was an analogue dial on the radio, but is now a digital touch sensitive wheel. Yet they are very similar interfaces between user and product. The iPod has a full colour screen, but this replaces the square speaker from the radio, with both features being an output of both products. ***3 marks***

Fully detailed description and analysis of historical influences
The Apple iPod/watch range has clear similarities with the Braun Radio from 1958. The overall rectangular shape has been maintained, giving a clean, crisp and minimalistic feel. The iPod retains the circular selector feature which was an analogue dial on the radio, but is now a digital touch sensitive wheel. Yet they are very similar interfaces between user and product. The iPod has a full colour screen, but this replaces the square speaker from the radio, with both features being an output of both products. The colour scheme has remained almost identical and the sharp use of silver grey is enhanced by subtle and

	simplistic decals. It is clearly evident that Jonathan Ive was inspired by Dieter Rams and his work when developing the iPod range. ***4 marks***	
	Total	**8**

Question 10

		AO3	AO4	Mark
	Analyse how designers consider issues such as maintenance, the environment and planned obsolescence on a solar lighting product that would be found in a garden or an open-air setting.	✓		12

- Lighting system would need to last the life of the product if the designer has made it a sealed system – Typical design obsolescence.
- If access is mentioned to change the lighting system the product must have some form of flexible seal to prevent rain/water entering the inside of the lighting product. Also to gain access could mean damaging the product. - Maintenance issue.
- The material used in the product should require no finishing or upkeep
- The material would need to be long lasting corrosion/weather.
- The material ideally would be made from recycled materials to address green/environmental issues. - Recycling in a positive way and reduce the need for materials from natural resources. - Recycled composite plastics.
- The solar lighting product can be positioned more flexibly in a garden/open air setting or in isolated areas where the user would not need to run mains power.
- The solar panels would need to be wiped clean.
- The solar lighting product system will mean there is no need for any cabling / copper wires.
- Using a solar system will mean no running costs to the consumer one the product is bought. - Keep energy costs / household bills down because it is not connected to national grid.
- There is no need for control components such as switches because the solar panel will illuminate the lamp in dark conditions automatically. – LDR built into solar panel.
- Solar lighting systems provide a green and sustainable method of outdoor illumination.
- There would need to be some form of guarantee by the manufacture, for example stating that the product would last for 'x' numbers of years, if the bulb is eliminating light for 'x' numbers of hours per day.
- Planned obsolescence is often seen as a negative point with respect to environmental issues, the designer may have tried to change this into a positive point of view by using recycled materials and a natural source of energy. Marketing point for the product.

	Guidance to markers You may award 1 mark for a relevant point within the essay or two marks if the point has been justified.	
	No answer or no relevant issues described or discussed.	0
	Simple description of two of the three issues within the question. Little, if any, understanding of the real issues of maintenance, the environment and planned obsolescence. Quality of Written Communication is limited, presenting material with limited coherence, many errors of grammar, punctuation and spelling.	1-3
	Some description of two of the three issues within the question. Some understanding of the real issues of maintenance, the environment and planned obsolescence. Quality of Written Communication is basic, presenting occasionally appropriate material with some coherence, some errors of grammar, punctuation and spelling.	4-6
	Description of the three issues within the question. Clear understanding of the issues of maintenance, the environment and planned obsolescence. Quality of Written Communication is good, presenting mainly appropriate material in a coherent manner, few errors of grammar, punctuation and spelling.	7-9
	Clear description of each of the issue within the question. Detailed understanding of the issues of maintenance, the environment and planned obsolescence. Quality of Written Communication is excellent, presenting wholly appropriate material in a coherent and logical manner, hardly any errors of grammar, punctuation and spelling.	10-12
	Total	**12**