



GCSE MARKING SCHEME

SUMMER 2022

**GCSE
DESIGN AND TECHNOLOGY –
ENGINEERING DESIGN
3601U10-1**

INTRODUCTION

This marking scheme was used by WJEC for the 2022 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

WJEC GCSE DESIGN AND TECHNOLOGY – ENGINEERING DESIGN

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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 points and 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 level 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 is, 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

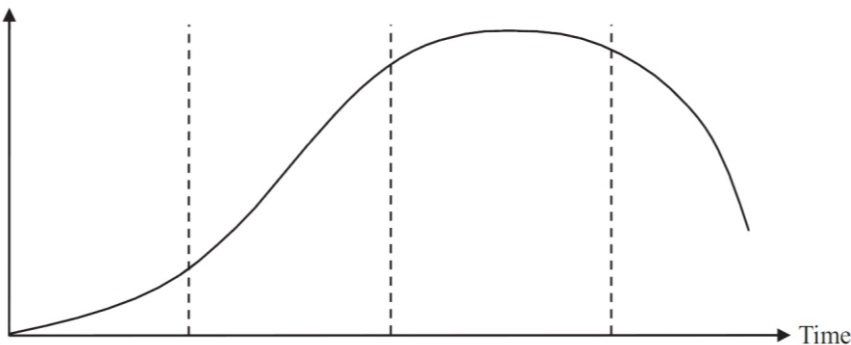
During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner.

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.

Question 1				
Study the photo below. The glass bottles have been recycled to become roof insulation.		AO3	AO4	Mark
(a)	Explain an environmental advantage of recycling the glass bottles into roof insulation.		✓	2
<p><i>Answers that indicate an understanding of sustainability should be awarded up to 2 marks based on:</i></p> <p><i>Waste does not go to landfill.</i> <i>Broken or mixed colour glass can have a second useful lifespan.</i> <i>The insulation will reduce energy use in household requirements.</i> <i>Insulation will result in lower greenhouse gas emissions.</i></p> <p>Accept any other appropriate answer relating to advantageous ecological impact.</p> <p>Guidance to markers</p> <p>Incorrect / no answer 0</p> <p>Basic explanation e.g. No glass will end up in rubbish tip. 1</p> <p>More detailed explanation e.g. The insulation will reduce greenhouse gases because a house will have lower heating requirement and the material is recycled and reused with a different useful function. 2</p>				
(b)	A laptop computer has an aluminium case. The raw aluminium ore is sourced from South America, then processed and manufactured in China to be sold in the United Kingdom (UK).		✓	2
(i)	Describe one benefit this has for UK consumers.			
<p><i>Answers that indicate an understanding of benefits this has for UK consumers should be awarded up to 2 marks based on:</i></p> <p><i>The main benefit is the selling price to the consumer this is going to be reduced. Students could discuss:</i></p> <ul style="list-style-type: none"> • Developing countries have lower wage costs. • Lower production costs. • Transportation costs of the ore are lower due geographic location ie. Closer to China than the UK. <p>Guidance to markers</p> <p>Incorrect/inappropriate / no answer. 0</p> <p>Brief description of one impact e.g. The laptop will be cheaper for UK consumers. 1</p> <p>More detailed description e.g. The laptop will be cheaper for UK consumers due to the lower cost of production in China. 2</p>				

(ii)	Describe why the laptop has a high carbon footprint.		✓	2
<p>High carbon footprint is the amount of harmful gases that are released into our atmosphere. - primarily carbon dioxide</p> <p>Main causes of carbon footprint</p> <ul style="list-style-type: none"> • Transportation • Electricity generation • Industrial processes and activities <p>Guidance to markers</p> <p>Incorrect/inappropriate / no answer. 0</p> <p>Brief description of one impact e.g. The laptop will be mass produced which will cause a high carbon footprint. 1</p> <p>More detailed description e.g. The laptop will be mass produced which will cause a high carbon footprint and the cost of transporting the laptop to the UK will increase the carbon footprint. 2</p>				
(c)	Explain how a manufacturer could produce the aluminium laptop for the UK market in a more sustainable way.		✓	4
<p>Answers that indicate an understanding of environmental responsibilities in designing and making products should be awarded up to 4 marks based on:</p> <ul style="list-style-type: none"> • Reducing transportation • Using recycled materials • Energy used to extract aluminium from ore is much higher than energy needed to recycle. • Using zero waste/closed loop manufacturing systems (eg mac mini bodies made from iphone waste.) <p>No answer or no relevant information presented or discussed. 0</p> <p>Brief description: e.g. The manufacturer could use recycled aluminium. 1</p> <p>More detailed response eg. The manufacturer could use recycled aluminium. The manufacturer could reduce transportation implications by relocating manufacturing to the UK. 2</p> <p>Detailed response somewhere between examples above and below. The manufacturer could use recycled aluminium which requires much less energy to reprocess compared to extracting aluminium from its bauxite ore. The manufacturer could reduce transportation implications by relocating manufacturing to the UK next this would reduce transportation costs. The manufacturer could offer incentives to UK consumers to recycle their product at the end of its life cycle. 3</p>				

	<p>Fully detailed response eg. The manufacturer could use recycled aluminium which requires much less energy to reprocess compared to extracting aluminium from its bauxite ore. The manufacturer could reduce transportation implications by relocating manufacturing to the UK. A highly automated, efficient UK manufacturing facility maybe cost competitive with a Chinese one once transportation costs are eliminated. The Aluminium could be sourced from recycled cans in the UK. The manufacturer could offer incentives to UK consumers to recycle their product at the end of its life cycle. The product could be designed for disassembly/ end of life/ circular design philosophy.</p>	4
Total		10

Question 2								
The graph below shows a product life cycle.		AO3	AO4	Mark				
(a)	Label the FOUR stages of a product life cycle in the table below.		✓	4				
<p>Guidance to markers</p> <p><i>Incorrect / no answer. 0 marks</i></p> <p>Introduction. 1 mark Growth 1 mark. Maturity 1 mark. Decline 1 mark.</p>  <table border="1" data-bbox="327 1055 1182 1122"> <tr> <td>introduction</td> <td>growth</td> <td>maturity</td> <td>decline</td> </tr> </table>		introduction	growth	maturity	decline			
introduction	growth	maturity	decline					
(b)	The graph below shows the product life cycle for two different products. Match the curve to the appropriate product by writing A or B in the correct box below.		✓	2				
<p>Answers that indicate an understanding of product life cycle should be awarded up to 2 marks based on:</p> <p>Guidance to markers</p> <p>Incorrect/no answer. 0</p> <p>Fidget spinner matches curve A 1</p> <p>Smart watch matches curve B 1</p>								

(c)	Explain what is involved in a LIFE CYCLE ANALYSIS when bringing new products to the market.		✓	4
<p>Answers that indicate an understanding of Life Cycle Analysis should be awarded up to 4 marks based on:</p> <p>A Life Cycle Analysis is a cradle to grave analysis of the total impact of a product throughout its life. The amount of water, CO₂, energy, particulate emissions etc. used in extraction of raw materials, processing of materials, manufacture, assembly, transportation, use of product and end of life/recycling must be fully considered to determine if a product is sustainable.</p> <p>Guidance to markers</p> <p>Incorrect/no answer. 0</p> <p><i>Brief explanation e.g.</i> The energy use of the product must be considered throughout its life. 1</p> <p><i>Explanation with some detail e.g.</i> The total impact of the product must be considered from cradle to grave such as how much energy it uses. 2</p> <p><i>More detailed description e.g.</i> The total impact of the product must be considered from cradle to grave such as how much energy it uses including transportation, manufacturing and use during the product's life. 3</p> <p><i>Fully detailed description of an appropriate method e.g.</i> The total impact of the product must be considered from cradle to grave such as how much energy, water, CO₂, damaging emissions and toxic chemicals it uses including transportation, manufacturing and use during the product's life and at the end of the product's useful life. 4</p>				
Total				10

Question 3				
The table below shows different energy sources.		AO3	AO4	Mark
(a)	Complete the table below by stating whether the energy source is renewable or non-renewable.		✓	4
	<p>Answers that indicate an understanding of renewable and non-renewable resources energy sources should be awarded up to 4 marks based on:</p> <p>Guidance to markers</p> <p><i>Incorrect / no answer.</i></p> <p><i>Correctly identify renewable/non-renewable status.</i></p> <p><i>Coal non-renewable</i></p> <p><i>Nuclear non-renewable</i></p> <p><i>Solar renewable</i></p> <p><i>Wind renewable</i></p>			0
				1
(b)	Describe ONE advantage for EACH energy source.		✓	8
	<p>Guidance to markers</p> <p><i>Answers that consider the following points should be awarded up to 2 marks each.</i></p> <p><i>COAL Advantage: High energy density/calorific value/ can be used on demand, established infrastructure, independent of weather conditions.</i></p> <p><i>Nuclear Advantage: can be used on demand/ clean/non-polluting, independent of weather conditions.</i></p> <p><i>Solar Advantage: non-polluting / short payback or return on investment period</i></p> <p><i>Wind Advantage: non-polluting/ short payback or return on investment period, highly sustainable, efficient in appropriate locations such as windy hilltop and offshore locations where there is a steady, consistent wind</i></p> <p><i>Incorrect/no answer.</i></p> <p><i>Brief explanation e.g.</i> Coal is a cheap energy source.</p> <p><i>Explanation with some detail e.g.</i> Coal is cheap and when burnt can produce a high energy source.</p>			0
				1
				2

(c)	Explain why solar panels are not yet widely used on electric cars.		✓	3
<p>Guidance to markers</p> <p>Incorrect/no answer. 0</p> <p>For each appropriate answer. 1</p> <ul style="list-style-type: none"> ● Solar panels add additional cost to the vehicle which may already be expensive. ● Solar panels won't charge cars fast enough currently. ● The technology is insufficiently developed currently. ● Solar panels are currently only capable of trickle charging cars. ● Unsuitable parking to sufficiently charge solar panels e.g parking in shaded areas, in a garage, covered car parks. ● The weight of the panels could hinder the vehicles performance. ● Fragility of the solar panels; in a crash this could result in more expensive repairs to a vehicle. <p>Accept any other valid reason.</p> <p>Solar panels are a good source of energy, but the quality and the energy produced is not great enough to be able to move an electric car efficiently today. The energy produced will only trickle charge a battery and not great enough to drive a motor to move a car.</p>				
Total				15

Question 4				
Apple is a leading technology company. Apple regularly uses aluminium for the case or body on its products.		AO3	AO4	Mark
(a)	Describe TWO properties of aluminium that make it suitable for the body or casing of Apple products.		✓	4
<p><i>Answers must that indicate an understanding of two different properties of Aluminium.</i></p> <p>Advantages Aluminium has a good strength to weight ratio. Aluminium can be anodised to give a coloured surface finish. Aluminium can be machined/polished to a luxurious surface finish. Aluminium can be machined very well. Aluminium can be recycled very efficiently. Aluminium has good resistance to corrosion.</p> <p>Guidance to markers</p> <p>No answer or no relevant information presented or discussed. 0</p> <p><i>Brief description e.g.</i> Aluminium is very strong and would make a good body casing. 1</p> <p><i>More detailed response e.g.</i> Aluminium is very strong for its weight, meaning the body casing will be stronger than a similar modern composite plastic design. 2</p> <p>Accept any appropriate answer.</p>				

(b)	Apple occasionally releases special edition products such as the 'RED' phone.		✓	3
(i)	Explain why the 'RED' phone would be batch produced.			
<p>Batch manufacturing is appropriate where an order for a limited number of similar products is placed by a client. Eg. British Airway may order 10 A350 planes which may be very similar yet sufficiently different from the 10 A350 planes that Quantas order to make them as separate batches.</p> <p>Market forces: market pull - the customer expects companies to produce special edition products.</p> <p>Manufacturing the product for a 'limited' time period.</p> <p>Guidance to markers</p> <p>Incorrect/no answer 0</p> <p><i>Brief description e.g.</i> Batch production is where a small number of identical products is manufactured 1</p> <p><i>More detailed response e.g.</i> Batch production is where a small number of identical products is manufactured. Jigs and template maybe used to improve or speed up work. 2</p> <p><i>Fully detailed response e.g.</i> Batch production is a small to medium level production system that includes some automation and repetition efficiencies that improve upon bespoke manufacture yet lack the full efficiencies of mass or continuous flow production. 3</p>				
(ii)	Components for the manufacturing of the 'RED' phone are ordered using JIT (Just In Time). Explain the term 'Just In Time'.		✓	3
<p>Just in Time is a term used in manufacturing and involves reducing stock/inventory and the amount of money tied up in the stock. It also reduces the need for large storage facilities. It relies on efficient ordering systems that ensure parts for production arrive when needed.</p> <p>Guidance to markers</p> <p>Incorrect/no answer 0</p> <p><i>Brief description e.g.</i> Parts are delivered only when needed 1</p> <p><i>More detailed response e.g.</i> Parts are delivered only when needed which make the manufacturing more efficient. 2</p> <p><i>Fully detailed response e.g.</i> Parts are delivered only when needed using efficient ordering systems with reliable manufacturing suppliers/partners which make the manufacturing more efficient and cost effective, reducing stock and inventory issues and increasing quality 3</p>				

(c)	<p>Analyse how Apple has developed innovative technologies and products. Historical and current innovation should be discussed together with comparisons to its major competitors.</p> <p>Marks will be awarded for the content of the answer and the quality of written communication.</p>	✓		10
<p>Answers that indicate an understanding of the Apple company should be awarded up to 10 marks based on:</p> <ul style="list-style-type: none"> • <i>Simple elegant design</i> • <i>One of first to target consumers for computers instead of corporates</i> • <i>They started company in a garage designing and making the first mac.</i> • <i>Wozniak was the engineer/ designer for original Mac computer with jobs primarily marketing and selling.</i> • <i>Jobs left apple to develop NEXT computers</i> • <i>The OS jobs developed at NEXT developed into MAC OS X when Jobs returned to apple.</i> • <i>Apple was nearly bankrupt when jobs returned. Finance from Microsoft saved Apple.</i> • <i>Jony Ive and Jobs developed a strong rapport almost immediately and began work on the first IMac</i> • <i>The iMac was a step change in PC design: first use of translucent and coloured plastics etc.</i> • <i>OS X became the first Unix based version of MAC OS. It used an open source kernel darwin based on BSD unix.</i> • <i>The iPhone was another revolutionary product, effectively decimating competitor such as Nokia and RIM/blackberry within a few years.</i> • <i>The combination of touch screen /GUI design/ camera made it a market leader in a short space of time.</i> • <i>Apple spotted potential for profitability based on premium product marketing, with profit margins that competitors could not match.</i> • <i>High resolution displays</i> • <i>AI chips</i> • <i>64 bit phone processors beginning to match desktop processor power.</i> • <i>Security chips and face recognition</i> <p><i>This is a non-exhaustive list of possible points. Examiners should accept any valid points relating to the history and innovations at apple.</i></p> <p>Guidance to markers</p> <p>Incorrect/no answer. 0</p> <p>Brief analysis with little detail of the history and innovations of Apple. Quality of Written Communication is limited, presenting material with limited coherence, many errors of grammar, punctuation and spelling. e.g. One or two point from the above list conveyed in a very simple fashion. See list above. 1-2</p> <p>More detailed analysis, with some explanation and detail of the history and innovations of Apple influence. Quality of Written Communication is basic, presenting occasionally appropriate material with some coherence, some errors of grammar, punctuation and spelling. e.g. Several (3-4 points) conveyed in a simple fashion. See list above. 3-4</p>				

	<p>Detailed analysis and explanation of the history and innovations of Apple. Quality of Written Communication is good, presenting mainly appropriate material in a coherent manner, few errors of grammar, punctuation and spelling. e.g. A good range of points conveyed clearly and well. See list above.</p> <p>Clear and detailed analysis and explanation of the history and innovations of Apple. Quality of Written Communication is excellent, presenting wholly appropriate material in a coherent and logical manner, hardly any errors of grammar, punctuation and spelling. e.g. Many points conveyed articulately (8 or more) See list above.</p>	<p>5-7</p> <p>8-10</p>
	Total	20

Question 5				
A games controller contains electrical and mechanical components.		AO3	AO4	Mark
(a)	A commercially produced printed circuit board (PCB) may require a protective solder mask or solder resist. Explain why this protective surface finish is required within the context of a commercial soldering process.		✓	5
	<ul style="list-style-type: none"> Solder resist stop the solder going where it should not. Prevents oxidation of the copper tracks. Could be used with reflow or wave commercial processes. <p>Guidance to markers</p> <p>No answer or appropriate response</p> <p>Simplistic response. Limited understanding evident. E.g. Solder resist stop the solder going where it shouldn't.</p> <p>Some explanation and understanding evident E.g. Solder resist stop the solder going where it shouldn't and prevents oxidation of the copper tracks. Could be used with reflow or wave commercial processes</p> <p>Clear evaluations with detailed reasoning. Detailed understanding evident. E.g. Solder resist is a surface finish which prevents solder flowing onto or bonding to particular areas of the PCB. A commercial process such as wave soldering, where a "wave" of molten solder flows across an entire circuit board indiscriminately, require solder resist to prevent solder sticking where it may cause a short circuit. It also prevents oxidation of the metal circuit.</p>			0 1 2-3 4-5
(b)	Study the two images of prototype printed circuits boards shown below.			
(i)	Describe why copper is used for the solder side of the PCB.		✓	2
	<p>Good conductor Can be easily soldered. Easily dissolved using appropriate chemicals to leave a track.</p> <p>Guidance to markers</p> <p>No answer or appropriate response</p> <p><i>Copper is a good conductor</i></p> <p><i>Copper is a good conductor and when soldered correctly, can make a good conductive joint between the component and the board</i></p>			0 1 2

(ii)	Name a suitable material for the component side of the PCB and discuss a physical property that makes it appropriate.		✓	3
<p>Guidance to markers</p> <p>Name of material:</p> <p>No answer or appropriate response 0</p> <p><i>Candidates should be awarded 1 mark for naming an appropriate material:</i> fiberglass/epoxy resin OR paper reinforced phenolic resin 1</p> <p><i>Candidate's response will need to address the physical properties of glass reinforced epoxy or paper reinforced phenolic resin as a material for the PCB:</i></p> <p>Physical properties:</p> <p>Epoxy or phenolic boards: excellent electrical insulator/ higher electrical resistance</p> <p>enough thermal degradation resistance to withstand soldering process.</p> <p>Guidance to markers</p> <p>No answer or no appropriate answer 0</p> <p>Answer explaining 1 key point from above E.g. The epoxy board has excellent electrical insulation. 1</p> <p>Answer explaining 2 key points from above E.g. The epoxy board has excellent electrical insulation as well as the required thermal resistance to withstand soldering. 2</p>				

(c)	Evaluate the process of soldering a prototype PCB within a typical school workshop environment in comparison with commercial processes.	✓		5												
Candidate's response will need to address the comparison between commercial and workshop-based practise.																
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th data-bbox="327 421 826 510" style="width: 50%;">School (typically soldering iron)</th> <th data-bbox="826 421 1300 510" style="width: 50%;">Commercial (typically reflow or wave machines)</th> </tr> </thead> <tbody> <tr> <td data-bbox="327 510 826 577">Low cost</td> <td data-bbox="826 510 1300 577">High cost</td> </tr> <tr> <td data-bbox="327 577 826 667">Requires manual dexterity and skill</td> <td data-bbox="826 577 1300 667">Highly automated requiring little human intervention</td> </tr> <tr> <td data-bbox="327 667 826 734">Slow process</td> <td data-bbox="826 667 1300 734">Fast process</td> </tr> <tr> <td data-bbox="327 734 826 824">Variable quality based on human skill/tiredness etc</td> <td data-bbox="826 734 1300 824">Highly consistent controlled processes with consistent quality</td> </tr> <tr> <td data-bbox="327 824 826 884">Highly Adaptable</td> <td data-bbox="826 824 1300 884">Slow/expensive to adapt process</td> </tr> </tbody> </table>					School (typically soldering iron)	Commercial (typically reflow or wave machines)	Low cost	High cost	Requires manual dexterity and skill	Highly automated requiring little human intervention	Slow process	Fast process	Variable quality based on human skill/tiredness etc	Highly consistent controlled processes with consistent quality	Highly Adaptable	Slow/expensive to adapt process
School (typically soldering iron)	Commercial (typically reflow or wave machines)															
Low cost	High cost															
Requires manual dexterity and skill	Highly automated requiring little human intervention															
Slow process	Fast process															
Variable quality based on human skill/tiredness etc	Highly consistent controlled processes with consistent quality															
Highly Adaptable	Slow/expensive to adapt process															
Guidance to markers																
No answer or no evaluation				0												
Simplistic evaluation, limited understanding evident. Soldering in a school workshop will be much cheaper compared to the costly commercial machines.				1												
Some evaluation evident. Some understanding evident. The cost for school soldering equipment is very low in comparison to the cost involved in wave soldering or reflow soldering. A typical school soldering iron requires a skilled human operator and is generally a slow process compared to an automated high-speed process such as wave soldering. Quality will be less in a school workshop.				2-3												
Clear evaluations with detailed understanding evident. The cost for school soldering equipment is very low in comparison to the cost involved in wave soldering or reflow soldering. A typical school soldering iron requires a skilled human operator and is generally a slow process compared to an automated high-speed process such as wave soldering. Quality will vary in a school workshop, depending upon the student's skill with a soldering iron, whereas a wave soldering machine will produce highly consistent quality assured results once calibrated correctly.				4-5												

(d)	Mechanical properties must be considered when selecting materials for the body/case of the games controller. Evaluate the mechanical material properties required.	✓		5
<p>Tensile strength: the material must be sufficiently strong to withstand the static forces placed up the device. Unnecessarily strong materials result in an over engineered and overly expensive design.</p> <p>Toughness The material must be able to absorb energy without breaking when dropped for example. An insufficiently tough material will break on impact causing the electronics inside to be damaged.</p> <p>Plasticity Is essential to enable the complex 3D form of the case to be moulded.</p> <p>Hardness is the resistance of a material to localized deformation.</p> <p>Insulated material ensures that the PCB and any other electronics do not short circuit resulting in device failure.</p> <p>Malleability would be a property to avoid in the case material. You would not want it to plastically deform under force.</p> <p>Accept any other appropriate answer relating to mechanical properties.</p> <p>Guidance to markers</p> <p>No answer or no evaluation. 0</p> <p>Simplistic evaluation, limited understanding evident. E.g. The material needs to be strong enough for the forces applied 1</p> <p>Some evaluation evident. Some understanding evident. E.g. The material needs to be strong enough for the forces applied and have sufficient toughness to absorb energy when dropped. 2-3</p> <p>Clear evaluations with detailed understanding evident. E.g. The material needs to be strong enough for the forces applied and have sufficient toughness to absorb energy when dropped. It must have sufficient hardness to withstand localised impacts such as being hit by a coin. It must also have sufficient plasticity to be moulded into the shape of the case. 4-5</p>		Total		20

Question 6				
An automatic door system is shown below. A programmable control system that operates the door. The system has an INFRARED SENSOR which senses a person's body heat. The INFRARED SENSOR is 'on' when a person stands in front of it. The INFRARED SENSOR is 'off' when no one is in front of the sensor.		AO3	AO4	Mark
(a) (i)	Explain why a flowchart could be used when programming the control system.		✓	2
	No answer or incorrect answer.			0
	Simplistic answer, limited understanding evident. E.g. A flowchart is easier for beginners to program.			1
	Clear answer and clear understanding evident. E.g. A flowchart is an easier graphical method to visualise the programming problem. Simulation of flowchart aids understanding of how program function/performs.			2
(ii)	Explain ONE advantage of using a macro or subroutine when programming.		✓	2
	<ul style="list-style-type: none"> • The subroutines break up complex programs. • Subroutines are easier to change/edit than a whole program. • Enables the reuse of code to make a programme smaller/more efficient. <p>Guidance to markers</p> <p>Incorrect/no answer</p>			0
	Simplistic answer, limited understanding evident. E.g. The advantages of a subroutines include breaking a complex programming task into simpler steps.			1
	Clear answer and clear understanding evident. E.g The advantages of subroutines include breaking complex programming task into simpler steps and enabling reuse of code to make the program smaller/more efficient.			2

(iii)	Draw a block diagram for the automatic door system in the space below.		✓	4						
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; text-align: center; padding: 5px;">INPUT</td> <td style="width: 33%; text-align: center; padding: 5px;">PROCESS</td> <td style="width: 33%; text-align: center; padding: 5px;">OUTPUT</td> </tr> <tr> <td style="text-align: center; padding: 5px;"> <div style="border: 1px solid black; width: 80%; margin: auto; padding: 5px;">Infrared sensor</div> </td> <td style="text-align: center; padding: 5px;"> <div style="border: 1px solid black; width: 80%; margin: auto; padding: 5px;">Controller</div> </td> <td style="text-align: center; padding: 5px;"> <div style="border: 1px solid black; width: 80%; margin: auto; padding: 5px;">Motor</div> </td> </tr> </table> <p>Guidance to markers</p> <p>Incorrect/no answer 0</p> <p>One mark for correctly labelling(order) INPUT/PROCESS/OUTPUT 1</p> <p>One mark for each correct component: see diagram above. 1</p>					INPUT	PROCESS	OUTPUT	<div style="border: 1px solid black; width: 80%; margin: auto; padding: 5px;">Infrared sensor</div>	<div style="border: 1px solid black; width: 80%; margin: auto; padding: 5px;">Controller</div>	<div style="border: 1px solid black; width: 80%; margin: auto; padding: 5px;">Motor</div>
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(iv)	Explain why a designer or engineer might use a block diagram.		✓	2						
<p>Answers that indicate an understanding of the function of a block diagram.</p> <p>Guidance to markers</p> <p>Incorrect / no answer 0</p> <p>Brief reason e.g. It's a simple way to visualise the circuit 1</p> <p>More detailed reason e.g It's a simple way to visualise the circuit before the next stage of designing a circuit diagram. 2</p>										

(b)	Complete the flowchart for the automatic door below by adding in correct statement and missing feedback loops <i>Note: do not write the subroutines themselves.</i>		✓	9
<p>Award 1 mark for each correct loop and programming statement. See diagram below.</p> <p>Award 1 mark for each programming statement (up to 4)</p> <p>Award 1 mark for each program correct YES/NO loop (up to 4)</p> <p>Award 1 mark for closing the program loop so it continues to repeatedly function.</p> <p>NB. Candidates should be awarded marks if wording is slightly different however, implies the same e.g. is sensor active?, sensor, infrared sensor.</p> <p>Marks should be rewarded if the flowchart would work with the correct terminology e.g. loops in different location.</p>				

(c)	The mechanical system used in the automatic door is shown below.		✓	1																												
(i)	State the correct name of the gear system shown.																															
Guidance to markers																																
Incorrect / no answer				0																												
Rack and Pinion				1																												
(ii)	The diagram below shows the Spur Gear with a radius of 65 mm. Calculate the distance in mm the door will move in one rotation of the gear.		✓	3																												
Circumference of a circle = $\pi \times \text{diameter}$				1																												
<i>Radius= 65 therefore, diameter = 65 x 2 = 130</i>																																
Circumference of a circle = 3.142 x 130				1																												
3.142 x 65 (reward 1 mark ONLY for $\pi \times \text{radius}$)																																
Circumference of a circle = 408.46 mm																																
<i>Accept answers that are close to this figure. (22/7 x 130 = 408.57)</i>				1																												
<i>You must allow for technical calculators which have a higher degree of accuracy for π.</i>																																
(iii)	The table below shows a parts list for the automatic door. Calculate the total cost and the total inclusive of 20% VAT.		✓	2																												
Allocate 1 mark for each correct calculation, up to 5 marks. See table below.																																
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