



Oxford Cambridge and RSA

**GCE**

**Design and Technology**

**H004/01: Principles of design engineering**

AS Level

**Mark Scheme for June 2023**

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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**MARKING INSTRUCTIONS**  
**PREPARATION FOR MARKING**  
**RM ASSESSOR**

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training*; *OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal <http://www.rm.com/support/ca>
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **number of required** standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

**MARKING**

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.
5. **Crossed Out Responses**  
Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

**Rubric Error Responses – Optional Questions**

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

**Multiple Choice Question Responses**

When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

**Contradictory Responses**

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

**Short Answer Questions** (requiring only a list by way of a response, usually worth only **one mark per response**)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

**Short Answer Questions** (requiring a more developed response, worth **two or more marks**)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

**Longer Answer Questions** (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.
7. Award No Response (NR) if:
  - there is nothing written in the answer space.

Award Zero '0' if:

- anything is written in the answer space and is not worthy of credit (this includes text and symbols).
















Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**  
If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.
9. *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*

10. For answers marked by levels of response:

- a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
- b. **To determine the mark within the level**, consider the following:

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

Annotation	Meaning
	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Tick
	Cross
	Confused (replaces the question mark)
	Benefit of doubt
	AO1 – Knowledge and understanding
	AO2 – Apply knowledge and understanding
	AO3 - Analyse
	AO4 - Evaluation
	Omission
	Not answered question
	Noted but no credit given
	Too vague
	Own figure rule
	Repetition

## 12. Subject Specific Marking Instructions

### INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet Instructions for Examiners. If you are examining for the first time, please read carefully Appendix 5 Introduction to Script Marking: Notes for New Examiners.

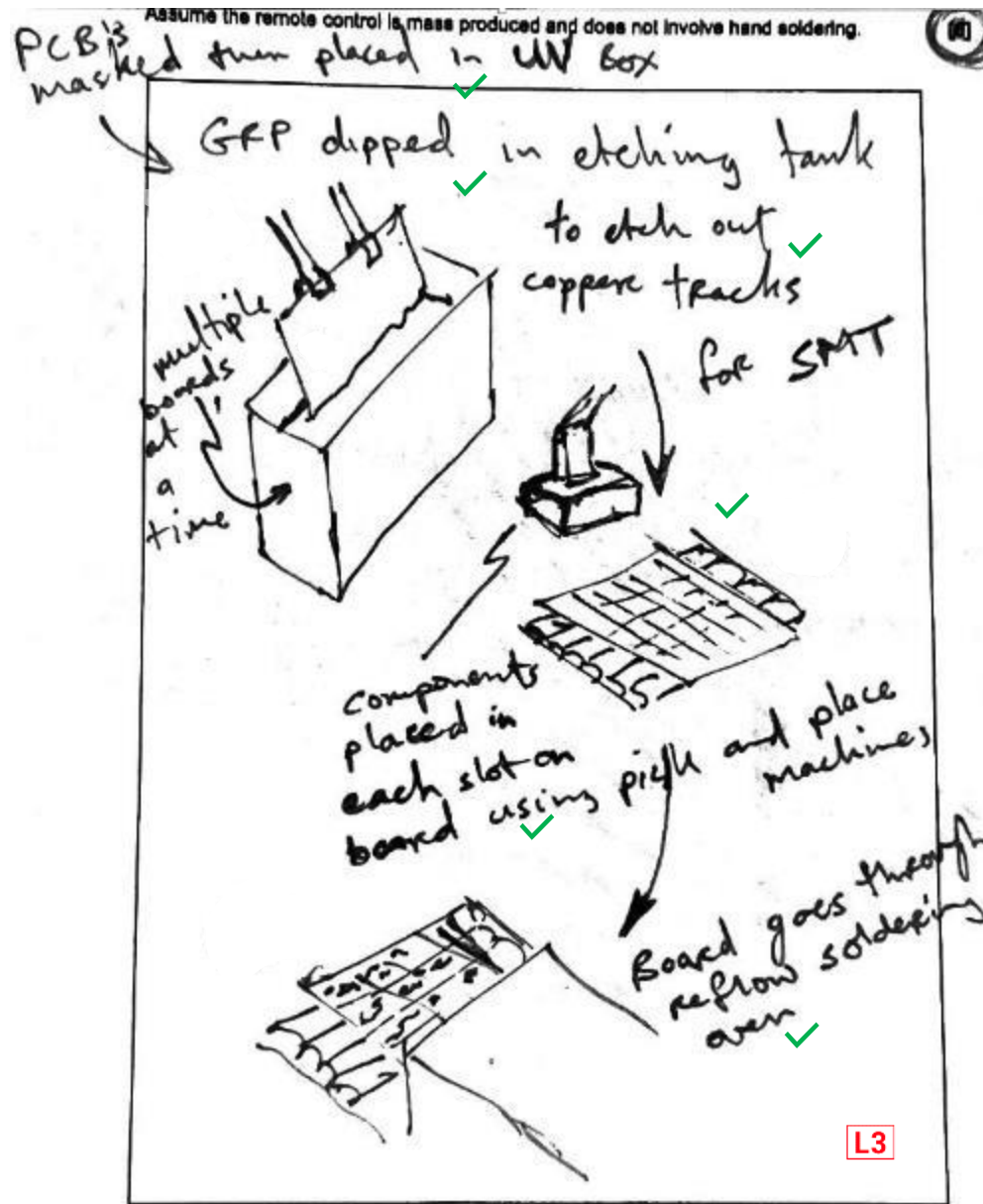
Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Question		Answer	Mark	Guidance
1	(a)	<p>Possible responses may include:</p> <ul style="list-style-type: none"> <li>• Bluetooth (1).</li> <li>• IR (1).</li> <li>• Any other valid suggestion.</li> </ul>	1	<p>One mark for identifying a wireless technology that could be used to connect the controller remotely to the electric skateboard.</p>
	(b)	<p>Possible factors may include:</p> <ul style="list-style-type: none"> <li>• Material selection (1) as the material will need to be easy to manufacture/cheap to buy/lightweight (1).</li> <li>• The ergonomics of the remote control (1) as it will need to be securely held while moving (1).</li> <li>• The anthropometrics/size of the remote control (1) as it will need to fit the user's hand (1).</li> <li>• The type of power source used (1) as this will be limited to the size of the remote control (1).</li> <li>• Bluetooth range (1) as the link between the controller and the board should work within a distance suitable for the tallest user without drop-out (1).</li> <li>• Safety (1) as the board should stop if the controller is out of range (1).</li> <li>• Any other valid suggestion.</li> </ul>	4	<p>In each case:</p> <p>One mark for identifying a factor that the designer would need to consider when designing the remote control unit.</p> <p>One mark for justifying why this factor would need to be taken into consideration.</p> <p>Specific reference to the context in the question is needed for marks to be awarded.</p>
	(c)	<p>Manufacturing a printed circuit board:</p> <ol style="list-style-type: none"> <li>1. Single layered or double layered PCB with photo-resist masked then exposed to UV light.</li> <li>2. PCB dipped in acid in an etching tank to remove unwanted copper.</li> <li>3. Lamination of double layered PCBs for multilayered PCBs.</li> </ol> <p>4a. Surface mount technology assembly / reflow soldering process used:</p> <ol style="list-style-type: none"> <li>i. CNC drill used to drill holes for link and wire connections</li> <li>ii. SMT Components placed in locations/slots using robotically controlled pick and place machines.</li> <li>iii. PCB goes through reflow soldering oven where all components are simultaneously soldered.</li> </ol> <p>4b. Through hole component /wave soldering process used:</p>		<p><b>Level 3 [5-6 marks]</b> The candidate demonstrates a good level of understanding in relation to a PCB and production methods. Both bullet points are covered which include how a PCB is manufactured on an industrial scale and how electronic components are soldered to it. Sketches, if used, will be clear and supported with relevant notes.</p> <p><b>Level 2 [3-4 marks]</b> The candidate demonstrates a sound level of understanding in relation to a PCB and production methods. At least one of the bullet</p>

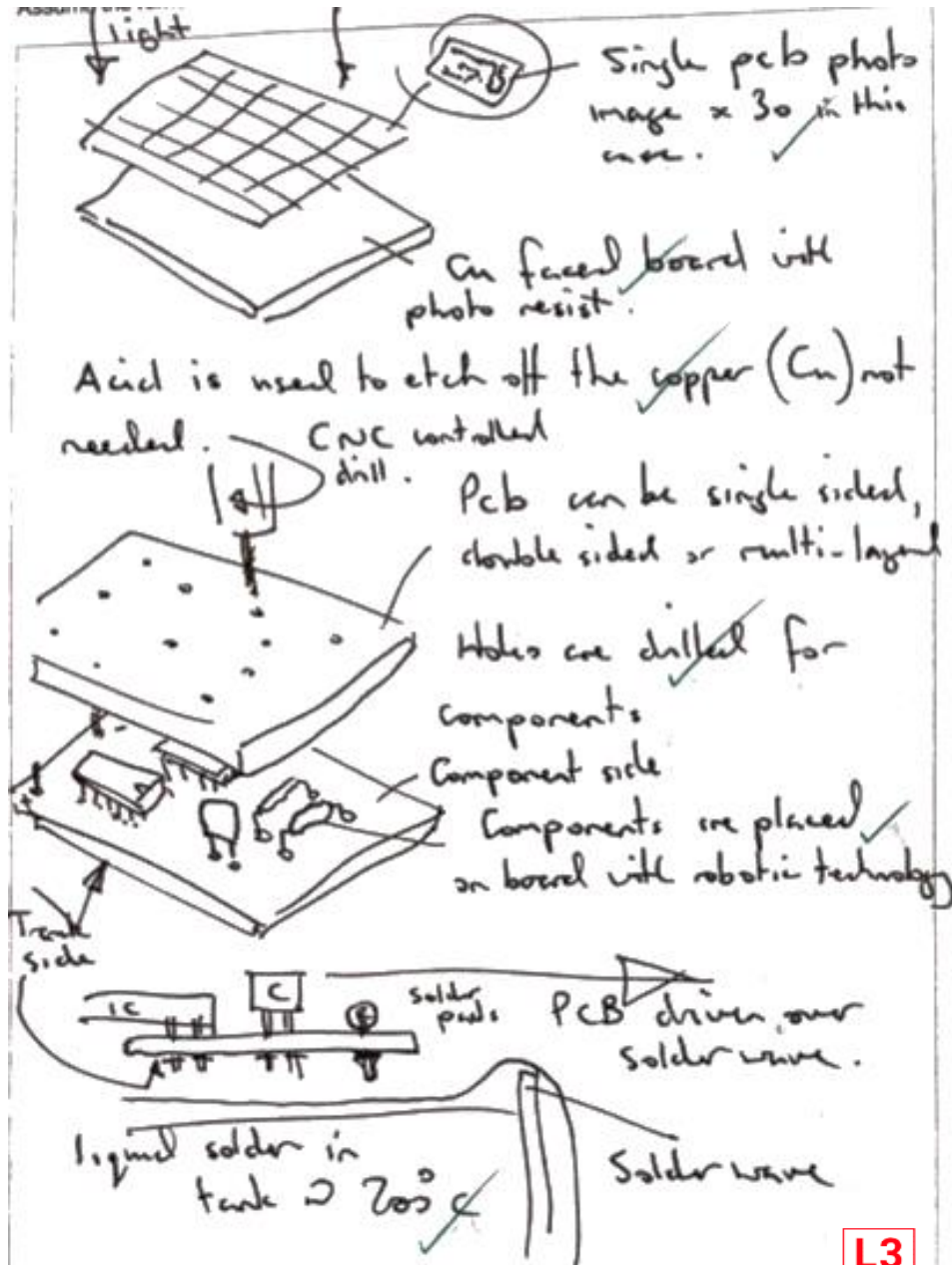


		<p>i. CNC drill used to drill holes for component wires, link and wire connections ii. Components added to PCB using robot handling technology iii. PCB is driven over wave of molten solder.</p> <p>Note: Candidates may use wave soldering process for SMT assembled PCBs. SMT components held in place by adhesive.</p> <p>Example responses:</p>	<p>points is covered. Sketches, if used, will for the most part be clear and supported with notes most of which are relevant.</p> <p><b>Level 1 [1-2 marks]</b> The candidate demonstrates a limited level of knowledge in relation to a PCB and production methods. At least one of the bullet points is covered. Sketches, if used, will be unclear with only basic notes to accompany them.</p> <p><b>0 marks</b> No response or no response worthy of credit.</p>
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Surface mounted technology (SMT) / Reflow soldering process



Through hole component / wave soldering process



L3

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	(d)	<p>Possible responses may include:</p> <ul style="list-style-type: none"> <li>• The use of pulse width modulation (1) adjusts the speed when the speed control adjuster is actuated (1).</li> <li>• The acceleration button is a potentiometer (1) so the further the speed control adjuster is actuated the more the motor accelerates (1).</li> <li>• When the speed control lever is pulled, the signal coming from the remote-control unit is received by the Bluetooth receiver (1) on the skateboard. This would be used to control the output voltage to the skateboard motor (1).</li> <li>• Any other valid suggestion.</li> </ul>	2	<p>Up to two marks for describing the system that is being used.</p> <p>Specific reference to the context in the question is needed for marks to be awarded.</p>
	(e)*	<p><b>Indicative content:</b></p> <p><b>Internal motor:</b></p> <p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• <b>Higher top speed:</b> Since there is no gear drive to multiply torque at the expense of speed, a hub driven electric skateboard is usually engineered to deliver a higher top speed versus an equally constructed belt-driven board.</li> <li>• <b>Less degradable parts:</b> No gear drive, belts or chains mean anything to lubricate or replace, thus reducing maintenance and cost. It also makes the motor water resistant, as there are fewer places for water to get into.</li> <li>• <b>Lighter:</b> Hub motors combine the wheel and motor into one unit, and therefore are lighter than a comparable belt driven electric skateboard.</li> </ul> <p><b>Disadvantages</b></p> <ul style="list-style-type: none"> <li>• <b>Harder to change wheels:</b> Since the motor is contained within the wheel, you can't swap wheels as easy as you can on a belt driven electric skateboard. Hub driven boards usually have fewer options when it comes to swapping out wheels.</li> <li>• <b>Less heat dissipation:</b> Hub motors are wrapped in a Urethane rubber sleeve, and therefore will store heat more than an externally mounted motor on a belt-driven board that is exposed to air circulation.</li> <li>• <b>Less torque:</b> Because there are no extra gears or belt drives the motor is reliant on its internal set up.</li> </ul> <p><b>Motor and belt:</b></p> <p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• <b>Higher torque:</b> A belt drive allows for an input gear on the motor, and an output gear on the wheel. Changing the size of these gears will change the torque multiplication available from the motor,</li> </ul>	8	<p><b>Level 3 [6-8 marks]</b></p> <p>The candidate has a clear understanding of the methods used to turn the wheels of an electric skateboard. They produce a thorough discussion in relation to the question by explaining a number of advantages and disadvantages of each method. The explanation is clear and well-developed, and the different methods are used effectively to exemplify the points being made.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples.</i></p> <p><b>Level 2 [3-5 marks]</b></p> <p>The candidate has a reasonable understanding of the methods used to turn the wheels of an electric skateboard. They produce a sound discussion in relation to the question by explaining a number of advantages and/or disadvantages</p>

	<ul style="list-style-type: none"> <li>• <b>More wheel options:</b> Belt driven boards will always have more wheel options compared to hub driven wheels. Since the motor is separate from the wheel, it can stay with the board and you have a larger range of compatible wheel types. Hub motors require you to either swap out the entire motor/wheel, or the Urethane sleeve over the hub motor.</li> <li>• <b>Better heat dissipation:</b> A belt driven board has the motor attached to the trucks and is open to circulating air when you're riding. This provides better heat dissipation when compared to a hub motor that is insulated by a Urethane rubber sleeve.</li> </ul> <p><b>Disadvantages</b></p> <ul style="list-style-type: none"> <li>• <b>Loud by design:</b> Belt driven boards are almost always louder. The belt itself will make some noise, and also the exposed motor. In a hub driven board, the motor is wrapped in thick Urethane rubber since it is enclosed in the wheel.</li> <li>• <b>Requires More Replacement of Parts:</b> A belt driven board will need its belt replaced about every 300-600 miles depending on the board manufacturer. The exposed belt is also susceptible to dirt, sand, and the occasional rogue pebble that might cause it to snap.</li> <li>• <b>Belt can get caught or snap:</b> As the user is riding the skateboard, Debris can fly up and potentially get caught in the belt system.</li> <li>• <b>Prone to dirt and water ingress:</b> This can lead to damage and degradation of the belt, causing slipping and breaking.</li> </ul> <p>Any other valid suggestion.</p>	<p>that would be taken into account. The explanation is sufficient although one or two opportunities are missed in referring to the different methods.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is for the most part relevant and supported by some evidence.</i></p> <p><b>Level 1 [1-2 marks]</b> The candidate has a basic knowledge of the methods used to turn the wheels of an electric skateboard. Any reference to the methods shown is largely descriptive in nature. The response contains no analysis or evaluation.</p> <p><i>The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.</i></p> <p><b>0 marks</b> No response or no response worthy of credit.</p>
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Question	Answer	Mark	Guidance
2 (a)	<p>Formula recall:  <math>2\pi r</math>            Radius of a circle:  <math>[80/2] = 40</math> [1]            Circumference of a circle:  <math>2\pi \times 40 = 251.33</math> cm [1]</p> <p>Perimeter of an arrow:  <math>10 + 30 + 5 + 26 + 26 + 5 + 30 = 132</math> cm [1]</p> <p>Total distance to be cut:  <math>251.33 + 132 = 383.33</math> cm [1]</p> <p>Conversion of mm to cm for laser cutter:  <math>[80/10] = 8</math> cm per second [1]</p> <p>Time taken:  <math>[383.33/8] = 47.91625 = 47.42</math> seconds [1]</p>	6	<p>No marks for recalling formula.</p> <p>Award six marks as follows:</p> <p>One mark for calculating radius of circle.</p> <p>One mark for calculating circumference of circle.</p> <p>One mark for calculating perimeter of arrow.</p> <p>One mark for calculating the total area to be cut.</p> <p>One mark for conversion from mm to cm per second of the laser cutter per second. Note: reward mark for mm to cm conversion if this has been done previously. Alternatively, the question can be answered by working in mms. Reward conversion from cm per second to mm per second.</p> <p>One mark for calculating the time taken in seconds to 2 decimal places.</p> <p>If correct answer is given without working out shown award full marks.</p> <p>Where an incorrect answer is given working out should be used to credit appropriate marks.</p> <p>*Allow error carried forward (ECF) where correct working out is shown.</p>

	<b>(b)</b>	<b>i</b> Break the arrow down into two sections.  Section 1 – Area of rectangle $[10 \times 30] = 300 \text{ cm}^2$ [1]  Section 2 – Use of Pythagoras Theorem to calculate missing length $C^2 = A^2 + B^2$ $[26]^2 = [10]^2 + [B]^2$ [1] $[B]^2 = 676^* - 100^* = 576$ $B = \sqrt{576^*} = 24 \text{ cm}$ [1]  Area of half an arrowhead $[ab]/2 = [24^* \times 10]/2 = 120 \text{ cm}^2$ [1]  Area of full arrowhead $120^* \times 2 = 240 \text{ cm}^2$ [1]  Total area: $300 \text{ cm}^2 + 240 \text{ cm}^2 = 540 \text{ cm}^2$ [1]	6	Award six marks as follows:  One mark for calculating area of rectangle.  One mark for using Pythagoras Theorem.  One mark for calculating missing length.  One mark for calculating area of half of arrowhead.  One mark for calculating area of full arrowhead.  One mark for calculating total area to be sprayed in $\text{cm}^2$ .  If correct answer is given without working out shown award full marks.  Where an incorrect answer is given working out should be used to credit appropriate marks.  *Allow error carried forward (ECF) where correct working out is shown.
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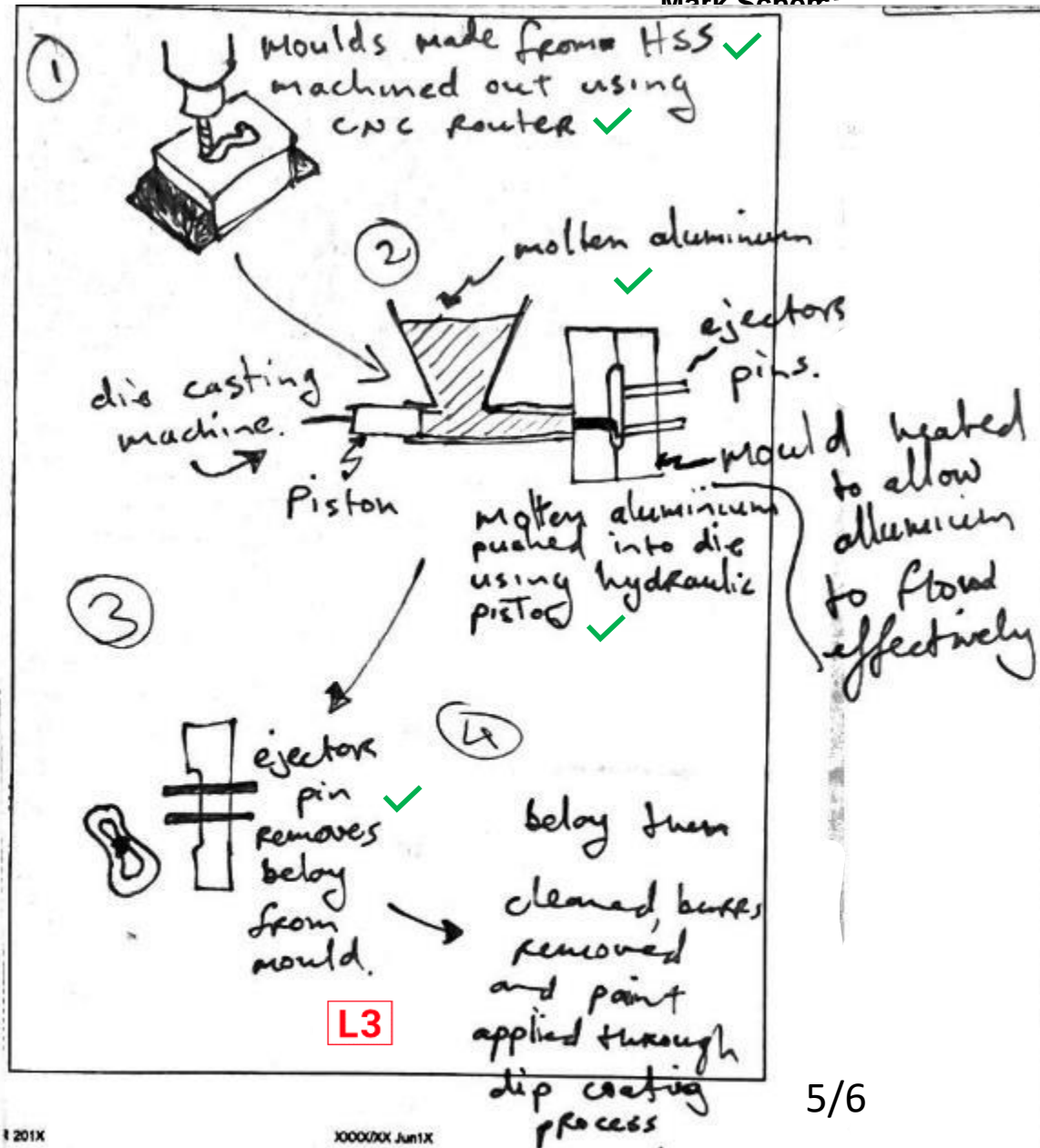
		<b>ii</b>	<p>Conversion of <math>\text{cm}^2</math> (area of arrow) to <math>\text{m}^2</math></p> <p><math>540^*/10\ 000 = 0.054\ \text{m}^2</math> [1]</p> <p>Number of arrows sprayed from one can</p> <p><math>2/0.054^* = 37.04</math> [1]</p> <p>Number of complete arrows</p> <p>37 arrows [1]</p>	3	<p>Award three marks as follows:</p> <p>Depending on how the candidate has answered the question:</p> <p>One mark for converting <math>\text{cm}^2</math> to <math>\text{m}^2</math>, or one mark for <math>\text{m}^2</math> to <math>\text{cm}^2</math>.</p> <p>One mark for calculating number of arrows sprayed from one can.</p> <p>One mark for determining number of complete arrows.</p> <p>If correct answer is given without working out shown award full marks.</p> <p>Where an incorrect answer is given working out should be used to credit appropriate marks.</p> <p>*Allow error carried forward (ECF) where correct working out is shown.</p>
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Question		Answer	Mark	Guidance
3	(a)	<p>Possible responses may include:</p> <ul style="list-style-type: none"> <li>• Thermo chromic vinyl/plastic/ film /paint (1).</li> <li>• Any other valid suggestion.</li> </ul>	1	One mark for identifying a smart material that could be used to check the power in a battery.
	(b)	<p>Total number of batteries in drawer:  <math>15+6 = 21</math> [1]</p> <p>Probability for one charged battery:  <math>15/21</math>            +            Probability for second charged battery:  <math>14/20</math> [both = 1]</p> <p>Probability of two charged batteries:  <math>[15/21] \times [14/20] = 1/2 = 1:2</math> or 50% [1]</p>	3	<p>Award three marks as follows:</p> <p>One mark for calculating total number of batteries in drawer.</p> <p>One mark for calculating both probability for one/two charged batteries.</p> <p>One mark for calculating probability of two charged batteries.</p>
	(c)	<p>Possible responses may include:</p> <p><b>Thermosetting polymer:</b>            Polyethylene/LDPE/Polypropylene (1).</p> <p><b>Reasons:</b></p> <ul style="list-style-type: none"> <li>• Polypropylene's chemical properties mean it does not react with acids (1), so should the batteries start to decompose, the acid leaked would be kept safely away from consumers behind the packaging (1).</li> <li>• Polypropylene is also highly resistant to corrosion and chemical leaking (1), so should the batteries start to decompose, the acid leaked would be kept safely away from consumers behind the packaging (1).</li> <li>• Polypropylene has a low density when compared to other polymers (1), so for manufacturers, they have the benefit of saving money from low weight (1).</li> <li>• It is available in a transparent form (1), so, as is the case here, the contents can be seen by the customer (1).</li> </ul>	5	<p>1 mark for identifying a thermosetting polymer.</p> <p>In each case:</p> <p>Up to a further two marks for explaining why the thermosetting polymer you have identified is suitable.</p> <p>Specific reference to the context in the question is needed for marks to be awarded.</p>

			<ul style="list-style-type: none"> <li>The material is lightweight but tough (strength to weight ratio) (1), and therefore has good resistance to crushing (1).</li> <li>Any other valid suggestion.</li> </ul>		
	<b>(d)</b>	<b>(i)</b>	<p>Possible responses may include:</p> <ul style="list-style-type: none"> <li>They help prevent accidents (1).</li> <li>They identify potential risks (1).</li> <li>It is a legal requirement (1).</li> <li>They help in dealing with storage of hazardous materials (1).</li> <li>Any other valid suggestion.</li> </ul>	2	<p>Up to two marks for explaining why schools need to have risk assessments.</p> <p>Use a mix and match approach with bullets.</p>
		<b>(ii)</b>	<p>Possible hazards may include:</p> <ul style="list-style-type: none"> <li>If batteries aren't stored properly, they could cause environmental issues (1),</li> <li>If not stored properly batteries could overheat and catch alight (lithium) (1).</li> <li>If acid from a damaged battery comes into contact with skin it could cause irritation (1).</li> <li>Old/flat batteries may leak out acid (1).</li> <li>Students could wire them up in an unsafe way (1) (causing a short circuit and overheating).</li> </ul> <p>Possible control measures may include:</p> <ul style="list-style-type: none"> <li>Ensure there is a designated battery storage area (1).</li> <li>Have a special bin for the correct disposal of batteries (1).</li> <li>Store all batteries in a cool dry place (1).</li> <li>Regularly inspect and check them (visually) (1).</li> </ul> <p>Any other valid suggestion.</p>	4	<p>Up two marks for identifying two hazards which should be in place for a school storing or using batteries.</p> <p>Up two marks for identifying two control measures which should be in place for a school storing or using batteries.</p>

Question	Answer	Mark	Guidance
4 (a)	<p>Possible responses may include:</p> <ul style="list-style-type: none"> <li>• Aluminium alloys are tough (1) meaning they can withstand impact (1).</li> <li>• Lightweight (1) meaning there is less weight to carry when climbing (1).</li> <li>• Good strength properties (1) so they can withstand a lot of force (1).</li> <li>• Cheaper than other materials (1) so they are cost effective (1).</li> <li>• Good resistance to corrosion (1) so they won't corrode in bad weather (1).</li> <li>• It can be finished with a smooth surface (1), which will enable the rope to run freely without snagging. (1)</li> <li>• Any other valid suggestion.</li> </ul>	4	<p>In each case:</p> <p>Up to two marks for explaining a reason why an aluminium alloy would be used in the belay device.</p> <p>Specific reference to the context in the question is needed for marks to be awarded.</p>
(b)	<p>For one mark:</p> <ul style="list-style-type: none"> <li>• It could become unsafe to use if a load above its max allowable load was used on it (1).</li> <li>• If it was damaged by an impact causing structural damage to it (1).</li> <li>• Ropes can wear away and create grooves in the belay device (1).</li> <li>• Any other valid suggestion.</li> </ul>	1	<p>One mark for identifying one way the belay device could become damaged and unsafe to use.</p> <p>Specific reference to the context in the question is needed for marks to be awarded.</p>
(c)	<p>Injection Die Casting process:</p> <ol style="list-style-type: none"> <li>1. Moulds machined from HSS using a cnc milling machine.</li> <li>2. Molten aluminium alloy added to die casting machine.</li> <li>3. Molten aluminium forced into die by piston.</li> <li>4. Water cooling of casting.</li> <li>5. Split dies open and ejector pins eject the cast belay.</li> <li>6. Belay is fettled to remove flash.</li> </ol>	6	<p><b>Level 3 [5-6 marks]</b></p> <p>The candidate has demonstrated a thorough understanding of the process needed to make the belay device with accurate technical terms and detailed consideration of any relevant equipment, machinery and materials required. Sketches if used will be clear and supported with relevant notes. The process will be end to end and clear in the way it is explained.</p> <p><b>Level 2 [3-4 marks]</b></p> <p>The candidate has demonstrated a sound understanding of some aspects of the process needed to make the belay device with reasonable use of technical terms and some consideration</p>



of any equipment, machinery and materials required. Sketches, if used, will for the most part be clear and supported with notes most of which are relevant. The end to end process may contain some gaps in understanding.

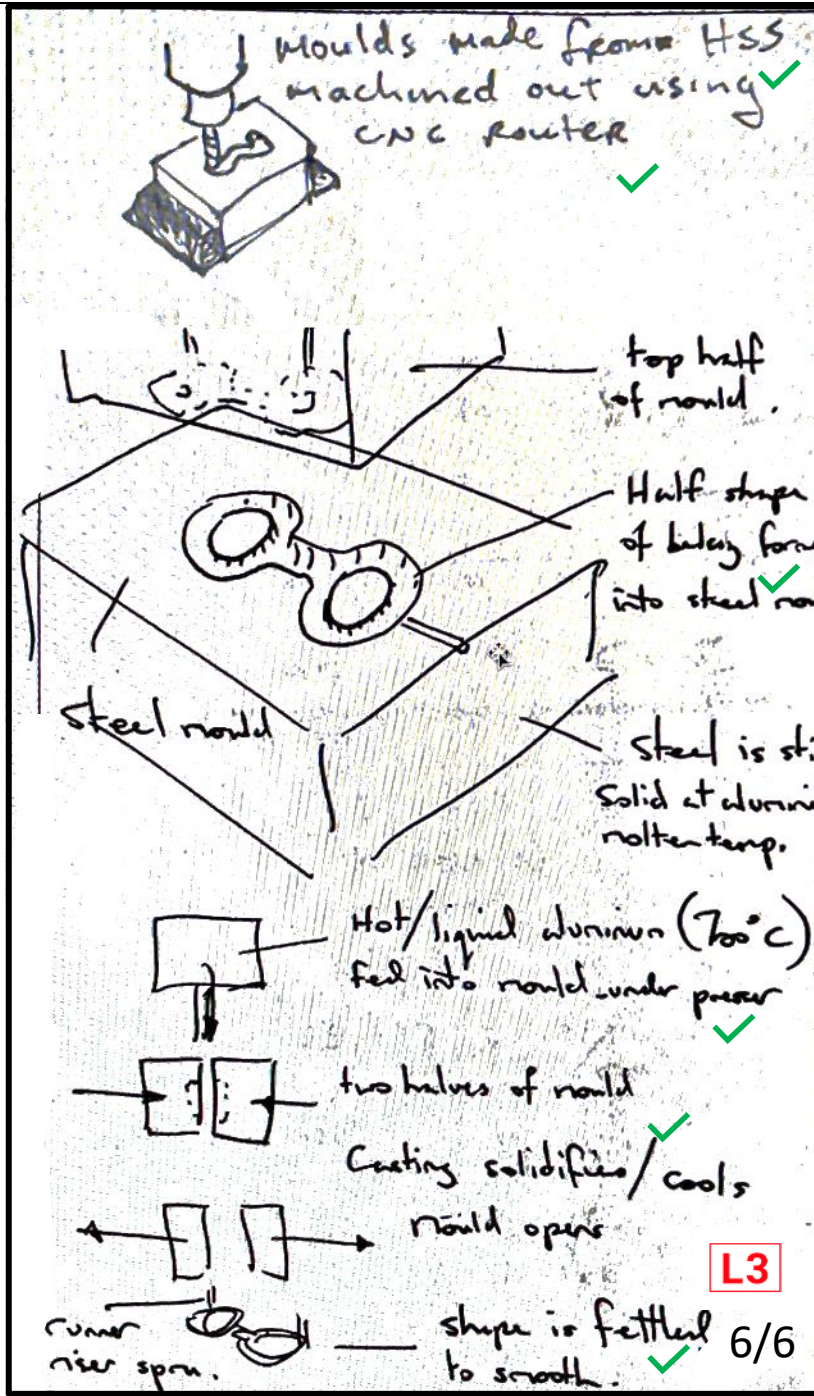
**Level 1 [1-2 marks]**

The candidate has demonstrated a limited knowledge of the process, applying this knowledge in a basic way to how the bely device would be made with limited use of technical terms and a basic consideration of any equipment, machinery and materials required. Sketches, if used, will be unclear with only basic notes to accompany them. The end to end process may not exist and if anything is basic in nature.

**0 marks**

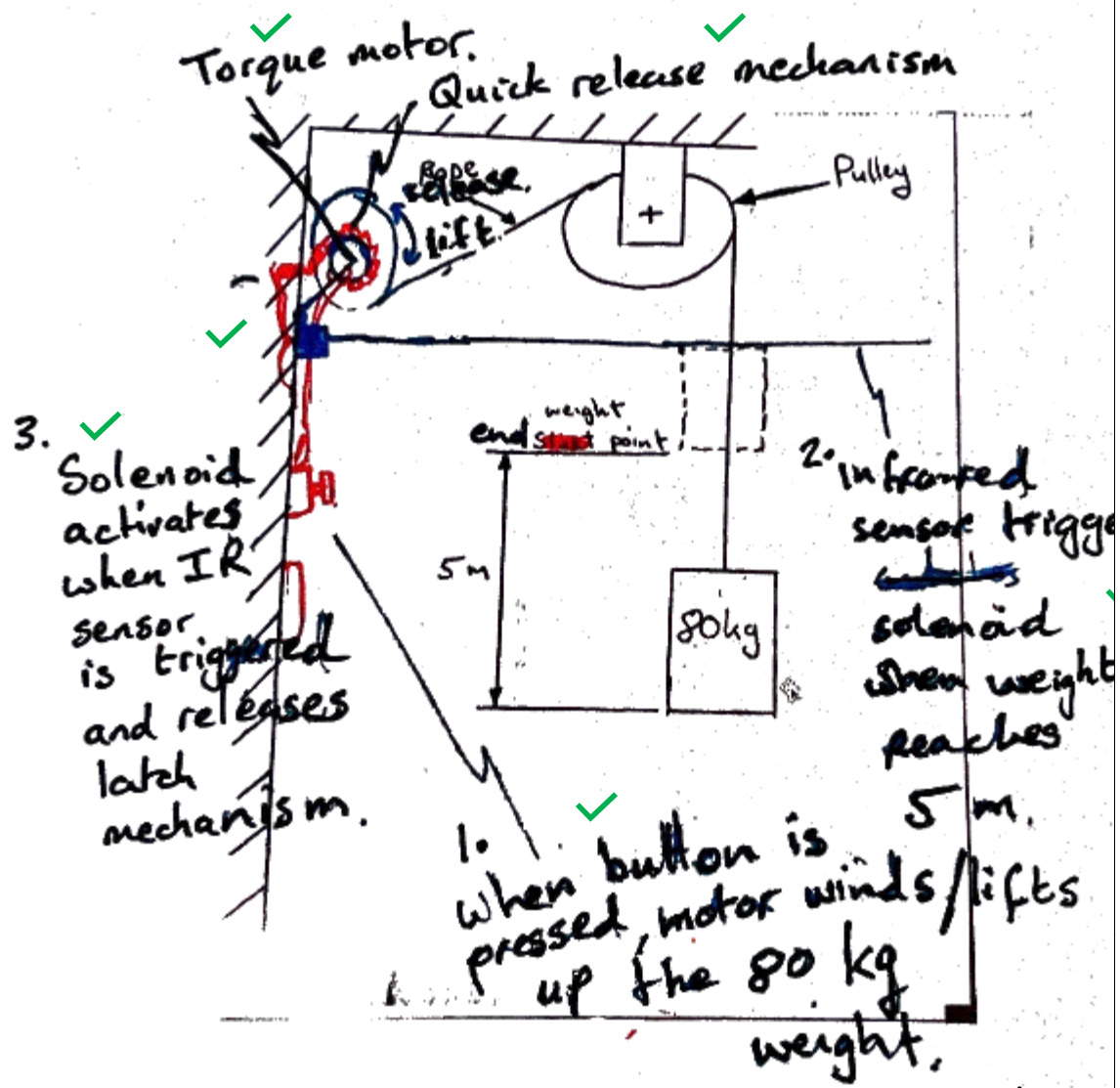
No response or no response worthy of credit.

		<p>Gravity die casting:</p> <ol style="list-style-type: none"><li>1. Split dies machined from HSS using a cnc milling machine.</li><li>2. Aluminum alloy melted.</li><li>3. Molten aluminium alloy is fed by gravity into the dies.</li><li>4. Casting solidifies as it cools.</li><li>5. Split dies opened and belay form ejected.</li><li>6. Belay is fettled to remove flash.</li></ol>		
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	<b>(d)</b>	<p>Young's Modulus = Stress/Strain      Stress = F/A [1 for both formulae]</p> <p>YM = F/[A x strain]</p> <p><math>A = \pi r^2</math></p> <p><math>r = 5 \text{ mm [climbing rope]} = 5 \times 10^{-3} = 0.005</math> [1]</p> <p><math>A = \pi r^2 = \pi [0.005]^2 = 0.00007853981</math> [1]</p> <p><math>F = 10\,000 \text{ N}</math></p> <p>Strain = 0.30</p> <p><math>YM = 10\,000/[0.00007853981 \times 0.3] = 424413215.837 \text{ Pa}</math> [1]</p> <p><math>424413215.837 / 10^9 = 0.42441321583 = 0.42 \text{ GPa}</math> [1]</p> <p>If candidates retain r as <math>5 \times 10^{-3}</math> and follow through process then award credit in normal way.</p>	5	<p>Award 1 mark for recalling both YM and stress formulae.</p> <p>Award 1 mark for conversion of radius linked to strain.</p> <p>Award 1 mark for calculating the area.</p> <p>Award 1 mark for calculating Young's Modulus in Pa.</p> <p>Award 1 mark for unit conversion into GPa.</p> <p>If correct answer is given without working out shown award full marks.</p> <p>Where an incorrect answer is given working out should be used to credit appropriate marks.</p> <p>*Allow error carried forward (ECF) where correct working out is shown.</p>
	<b>(e)</b>	<b>i</b>		<p>6</p> <p>In the annotated sketches seen (either in text or visual form):</p> <p>Award 2 marks for an explanation of action after button pressed.</p>





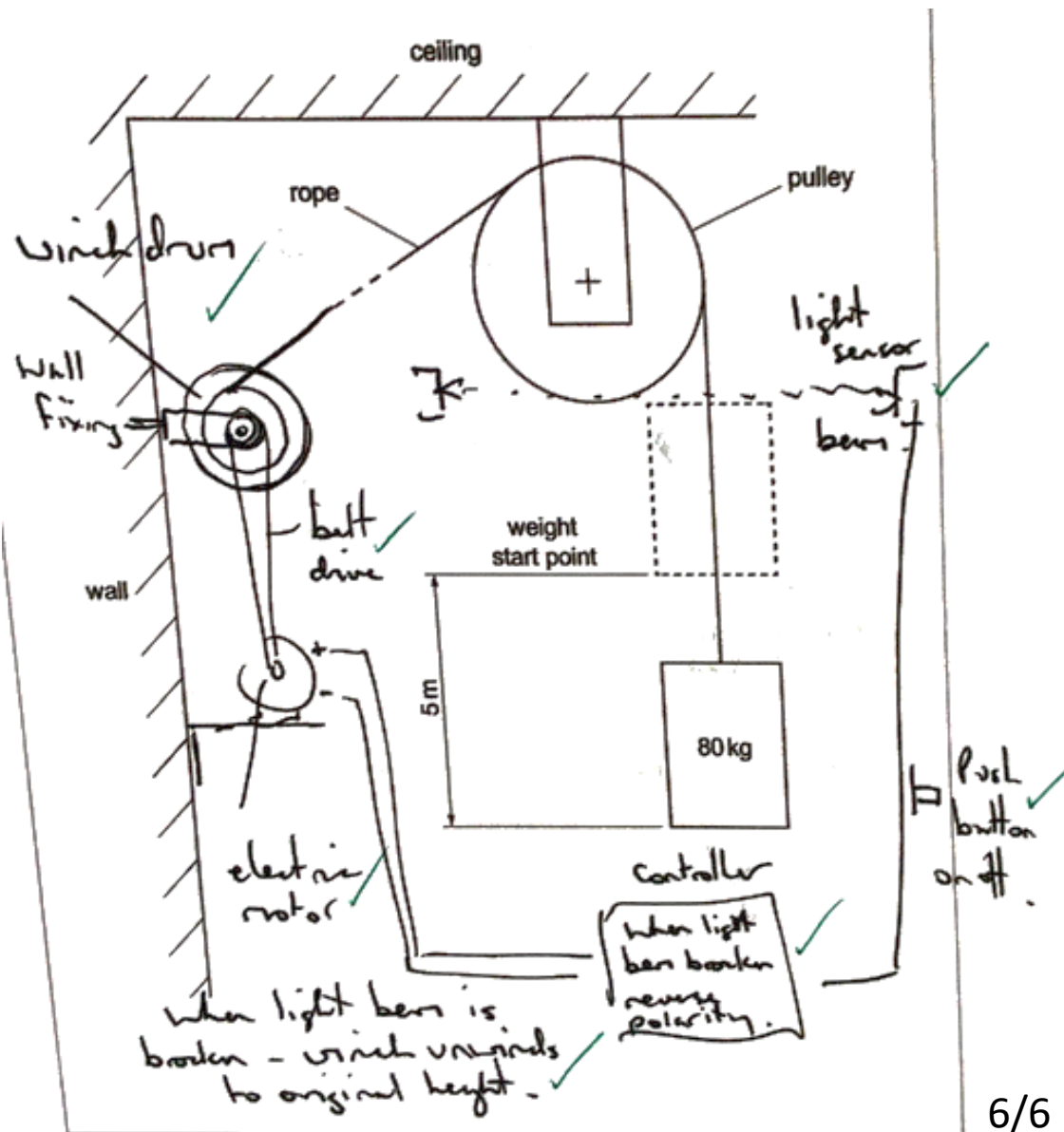
Award 2 marks for an explanation of the trigger when the weight reaches 5m.

Award 2 marks for the explanation of the release mechanism.

Award marks for any other valid responses (e.g.):

- Using a pneumatic piston
- Having a pneumatic limit switch
- Electro- magnetic switch
- Snail cam

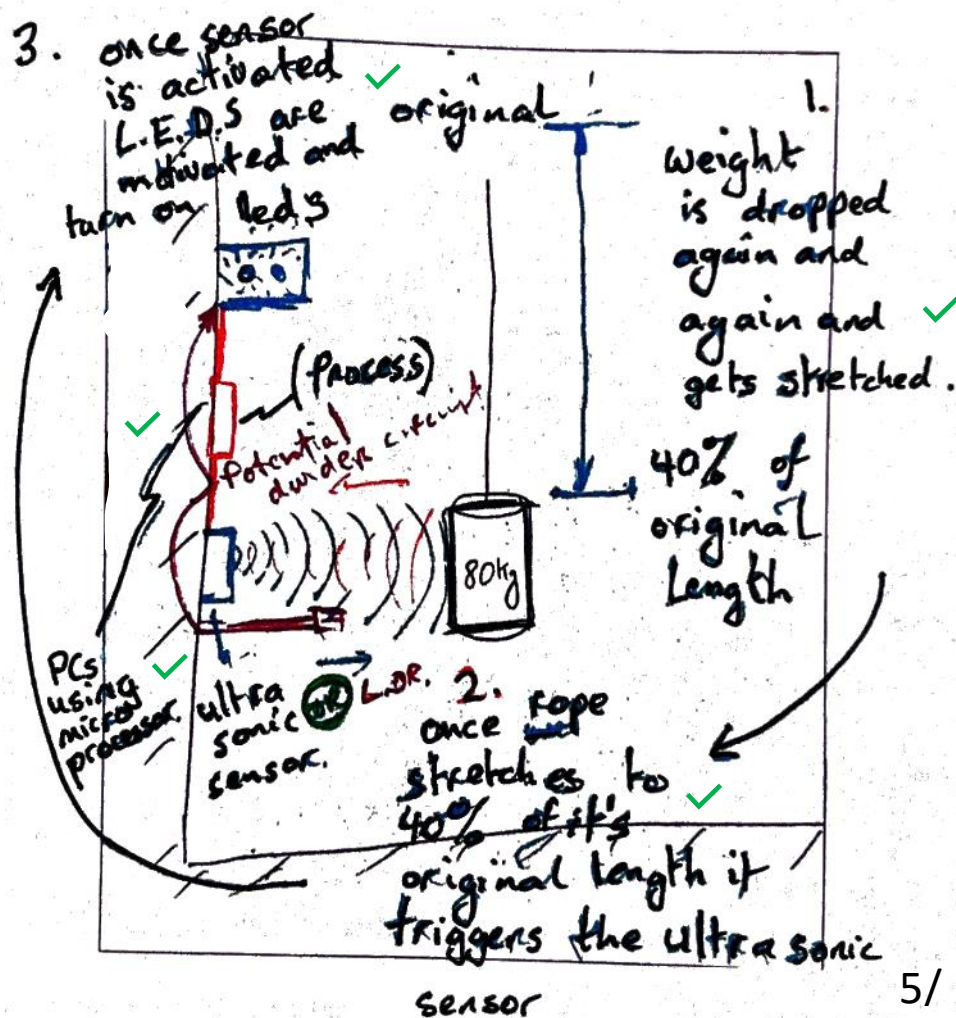




6/6

[6]

ii



5

In the annotated sketches seen (either in text or visual form):

Award 2 marks for an explanation of how an LED can be illuminated if the rope stretches causing the weight to pass the line.

Award 2 marks for the explanation of how a sensor can be used to detect the weight's distance below this line.

Award 1 mark for an explanation of how a display can be used to indicate this distance.

5/

Question	Answer	Mark	Guidance
5 (a)	<ul style="list-style-type: none"> <li>Companies will need to consider the marketing mix (1) to give their products the best chance of being successful (1).</li> </ul>	4	In each case:

		<ul style="list-style-type: none"> <li>• Companies will need to consider how best to relay the distinctive qualities and characteristics of products (1) that will attract/retain new/existing customers (1).</li> <li>• Companies will need to think about pricing strategies (1) to ensure the method of pricing reflect where a product is at in its lifecycle (1).</li> <li>• Companies will need to think about the type of promotional campaign they want (1) to attract new customers or change brand loyalty (1).</li> <li>• Companies will need to think about product placement (1) and the best channels of communication to use (1).</li> <li>• Companies will need to consider advertising strategies (1) to ensure the right group of end users is targeted (1).</li> <li>• Companies will need to be able to satisfy demand for their new products (1) by undertaking market research with a range of stakeholders (1).</li> <li>• Any other valid suggestion.</li> </ul>		<p>One mark for identifying a factor that companies will need to take into account when bringing new products to market.</p> <p>One mark for explaining the chosen factor.</p>
(b)*		<p><b>Indicative content:</b></p> <p><b>What manufacturers can do to help the environment:</b></p> <ul style="list-style-type: none"> <li>• Use recycled materials where possible.</li> <li>• Reduce packaging – blown card as used in egg boxes is used instead of PE foam packaging. iPhone X upwards are not supplied with USB 13amp plug adapters to reduce the overall package size.</li> <li>• Reduce transportation costs by manufacturing the product close to raw material source.</li> <li>• Use renewable energy sources to power the plant.</li> <li>• Use emission filters in line with the Geneva convention guidelines.</li> <li>• Make phones that have longer lifespans (e.g. Battery life).</li> <li>• Reduce built in obsolescence – upgrade every two year rather than every year e.g. iPhone 11,12,13.</li> <li>• Improve repairability / right to repair – e.g. it is very difficult to have the screen of an iPhone 12, 13 replaced.</li> <li>• Label materials used.</li> <li>• Design product so different materials separate easily (better for recycling).</li> <li>• Manufacturers can incentivise recycling/ money off next purchase.</li> <li>• Encourage consumers to return / exchange their old phones in order to improve recycling and avoid landfill.</li> <li>• Award any other valid suggestion.</li> </ul>	8	<p><b>Level 3 [6-8 marks]</b></p> <p>The candidate has a clear understanding of environmental impact. They produce a thorough discussion in relation to the question by explaining a number of ways in which manufacturers in the mobile phone industry can help reduce their impact on the environment. The explanation is clear and well-developed and more than two examples of more environmentally friendly methods are used appropriately and effectively to exemplify the points being made.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated with the use of examples.</i></p> <p><b>Level 2 [3-5 marks]</b></p> <p>The candidate has a reasonable understanding of environmental impact. They produce a sound discussion in relation to the question by explaining a number of ways in which manufacturers in the mobile phone industry can help reduce their impact on the environment. One</p>

				<p>or two examples of more environmentally friendly methods will be provided. The explanation is sufficient although one or two opportunities are missed in referring to the different methods.</p> <p><i>There is a line of reasoning presented with some structure. The information presented is for the most part relevant and supported by some evidence.</i></p> <p><b>Level 1 [1-2 marks]</b> The candidate has a basic knowledge of environmental impact. Any reference to the ways environmental impact can be reduced is largely descriptive in nature. An example of a more environmentally friendly method may be provided, but it may be inappropriate to the discussion. The response contains no analysis or evaluation.</p> <p><i>The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.</i></p> <p><b>0 marks</b> No response or no response worthy of credit.</p>
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