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# **GCSE MARKING SCHEME**

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**SUMMER 2019**

**DESIGN AND TECHNOLOGY - UNIT 1  
ENGINEERING DESIGN  
3601U10-1**

## **INTRODUCTION**

This marking scheme was used by WJEC for the 2019 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.

## **GCSE DESIGN AND TECHNOLOGY**

### **UNIT 1 - ENGINEERING DESIGN**

#### **SUMMER 2019 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 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**

Question 1				
		AO3	AO4	Mark
(a)	<p>The picture below shows the International Organisation for Standardisation logo.</p> <p>Describe <b>one</b> advantage to the consumer of labelling products with the ISO logo.</p>		✓	2
<p><i>Answers that indicate an understanding of the purpose of standardising bodies such as ISO should be awarded up to 2 marks based on:</i></p> <p><b>Guidance to markers</b></p> <p>Incorrect / no answer. <span style="float: right;"><b>0</b></span></p> <p>Brief description e.g. Standards give consumers confidence <span style="float: right;"><b>1</b></span></p> <p>More detailed description e.g. Consumers know that products conform to strict standards giving confidence when purchasing the product. <span style="float: right;"><b>2</b></span></p>				
(b) (i)	<p>The Trade Descriptions Act specifies how companies can describe their products or services.</p> <p>Explain what could happen to a company that does not accurately describe their product.</p>		✓	2
<p><i>Answers that indicate an understanding of the trade description act should be awarded up to 2 marks based on:</i></p> <p>The Trade Descriptions Act makes it an offence for a trader to make false or misleading statements about goods or services. It carries criminal penalties and is enforced by Trading Standards Officers, making it an offence for a trader to:</p> <ul style="list-style-type: none"> <li>• apply a false trade description to any goods</li> <li>• supply or offer to supply any goods to which a false description has been applied</li> <li>• make false statement about the provision of any services</li> <li>• request a replacement product.</li> </ul> <p><b>Guidance to markers</b></p> <p>Incorrect / no answer. <span style="float: right;"><b>0</b></span></p> <p>Brief description e.g. It is against the law to not describe products accurately <b>or</b> they could be taken to court and fined. <span style="float: right;"><b>1</b></span></p> <p>More detailed description e.g. The Trade Descriptions Act makes it a criminal offence for a trader to make false or misleading statements about goods or services. <span style="float: right;"><b>2</b></span></p>				

(ii)	Outline the rights of a consumer who has purchased a product which has <b>not</b> been accurately described.		✓	2
<p><i>Answers that indicate an understanding of the trade description act should be awarded up to 2 marks based on:</i> The rights of a consumer and the responsibilities of the manufacturer.</p> <p><b>Candidates could discuss some of the following:</b></p> <ul style="list-style-type: none"> <li>• Satisfactory quality - Goods shouldn't be faulty or damaged when you receive them. You should ask what a reasonable person would consider satisfactory for the goods in question. For example, bargain-bucket products won't be held to as high standards as luxury goods.</li> <li>• Fit for purpose - The goods should be fit for the purpose they are supplied for, as well as any specific purpose you made known to the retailer before you agreed to buy the goods.</li> <li>• As described - The goods supplied must match any description given to you, or any models or samples shown to you at the time of purchase.</li> <li>• Refund or replacement of goods.</li> </ul> <p><b>Guidance to markers</b></p>				
<p>Incorrect / no answer. <span style="float: right;"><b>0</b></span></p>				
<p>Brief description e.g. It is against the law to not describe products accurately <b>or</b> they could be taken to court and fined. <span style="float: right;"><b>1</b></span></p>				
<p>More detailed description e.g. The Laws also allow consumers to get their money back if goods are found to be faulty or if products do not perform in the way claimed by the manufacturer. <span style="float: right;"><b>2</b></span></p>				

(c)	Explain the difference between market pull and technology push.		✓	4
<p>Answers that indicate an understanding of market pull and technology push should be awarded up to 4 marks based on:</p> <p><b>Technology push</b></p> <p>Technology push is when products are designed/re-designed because of changes in materials or manufacturing methods. This might mean that new materials and technologies have become available, with improved properties; or that improvements in manufacturing processes mean a manufacturer can make the product cheaper or more efficiently, which reduces manufacturing costs or allows the product to function in new ways.</p> <p><b>Market pull</b></p> <p>Market pull is when product ideas are produced in response to market forces. Examples of market influences include:</p> <ul style="list-style-type: none"> <li>● A demand from consumers for new or improved products.</li> <li>● A competing product is launched by another manufacturer.</li> <li>● A manufacturer wants to increase their share of the market.</li> </ul> <p>No answer or no relevant information presented or discussed. <span style="float: right;">0</span></p> <p>Brief description for <b>one</b> of the terms: e.g. Market pull is the demands of the consumer. <span style="float: right;">1</span></p> <p>More detailed response including description of both terms: e.g. Market pull is the demands of the consumer whereas technology push relates to developments of the manufacturer. <span style="float: right;">2</span></p> <p>Detailed response for <b>one</b> of market pull and technology push, with a weaker response for the other. See examples above and below. <span style="float: right;">3</span></p> <p>Fully detailed response for <b>both</b> market pull and technology push e.g. Market pull is driven by the needs and wants of the consumer and market research allows companies to determine the (changing) preferences of the consumer allowing the manufacturer to respond appropriately. Technology push is driven by new technological developments in materials and manufacturing that allow manufacturers to create products with functionality and feature the consumer has hitherto not considered. <span style="float: right;">4</span></p>				
<b>Total</b>				<b>10</b>

Question 2				
Complete the sentence below by adding in the missing words.		AO3	AO4	Mark
(a)	Sustainability in design terms means the avoidance of the over use of _____ resources in order to maintain an ecological balance for _____ generations		✓	2
<b>Guidance to markers</b> <i>Incorrect / no answer.</i>				0
<i>Natural/finite/non-renewable.</i>				1
<i>Future/next</i>				1
<i>Accept and other appropriate answer.</i>				
(b)	Explain <b>one</b> advantage and <b>one</b> disadvantage of using disposable eco plates.		✓	4
<p>Answers that indicate an understanding of sustainability and life cycle analysis and the advantage and disadvantage should be awarded up to 4 marks based on:</p> <p>A balanced answer that provides details of one advantage and one disadvantage. Advantages could refer to no need for energy or water usage to clean, end of life cycle biodegradability, possibly carbon neutral if material sourced sustainably. Disadvantages could reference energy source for production not sustainable, potential transport cost to landfill and more frequent transport to shops, limited usage/lifespan, overall life cycle analysis for product worse compared to lifecycle for non disposable plate, potential litter problem.</p> <p><b>Guidance to markers</b></p> <p><i>Incorrect/no answer.</i></p> <p><i>Brief explanation, very little detail e.g. Advantage - the consumer does not have to clean plate or disadvantage - could cause a litter problem.</i></p> <p><i>Explanation with some detail e.g. Advantage - the consumer can compost the plate at home to avoid landfill waste. disadvantage - The plate may take more energy to make.</i></p> <p><i>More detailed description of an appropriate method e.g. Advantage - The product will be eco-friendly if the product is sustainably sourced and manufactured and can be composted to be carbon neutral - Disadvantage A traditional multi use plate may have a better carbon footprint or lifecycle analysis compared to the eco-product.</i></p> <p><i>Fully detailed description of an appropriate method e.g. Advantage - If the energy sources for manufacture and transportation are sustainable, the product may be environmentally friendly, particularly if the land usage does not impact on important food crops or utilise excessive water and the option to compost at home would eliminate transportation implications at the end of life.</i></p> <p>Disadvantage - The plates may use more energy in total compared to the equivalent conventional plate and therefore have a worse environmental impact when the whole life cycle analysis is conducted. (water usage, transportation, CO2, impact on food crops factors maybe elaborate on as part of a comprehensive response)</p>				0
<p><i>Brief explanation, very little detail e.g. Advantage - the consumer does not have to clean plate or disadvantage - could cause a litter problem.</i></p>				1
<p><i>Explanation with some detail e.g. Advantage - the consumer can compost the plate at home to avoid landfill waste. disadvantage - The plate may take more energy to make.</i></p>				2
<p><i>More detailed description of an appropriate method e.g. Advantage - The product will be eco-friendly if the product is sustainably sourced and manufactured and can be composted to be carbon neutral - Disadvantage A traditional multi use plate may have a better carbon footprint or lifecycle analysis compared to the eco-product.</i></p>				3
<p><i>Fully detailed description of an appropriate method e.g. Advantage - If the energy sources for manufacture and transportation are sustainable, the product may be environmentally friendly, particularly if the land usage does not impact on important food crops or utilise excessive water and the option to compost at home would eliminate transportation implications at the end of life.</i></p>				4



(c)	<p>Repair is one of the 6 Rs of sustainability. Complex electronic products are often difficult to repair like the mobile phone shown below.</p> <p>Explain the function of self-repairing (micro-encapsulated) materials and how this would improve the sustainability of a mobile phone.</p>		✓	4
<p>Answers that indicate an understanding of the the 6 r's and sustainability should be awarded up to 4 marks based on:</p> <p><b>Guidance to markers</b></p> <p>Incorrect/no answer. <span style="float: right;"><b>0</b></span></p> <p><i>Brief explanation, very little detail e.g.</i> It can fix itself. <span style="float: right;"><b>1</b></span></p> <p><i>Explanation with some detail e.g.</i> The material can repair itself when damaged. <span style="float: right;"><b>2</b></span></p> <p><i>More detailed description of an appropriate method e.g.</i> The material can repair itself when damaged leading to an increased lifespan. <span style="float: right;"><b>3</b></span></p> <p><i>Fully detailed description of an appropriate method e.g.</i> The material can repair itself using embedded microcapsules of <b>healing</b> agents (such as resins) when damaged leading to an increased lifespan and result in a more sustainable product. <span style="float: right;"><b>4</b></span></p>				
			<b>Total</b>	<b>10</b>

Question 3				
	AO3	AO4	Mark	
<p>Designers and Engineers use virtual testing when designing with 3D CAD. The first image below illustrates the handlebars and stem from a bicycle and how the force is applied. The second image shows the stress within the stem from the applied force. If a product is overstressed it may break. Products are usually designed a factor of safety of 2 meaning it is at least twice as strong as needed.</p>				
(a)	Describe in detail <b>one</b> advantage of virtual testing using a CAD system compared to traditional physical product testing.		✓	2
<p><b>Answers that indicate an understanding of virtual testing should be awarded up to 2 marks based on:</b></p> <p>The cost and time benefits of virtual testing; essentially the ability to test many iterations more economically and in a more time efficient manner than physical testing of a design. Students may use terms such as Finite Element Analysis FEA or Computational Fluid Dynamics CFD. Credit should be given if Generative Design is mentioned; where AI uses FEA and CFD code to automatically optimise the design with little or no human intervention - cloud/super computers can create thousands of design variations until an optimal solution is found.</p> <p><b>Guidance to markers</b></p> <p><i>Incorrect / no answer.</i> <span style="float: right;"><b>0</b></span></p> <p><i>Brief description</i> <i>It is cheaper than making a physical model to test.</i> <span style="float: right;"><b>1</b></span></p> <p><i>More detailed description</i> <i>It is cheaper than testing a physical product. A large number of design iterations can be simulated/tested to optimise and improve the design before money is spent on physical prototype.</i> <span style="float: right;"><b>2</b></span></p>				

(b)	Complete the table below by inserting True or False next to each of the statements related to the CAD model.		✓	6
	1 mark for each correct answer.			
	The design is most likely to fail at point <b>A</b> .		True	
	Material could be removed to reduce the weight at point <b>B</b> .		True	
	The design will bend upwards under load.		False	
	The blue colour indicates areas of low stress.		True	
	The design passes the specification factor of safety target of twice maximum stress.		False	
This product would be safe to use under these forces.		False		
(c) (i)	Name a suitable material to manufacture the bike stem.		✓	1
	Guidance to markers Incorrect/no answer.			0
	Carbon fibre, Titanium, Aluminium alloy, Steel/Stainless			1
(ii)	Bolts are used to clamp the stem in place securely. Name a suitable material for the bolts and explain why this material is suitable.		✓	3
	1 mark for use and 2 marks for explanation.			
	Named material - stainless steel or titanium			1
	Accept mild steel			
	<b>Guidance to markers</b>			
	Incorrect/no answer.			0
Brief explanation with little detail e.g. very strong			1	
More detailed description e.g. High tensile strength and good corrosion resistance.			2	
Accept any appropriate answers for appropriate physical or mechanical properties.				

(iii)	A logo or brand name is required as part of the aesthetic finish of the product. Name a technique for applying a logo to the product and outline the main manufacturing steps.		✓	3
	1 mark for use and 2 marks for explanation.			
	Named technique - CNC engraved, laser engraved, CAMM 1 vinyl, accept any appropriate answer.			1
	Guidance to markers Incorrect/no answer.			0
	Brief explanation with little detail e.g. For CNC engraver: Use a V point engraving tool to create the logo.			1
More detailed description e.g. For laser process: The Logo should be exported from an appropriate CAD package (such as 2D design) and the laser settings must have the correct power and speed setting for engraving and a laser etching spray is normally used on CO2 lasers.			2	
Accept any appropriate answers for appropriate technique.				
			<b>Total</b>	<b>15</b>

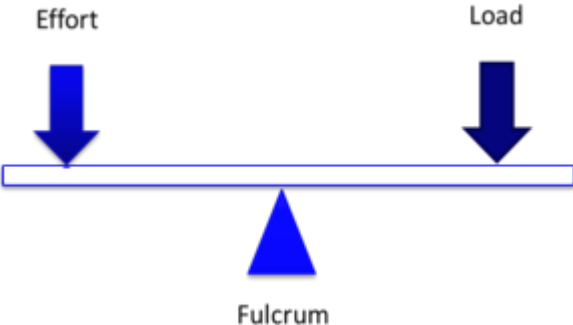
<b>Question 4</b>				
The images below show an existing door handle and a new prototype design.		<b>AO3</b>	<b>AO4</b>	<b>Mark</b>
(a) (i)	<p>To test the performance of the new design, a prototype handle was made using a CNC milling machine.</p> <p>Explain <b>one</b> advantage and <b>one</b> disadvantage of using a CNC milling machine compared to a 3D printer.</p>		✓	<b>4</b>
<p><i>Answers that indicate an understanding of the advantages and disadvantages of CNC Milling compared to 3D printing should be awarded up to 4 marks based on: Candidates are required to write an advantage and disadvantage of CNC vs. 3D printing.</i></p> <p><b>Advantage</b> CNC is a very well understood process for making high quality metal components. The products can be machined from a variety of alloys and materials that may not be able to be 3D printed. The CNC machine to produce this metal part will be a lot less expensive than the equivalent metal 3D printer. A 3D machined component is likely to behave more similarly to the production version.</p> <p><b>Disadvantage</b> There are some hollow forms and complex geometries that 3D printers may be able to produce that CNC machine cannot. As the designs become more complex 4th, 5th Axis machines become increasingly necessary and expensive. Repeated tool changes.</p> <p><b>Guidance to markers</b></p> <p>No answer or no relevant information presented or discussed.</p> <p>Brief description e.g. Advantage: 3D Machined metal part will be stronger than a 3D printed part</p> <p>Disadvantage: 3D machining can not make some shapes a 3D printer can</p> <p>More detailed response e.g. Advantage: 3D Machined metal part will be stronger than a 3D printed part, be cheaper to produce and the machine itself is less expensive.</p> <p>Disadvantage: 3D machining can not make some shapes a 3D printer can such as complex organic and hollow form geometries, which may create structurally superior geometry.</p> <p>Accept any appropriate answers.</p>				<p><b>0</b></p> <p><b>1 each</b></p> <p><b>2 each</b></p>

(ii)	<p>An additional prototype handle is to be created by metal casting.</p> <p>Describe a process of metal casting the handle.</p>		✓	6
<p>Answers that indicate an understanding of casting (sand,lost wax/investment could also be acceptable) should be awarded up to 6 marks based on:</p> <ul style="list-style-type: none"> <li>• Place a pattern in sand to create a mould.</li> <li>• Incorporate the pattern and sand in a gating system.</li> <li>• Remove the pattern.</li> <li>• Fill the mould cavity with molten metal.</li> <li>• Allow the metal to cool.</li> <li>• Break away the sand mould and remove the casting.</li> <li>• Finishing including: Deburring filing, sand blasting, anodising, etc</li> </ul> <p>Guidance to markers</p> <p>Accept the stages in the process above, up to a total of 6 marks. You may award 1 mark for each appropriate stage identified. Accept stages out of order, and stages may differ depending on the chosen casting method.</p>				

(b)	<p>Analyse James Dyson's innovative products and how they have influenced the market and his 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 James Dyson and his company should be awarded up to 10 marks based on:</p> <ul style="list-style-type: none"> <li>• Serial inventor before fame with DC01: ball barrow and sea truck.</li> <li>• Cyclonic action.</li> <li>• Initially tried to license technology to existing vacuum brands but turned down mainly due to technology eliminating profit margins form sale of bags.</li> <li>• Many competitors have tried to emulate Dyson style and engineering concepts.</li> <li>• Aggressive legal action to protect patents.</li> <li>• Great emphasis on gaining patent protection</li> <li>• First launched in japan under a license agreement as “G force”</li> <li>• Cyclonic action in vacuum cleaners, starting with DC01</li> <li>• Bagless vacuum cleaners</li> <li>• Futuristically styled products and yellow / grey / purple colour schemes Gender neutral.</li> <li>• Many revitalised cleaners in the range,</li> <li>• portability and wireless</li> <li>• Quick to discontinue unsuccessful products such as CR01 washing machine.</li> <li>• Developed Air blade hand dryers with improved force / drying</li> <li>• Market disruptor: rapidly rose from no market share to Market leader in vacuum cleaners.</li> <li>• Digital motors: a key technology in enabling performance of battery power devices.</li> <li>• Sophisticated dual cyclonic action improved suction and performance over others.</li> <li>• Perceived higher quality than competitors.</li> <li>• Replaced bags with transparent container to show effectiveness of cleaning.</li> <li>• Reliability and excellent build quality Support / Customer services / aftersales.</li> <li>• Bright, non-white products with high aesthetic value, as well as functional value.</li> <li>• Bladeless fans (market disruptor)</li> <li>• 360 eye robotic cleaner</li> <li>• Dyson hairdryer (market disruptor)</li> <li>• Significant use of Virtual testing in CAD, using FEA(Finite Element Analysis for simulation forces and stresses) and CFD (computational Fluid Dynamics to model air flow efficiency in products)</li> <li>• Significant emphasis on testing and use of scientific evidence to show performance advantages over competitors.</li> <li>• Supportive of young engineers and Design Technology, recently creating Dyson University course.</li> <li>• High value jobs kept in UK, manufacturing outsourced to cheaper locations, typically far east.</li> </ul>				

	<p><b>Guidance to markers</b></p> <p><b>Incorrect/no answer.</b></p> <p>Brief analysis with little detail of influence and innovations of Dyson. 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.</p> <p>More detailed analysis, with some explanation and detail of influence and innovations of Dyson. 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.</p> <p>Detailed analysis and explanation of influence and innovations of Dyson. 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 influence and innovations of Dyson. 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><b>0</b></p> <p><b>1-2</b></p> <p><b>3-4</b></p> <p><b>5-7</b></p> <p><b>8-10</b></p>
	Total	20



<b>Question 5.</b>				
Study the image of a seesaw shown below.		<b>AO3</b>	<b>AO4</b>	<b>Mark</b>
(a) (i)	Circle the correct classification for the lever used in the seesaw.		✓	<b>1</b>
	Class 1                      Class 2                      Class 3			
	Incorrect/no answer.			<b>0</b>
	Class 1			<b>1</b>
(ii)	Define the term equilibrium in relation to the seesaw.		✓	<b>1</b>
	Incorrect/no answer.			<b>0</b>
	Equilibrium is when the forces are in balance. or The force multiplied by the distance on each side of the seesaw fulcrum are equal. Or The moments are equal.  <i>Accept any alternative wording with equivalent meaning.</i>			<b>1</b>
(iii)	In the space below draw and label a diagram of the seesaw mechanism.		✓	<b>3</b>
	<div style="text-align: center;">  <p style="text-align: center;">Fulcrum</p> </div> <p><b>Guidance to markers Incorrect/no answer</b></p> <p><b>Award 1 mark for each of:</b></p> <ul style="list-style-type: none"> <li>• Fulcrum/Pivot</li> <li>• Load</li> <li>• Effort</li> </ul>			

(b)	Use the principle of moments to calculate how much force F the user must apply to open the bottle if 200N at the bottle cap is sufficient to remove the lid.		✓	5												
<p>Marks for working out calculation should include:</p> <table border="1" data-bbox="331 405 1023 736"> <tr> <td><b>Incorrect/no answer.</b></td> <td><b>0 mark</b></td> </tr> <tr> <td>Taking moments through force/point R</td> <td><b>1 mark</b></td> </tr> <tr> <td>clockwise moments = <math>200 \times 20</math></td> <td><b>1 mark</b></td> </tr> <tr> <td>anti-clockwise moments = <math>100 \times F</math></td> <td><b>1 mark</b></td> </tr> <tr> <td>Correctly rearranging formula: <math>\frac{200 \times 20}{100} = F</math></td> <td><b>1 mark</b></td> </tr> <tr> <td>Correct answer: <math>F = 40</math> N or greater</td> <td><b>1 mark</b></td> </tr> </table>					<b>Incorrect/no answer.</b>	<b>0 mark</b>	Taking moments through force/point R	<b>1 mark</b>	clockwise moments = $200 \times 20$	<b>1 mark</b>	anti-clockwise moments = $100 \times F$	<b>1 mark</b>	Correctly rearranging formula: $\frac{200 \times 20}{100} = F$	<b>1 mark</b>	Correct answer: $F = 40$ N or greater	<b>1 mark</b>
<b>Incorrect/no answer.</b>	<b>0 mark</b>															
Taking moments through force/point R	<b>1 mark</b>															
clockwise moments = $200 \times 20$	<b>1 mark</b>															
anti-clockwise moments = $100 \times F$	<b>1 mark</b>															
Correctly rearranging formula: $\frac{200 \times 20}{100} = F$	<b>1 mark</b>															
Correct answer: $F = 40$ N or greater	<b>1 mark</b>															
(c)	Evaluate the functional and mechanical properties of stainless steel that makes it appropriate for the bottle opener.		✓	5												
<p><b><i>Candidate's response will need to address the selection of stainless steel as a material for the bottle opener in terms of functional and mechanical factors:</i></b></p> <p>Functional Corrosion resistance Resistant to abrasion Inert and food safe</p> <p>Mechanical properties Good hardness relative to softer bottle caps Good stiffness/modulus of elasticity(resistant to bending) Good Ultimate tensile strength Good toughness/ resistance to impact</p> <p><b><i>Guidance to markers</i></b></p> <p>No answer or no evaluation. <span style="float: right;"><b>0</b></span></p> <p>Simplistic evaluation but no reasoning limited understanding evident. E.g. The bottle opener is made from stainless steel because it is hard wearing. <span style="float: right;"><b>1</b></span></p> <p>Some evaluation evident and limited reasoning. Some understanding evident. E.g. The bottle opener is made from stainless steel because it is will not rust and it is strong enough to remove the bottle caps. <span style="float: right;"><b>2-3</b></span></p> <p>Clear evaluations with detailed reasoning. Detailed understanding evident. E.g Stainless steel has superior corrosion resistance and is safe for use with food; it has a higher stiffness/ modulus of elasticity compared to the bottle cap material, meaning the cap will always deform before the bottle opener. <span style="float: right;"><b>4-5</b></span></p>																

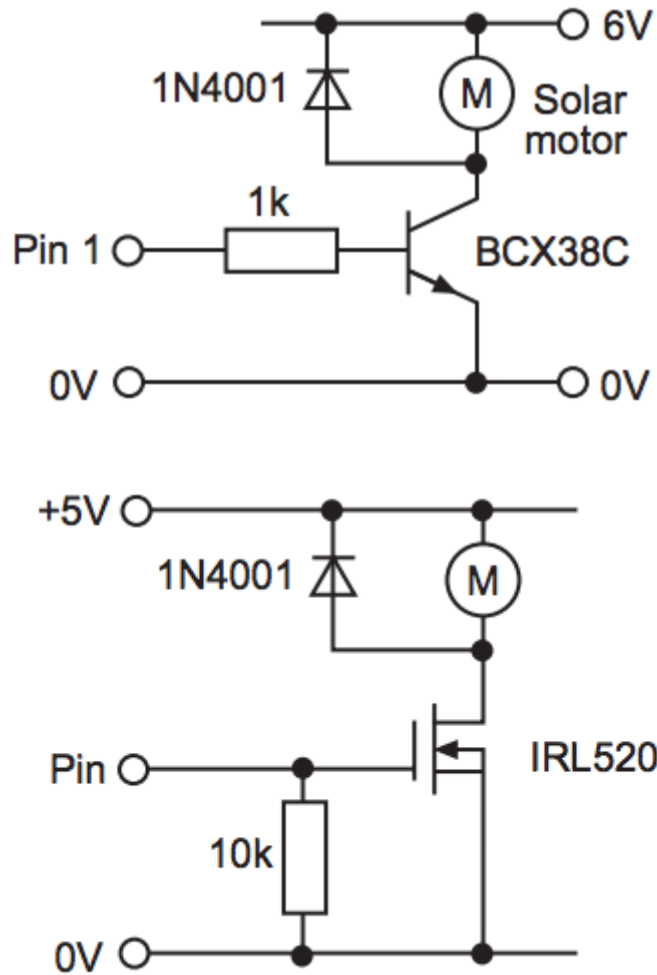
(d)	<p>A hardwood handle is bonded to the stainless steel body of the bottle opener.</p> <p>Evaluate how this benefits the user and impacts on recyclability.</p>	✓		5
<p>Candidate's response will need to address the benefits to the user and the recyclability/environmental issues.</p> <p>Benefits for user:</p> <ul style="list-style-type: none"> <li>• Improved comfort</li> <li>• Improved grip</li> <li>• Aesthetic preference</li> </ul> <p>Potential issues relating to recyclability and waste:</p> <ul style="list-style-type: none"> <li>• More materials increases complexity of recycling</li> <li>• Bonding of materials makes separation of materials difficult</li> <li>• Hardwoods may not come from a sustainably managed forest.</li> </ul> <p><b>Guidance to markers</b></p> <p>No answer or no evaluation. <span style="float: right;">0</span></p> <p>Simplistic evaluation but no reasoning limited understanding evident. <span style="float: right;">1</span></p> <p>E.g. The handle will make it more comfortable or it will be harder to recycle.</p> <p>Some evaluation evident and limited reasoning. Some understanding evident.</p> <p>The handle will make it more comfortable due to the width spreading the force more evenly over the finger or it will be harder to recycle due to the materials being joined. <span style="float: right;">2-3</span></p> <p>Clear evaluations with detailed reasoning. Detailed understanding evident.</p> <p>The wider handle increases comfort by distributing force more evenly and allows for a better grip improving function or it will be harder to recycle due to the materials being permanently joined, preventing separation for recycling as well as doubling the number of materials requiring recycling. <span style="float: right;">4-5</span></p>				
<b>Total</b>				<b>20</b>

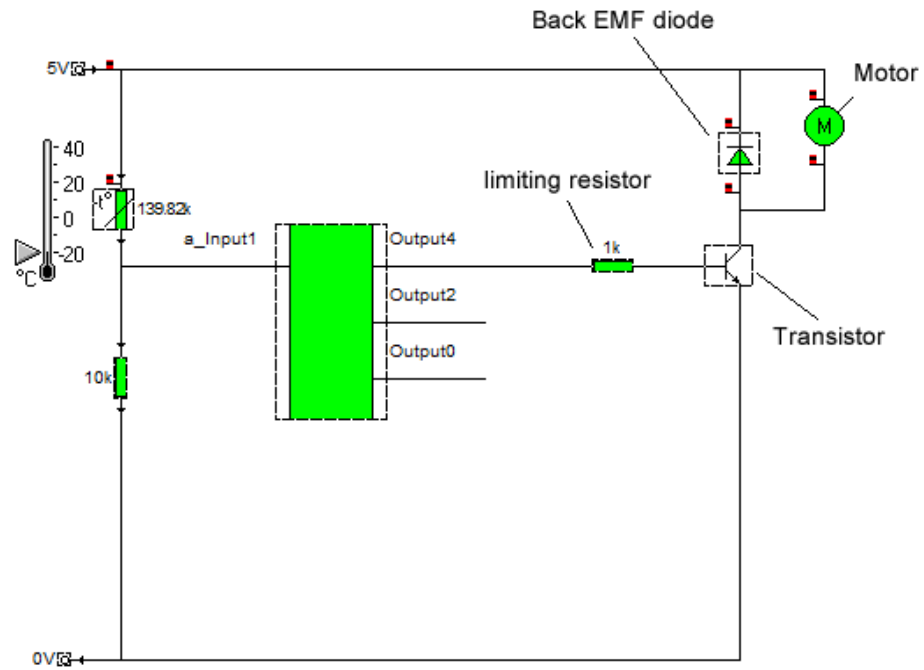
<b>Question 6</b>				
A microcontroller circuit diagram for a reptile enclosure is shown below. The light also provides heat for the enclosure. Name one input sensors and one output component.		AO3	AO4	Mark
(a) (i)	Name of input sensor		✓	1
	Incorrect/no answer.			0
	<i>Candidates should be awarded 1 mark for naming an appropriate input :</i> <b>Thermistor</b>			1
(ii)	Name of output component		✓	1
	Incorrect/no answer.			0
	<i>Candidates should be awarded 1 mark for naming an appropriate output:</i> <b>LED or bulb or heat sensor</b>			1
(b) (i)	The microcontroller circuit is used to control the temperature in a reptile enclosure.		✓	1
	Circle whether the input sensor is a digital or analogue device.			
	Guidance to markers Incorrect / no answer.			0
The device is analogue.			1	
(ii)	Explain the advantages of using a reprogrammable PIC microcontroller when creating a prototype.		✓	2
	Answers that indicate an understanding of the advantages of reprogrammable controllers should be awarded up to 2 marks based on:			
	<b>Guidance to markers</b> Incorrect / no answer.			0
	Brief reason e.g. It can be used many times or for other circuits.			1
More detailed reason e.g. It can be reprogrammed many times to refine the function of the circuit and optimise the products performance.			2	

(c)	Describe how the control system could be calibrated so that the lamp will switch on at 20 degrees.		✓	3
<p>Answers that indicate an understanding of calibration of components or use of a variable resistor should be awarded up to 3 marks based on:</p> <p>Analogue calibration boards allows microcontroller users to experiment with analogue sensors to calculate the threshold values that should be used within programs (when programming microcontrollers with analogue input pins). The display shows the value 0 to 255 when an analogue sensor is connected. By altering the input condition (e.g. temperature for a thermistor sensor) the value of the threshold input can be recorded.</p> <p>Or</p> <p>A variable resistor could replace the 10K pull down resistor and through experimental trial and error the threshold value maybe achieved by adjusting it whilst the sensor is at the correct ambient temperature.</p> <p>Or a student could experiment with the threshold level in programming, by repeatedly adjusting and reprogramming until it triggers at the correct ambient temperature.</p>				
<p><b>Guidance to markers</b></p>				
Incorrect / no answer.				0
Brief reason e.g. It can be adjusted through experiments.				1
More detailed reason e.g. It can be reprogrammed many times until it triggers at the right temperature.				2
Very detailed reason e.g. It can be reprogrammed through trial and error or calibrated using specialist circuits or a variable resistor could be swapped for the 10k resistor to adjust the threshold trigger value.				3

(d)	Two prototype designs have been created to test the performance of the reptile enclosure. The prototype is to test how well the system keeps the enclosure at the appropriate temperature. Study the two prototype designs below.			
(i)	State <b>which</b> prototype design will function better.		✓	1
	Prototype 2			
(ii)	Explain <b>why</b> this prototype design functions better.		✓	2
	<p>Answers that indicate an understanding of feedback within a system should be awarded up to 3 marks based on:</p> <p>Prototype 1 will result in a fluctuating (unstable feedback loop) on/off of the heating bulb as the sensor is too close, resulting in the reptile probably never receiving the appropriate thermal comfort.</p> <p><b>Guidance to markers</b></p> <p>Incorrect / no answer. <span style="float: right;"><b>0</b></span></p> <p>Brief reason e.g. temperature reading more accurate <span style="float: right;"><b>1</b></span></p> <p>More detailed reason e.g. The temperature at the sensor will more closely match the temperature the reptile experiences in prototype 2. Prototype 1 has the sensor too close to the bulb and it will switch off before the reptile is at the appropriate temperature. <span style="float: right;"><b>2</b></span></p>			

(iii)	<p>The design team believe they can further improve by adding a <b>fan</b> for a third prototype.</p> <p>Draw and label the new components to power the fan connecting from output pin 4.</p>		✓	6
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Possible solution include transistor or mosfet drivers. Motor driving chips such as L293D are also acceptable. Exact specification for components is not required.

<b>Incorrect/no answer.</b>	<b>0 mark</b>
Adding motor symbol	<b>1 mark</b>
Adding transistor or mosfet	<b>1 mark</b>
Adding Back emf diode	<b>1 mark</b>
Limiting resistor/pull down resistor	<b>1 mark</b>
Labelling components	<b>1 mark</b>
Correct connection for tracks to +V and ground	<b>1 mark</b>



(e)	The third prototype was found to be noisy due to the fan spinning too fast. The design team have added the gear system shown below:			
(i)	Name the gear system used.		✓	1
	<p><b>Guidance to markers</b></p> <p>Incorrect / no answer.</p> <p>Worm gear Worm drive</p> <p>Accept appropriate answers.</p>			0
(ii)	Explain why this is a good choice to slow the fan down.		✓	2
	<p>Answers that indicate an understanding of gear ratios and gear systems should be awarded up to 2 marks based on:</p> <p><b>Guidance to markers</b></p> <p>Incorrect / no answer.</p>			0
	<p>Brief reason e.g. It will slow down the speed a lot.</p>			1
	<p>More detailed reason e.g. Worm gears are capable of achieving very high ratios compared to spur gears and in a compact space.</p>			2
(iii)	The motor spins at 1200 RPM. The gear has 40 teeth. Calculate how fast the fan spins.		✓	2
	<p>Answers that indicate an understanding of gear velocity ratios should be awarded up to 2 marks based on:</p> <p>Correctly stating the formula to calculate velocity ratios:  <math>RV \text{ of driver} \times \text{teeth on driver} = RV \text{ of driven} \times \text{teeth on driven}.</math>  Applying and calculating the result.</p> <p><b>Guidance to markers</b></p> <p>Incorrect / no answer.</p>			0
	<p>Correct answer: 30rpm but no evidence of calculations</p> <p>Correct answer: 30rpm with evidence of calculations:  <math>1200 \times 1 = 40 \times \text{RPM of fan}</math>  <math>\frac{1200}{40} = 30 \text{ RPM}</math></p>			1 2

(iv)	Draw and label a diagram showing how the fan can have a rotational velocity (RV) of 40 RPM.		✓	3
<div style="text-align: center;"> </div> <p>Answers that indicate an understanding of gear symbols should be awarded up to 3 marks based on:  Appropriate diagram of worm gear system  Correct labelling of constituent parts of worm gear system  Correctly identifying the gear wheel should have 30 teeth to give a desired output RPM of 40</p> <p>The gear wheel should have 30 teeth.  <b>Guidance to markers</b></p> <p>Incorrect / no answer. <span style="float: right;">0</span></p> <p>Labelling 30 teeth <span style="float: right;">1</span>  labelling of constituent parts of worm gear system <span style="float: right;">1</span>  Appropriate diagram of worm gear system <span style="float: right;">1</span></p> <p>Accept either type of drawing if labelled correctly.</p>				
<b>Total</b>				<b>25</b>