

GCE

Design and Technology

H004/01: Principles of design engineering

AS Level

Mark Scheme for June 2025

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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 available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

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, email or via the RM Assessor messaging system.
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).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

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 the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.
7. There is a NR (**No Response**) option. Award NR (No Response):
- if there is nothing written at all in the answer space
 - OR if there is a comment which does not in any way relate to the question (e.g., 'can't do', 'don't know')
 - OR if there is a mark (e.g., a dash, a question mark) which is not an attempt at the question.
- Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).
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.**
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

11. Annotations

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
	Noted but no credit given
	Benefit of doubt
	Level 1 response
	Level 2 response
	Level 3 response
	Error carried forward
	Omission
	Not answered question
	Confused (replaces the question mark)
	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	Indicative Content	Marks	Guidance
1 (a)	Possible technological advances may include: • Capacity and speed of chips/IC has increased significantly over time (1) increasing the capacity to run code quickly leading to the development of code (1). • The storage of memory has increased with the development of integrated circuits (1) leading to compact games consoles that have high operating speeds and graphic resolution (1). • The development in size and resolution of tv's & monitors (1) has led to high resolution compact screens that can be embedded in handheld devices (1). • Development of better graphics via design or better graphics cards (1) has led to realistic video graphics on compact screens (1). • Coding languages and interfaces have got better and easier to code (1) leading to increasing demand for more powerful games consoles and technology push (1). • Increasing speed of internet connection (1) has led to games consoles no longer having CD/DVD/Blu-Ray/cartridge readers for games as they can now be downloaded (1). • Miniaturization (1). With each new development in in electronics the components have got smaller. Smaller components take up less space, so functionality can be improved in the same space (1). • Touch sensitive surfaces (1). Games can be controlled by touching the screen rather than using a joystick or controller. This means it is more portable and can fit in a pocket (1). • Any other valid suggestion.	4	In each case: One mark for identifying a technological advancement which has influenced the evolution of games consoles. One mark for describing this technological advancement. Specific reference to the context in the question is needed for marks to be awarded.
(b)	Possible ways may include: • Focus groups can provide feedback about aesthetics (1) that can lead to the development of games console design to suit specific user groups (1). • Focus groups can provide feedback about build quality (1) that can lead to development of aesthetics, quality of materials, structural integrity and perceived quality (1). • Strain on players over time (1) related to the size and weight of controllers or portable games consoles (1). • Discomfort using controllers over time (1) could lead to improved ergonomic design such as the new layout of controls (1).	2	One mark for identifying a way in which stakeholder testing could inform the development of games consoles. One mark for explaining how stakeholder testing

Question	Indicative Content	Marks	Guidance
	- Identifying if the users are predominantly male or female (1). This would help with the choice of colours used for the pigments in the plastic moldings (1). - Stakeholders can give non-biased opinions identifying the advantages and disadvantages of the product (1). This would help the manufacturer make improvements to aspects such as aesthetics and size (1). - Any other valid suggestion.		informs the development process. Specific reference to the context in the question is needed for marks to be awarded.
(c)*	Indicative content: Gaming accessories: - Controllers. - Controller charging stations. - Steering wheel controllers and pedals. - Headsets. - Headphones. - Microphones. - Flight sticks. - External storage devices. - Console stands. - Console covers / skins. - Cables. - Gaming chairs. - Decal kits. Energy Sources - Accessories, such as headsets, controllers, racing wheels and external storage devices, incorporate polymers and printed circuit boards that rely on the mining of metals such as copper, the extraction and manufacture of new polymers, linking the manufacture to high carbon emissions.	8	Level 3 [6-8 marks]: The candidate has a clear understanding of the implications of growth. They produce a thorough discussion in relation to the question by explaining the implications of the growth in accessories on both energy sources and the environment. The explanation is clear and well-developed and the different examples of products are used effectively to exemplify the points being made. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant</i>

Question	Indicative Content	Marks	Guidance
	• Controller charging stations and racing wheels can use additional power supply to the main console, increasing the energy consumption of the gaming experience. • Most accessories, such as headsets and racing wheels, are cheaply made in large batches in Chinese factories where there is less legislation relating to energy consumption and related carbon emissions. Transportation of these accessories to Europe is usually by ships using finite fossil fuels and releasing harmful carbon emissions into the environment. • They can either be plugged in to the gaming machine using a USB cable or they can run independently using built-in rechargeable batteries. Small batteries are made from nickel, cobalt and lithium metal. These have to be mined and processed in order to make them usable, then housed in a custom designed plastic housing. • Any other valid suggestion. Environment • All games consoles have designed obsolescence which will likely lead to the accessories also being redundant over time, leading to landfill or complex recycling. • A huge range of low-quality accessories are available online, such as controllers that are a fraction of the purchase price of the console manufacturer's controller. These are unlikely to have been subjected to the same rigorous testing and have the same build quality and will lead to landfill within a short period of time. • Many accessories are themed or follow a current buying trend e.g. Marvel PlayStation 5 skin, these lead to increased energy consumption during manufacture, and lead to increased burden on waste management systems, such as land-fill. • At the end of their working life, they will either be thrown away into landfill, so the chemicals in them will eventually leach away into their separate materials or be recycled which uses energy. • Any other valid suggestion.		<i>and substantiated with the use of examples.</i> Level 2 [3-5 marks]: The candidate has a reasonable understanding of the implications of growth. They produce a sound discussion in relation to the question by explaining the implications of the growth in accessories on energy sources and/or the environment. The explanation is sufficient although one or two opportunities are missed in terms of the use of product examples. <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> Level 1 [1-2 marks]

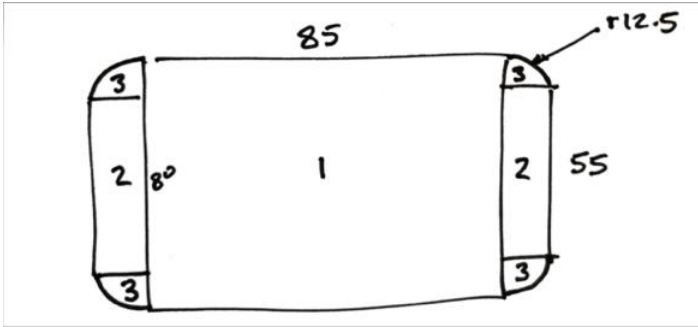
Question	Indicative Content	Marks	Guidance
			The candidate has a basic knowledge of the implications of growth. Any reference to either energy sources or the environment is largely descriptive in nature. The response has limited product examples if any and contains no analysis or evaluation. <i>The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.</i> 0 marks No response or no response worthy of credit.
(d)	Possible features may include: • Ribs that can be seen in the lower-case hand grip (1) prevent the case from being crushed when gripped. (1) • Screw posts as seen in the lower-case have reinforcing ribs between them and the outer shell (1) this will prevent forces from impact when dropped, fracturing the screw posts. (1) • Complex reinforcing forms resembling cuboid sections are positioned adjacent to the opening for triggers (1) these will prevent flexing, or crushing of the case when subjected to	4	In each case: One mark for identifying a feature of the controller that improves strength and durability.

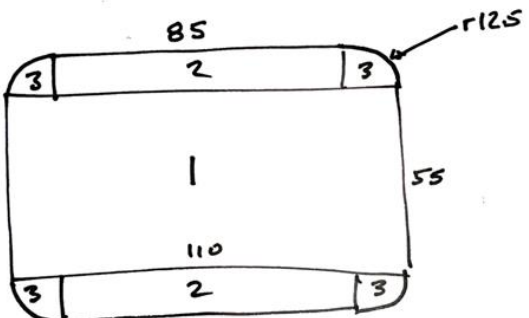
Question	Indicative Content	Marks	Guidance
	forces from gripping fingers (1) - Clips to the top of the lower case are reinforced with vertical sides (1) to prevent them snapping off. (1) - In the open half of the handset, there are small ribs that connect the insides of the curved sides of the handle.(1) These act as reinforcement to the thin body of the handset giving extra strength and rigidity. (1) - Any other valid suggestion.		One mark for justification of why feature improves strength and durability. Specific reference to the context in the question is needed for marks to be awarded.
(e)	Possible physical tests to assess performance: Accuracy: - Check to see that the buttons are the correct size for the apertures in the front casing (1). - Check to see that the buttons align centrally with the apertures in the casing (1). - Check to see that screw posts and clips align (1). - Xray testing to check for imperfections in the printed circuit board (1). - Any other valid suggestion. Functionality: - Stress testing to check controller's structural integrity remains after impact from dropping (1). - Continuity check of PCB (1). - Check to see that the buttons bounce back after they have been pressed (1). - User testing (1). - Any other valid suggestion. Performance: - Test battery capacity after a set number of repeat charging and dis-charging cycles (1). - Stress testing to check moving components, such as push-switches and joysticks, perform for an acceptable product lifespan (1). - Test to see how long it takes for the signal from the buttons being pressed to be passed to	3	For each criterion: One mark for identifying a suitable physical test that would be carried out. Specific reference to the context in the question is needed for marks to be awarded.

Question	Indicative Content	Marks	Guidance
	the electronics (1). Any other valid suggestion.		
(f)	Formula to use is: $P(A \text{ and } B) = P(A) \times P(B)$ $P(A \text{ and } B) = 0.04 \times 0.024 [1]$ $= 0.00096 [1]$	2	Award two marks as follows: One mark for entering correct values into formula One mark for calculating probability. 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.

Question	Indicative Content	Marks	Guidance
2	(a)(i) Energy = power x time ($E=Pxt$) [1] First 30 minutes of printer running Power (P) = 105 W and time (t) in 30 minutes 1 watt = 1 joule per second ($1W = 1 J/s$) 30 minutes = $30 \times 60 = 1800$ seconds [1] $E = 105 \times 1800^* = 189000 J$ [1]	3	Award three marks as follows: One mark for recalling formula. One mark for conversion of minutes into seconds. One mark for calculating how much power in J is used in the first 30 mins. 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.

Question	Indicative Content	Marks	Guidance
(ii)	3 hours = 180 minutes 3 hours 22 minutes = 202 minutes 202 minutes = 12120 seconds [1] $E = 48 \times 12120^* = 581760$ [1] $581760^*/1000 = 581.76$ kJ [1]	3	Award three marks as follows: One mark for converting minutes to seconds. One mark for calculating how much power is used in remaining time. One mark for converting answer to kJ. 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.

Question	Indicative Content	Marks	Guidance
(b)	Volume to remove from corners = Volume of 25 x 25 x 30 cuboid – Volume of cylinder $= 18750 \text{ mm}^3$ [1] - 14726.22 mm^3 $= 4023.78 \text{ mm}^3$ [1] Volume of the contents of the trinket tray = Volume of cuboid – volume to remove from corners = $264000 - 4023.78^* = 259976.22 \text{ mm}^3$ [1] $= 259976.2 \text{ mm}^3$ [1] Alternative method 1:  Volume = $V_1 + 2V_2 + 4V_3$ $V_1 = 85 \times 80 \times 30 = 6800 \times 30 = 204000$ [1] $2V_2 = 2 \times 12.5 \times 55 \times 30 = 41250$ [1] $4V_3 = 4 \times \frac{1}{2} \times 12.5^2 \times 30 = 14726.21556$ [1] Volume = $204000^* + 41250^* + 14726.21556^* = 259976.2 \text{ mm}^3$ 1 d.p. [1]	4	Award four marks as follows: One mark for calculating the volume of the 25 x 25 x 30 cuboid. One mark for calculating the volume of the corners to be removed from the large cuboid. One mark for calculating the volume of the contents of the trinket tray. One mark for rounding answer to 1 decimal place. If correct answer is given without working out shown award full marks. Where an incorrect answer is given working out should be used to

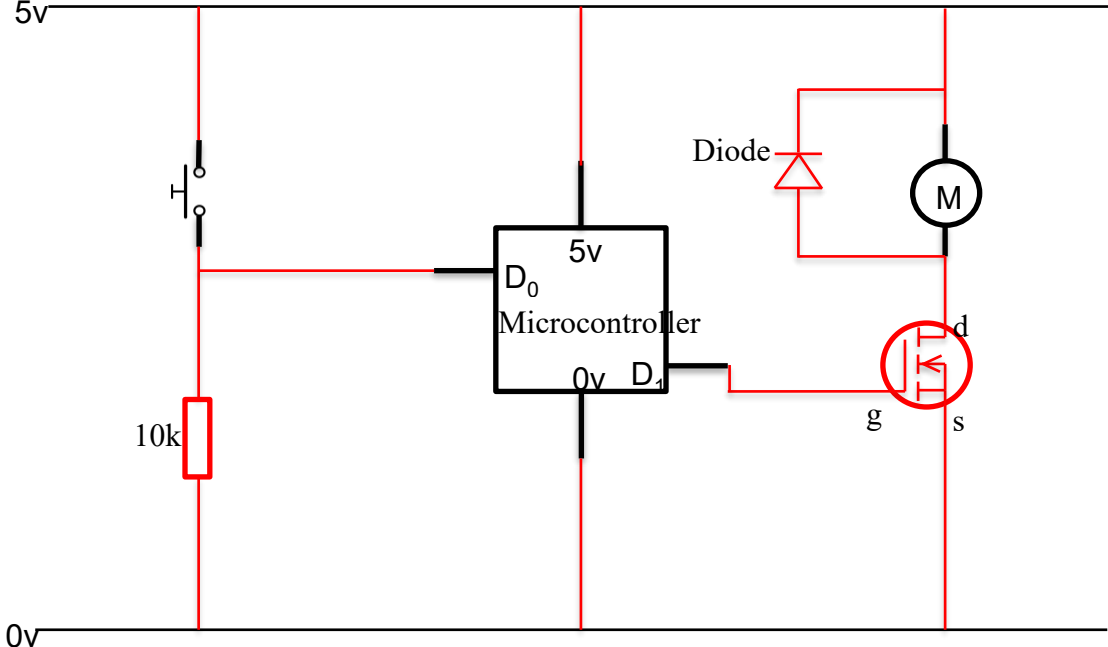
Question	Indicative Content	Marks	Guidance
	Alternative method 2:  Volume = $V_1 + 2V_2 + 4V_3$ $V_1 = 110 \times 55 \times 30 = 6050 \times 30 = 181500$ [1] $2V_2 = 2 \times 12.5 \times 85 \times 30 = 63750$ [1] $4V_3 = \pi 12.5^2 \times 30 = 14726.21556$ [1] Volume = $181500^* + 63750^* + 14726.21556^* = 259976.2 \text{ mm}^3$ 1 d.p. [1]		credit appropriate marks. *Allow error carried forward (ECF) where correct working out is shown.
(c)	Scaling ratio of volume = $x^3:y^3$ Therefore $3^3:5^3 = 27:125$ [1] Volume of larger container = $(125^* / 27^*) \times 1872 = 8666.66666 \text{ cm}^3$ [1] = 8667 cm^3 [1]	3	Award three marks as follows: One mark for calculating the individual ratios One mark for calculating the volume of the larger container

Question		Indicative Content	Marks	Guidance
				One mark for rounding answer to 0 decimal places. 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. **Award up to two ECF marks where the ratio 3:5 is used instead of $3^3:5^3$.

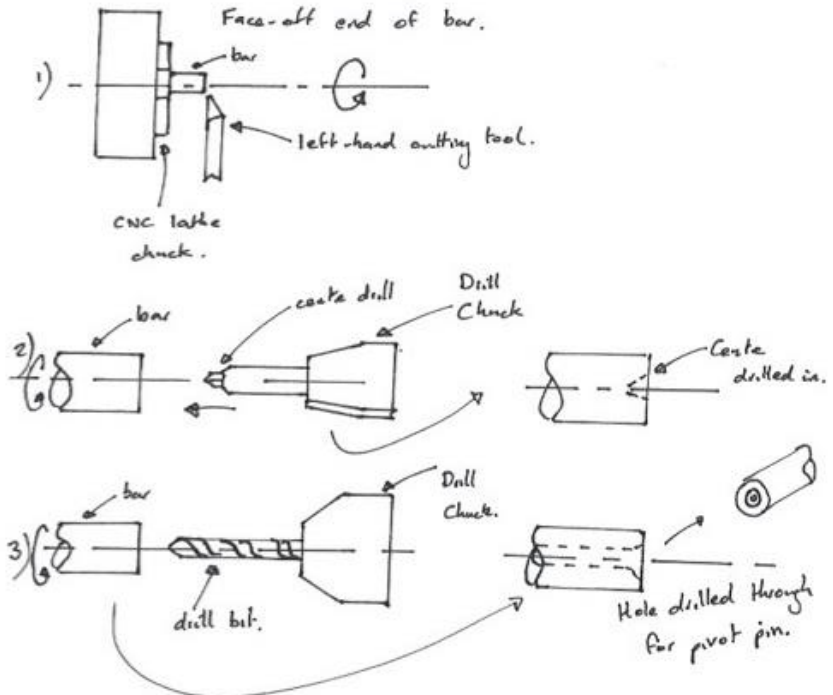
Question	Indicative Content	Marks	Guidance
3	(a) Possible methods may include: • The design can be tested using finite element analysis (FEA) (1), to determine how it will perform under load and stresses associated with walking (1). • The design can be tested using finite element analysis (FEA) (1), to develop structural integrity and how it will perform under impact from foreign bodies (1). • The design can be simulated with different materials (1) to identify an appropriate material that will balance cost / strength / weight (1). • Light-weighting algorithms can be run (1) to further reduce material and thus reduce cost (1). • Stress analysis would have been used in the design software to calculate the loads on each member and then calculate the thickness (cross-sectional area) of each member (1). The number of calculations needed to calculate this manually would have been vast; using the CAE software would have been quicker and less prone to error (1). • Design developed using generative design (1) to reduce the amount of material required (1). • Any other valid suggestion.	4	In each case: One mark for identifying a suitable method of CAE that could have been used in the design of the 3D printed prosthetic leg. One mark for justifying why the chosen method is suitable. Answers must be appropriate for the specific context given.
	(b) Possible responses may include: Products: • Bicycle frames for elite athletes (1). • Concept car (1). • Bespoke jewellery (1). • Bespoke prosthetic limb (1). • Bespoke wedding dress (1). Reasons: • For the bicycle, this allows the distance between key components, handlebars, saddle, pedals etc to be adjusted minutely for optimum performance (1). • To show aesthetics (1). • Potential clients can see the size, shape and colour scheme of the design (1).	2	One mark for identifying a product that is manufactured using a one-off method of production. One mark for justifying why this production method is suitable for chosen product.

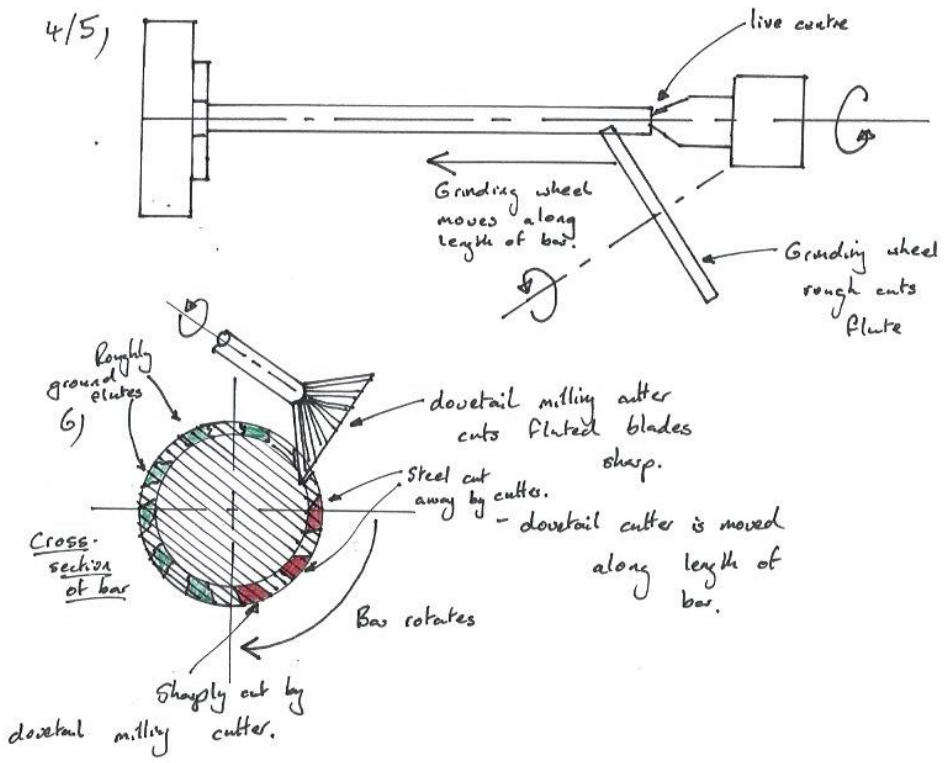
Question	Indicative Content	Marks	Guidance
	• Functionality (1). • Potential clients can how the product is meant to function and how different features work (1). • Customisable (1). • Users can personalise their products (1). • Any other valid suggestion.		
(c)	Possible responses may include: • Aluminium, magnesium and titanium alloys have better strength to weight ratios than plastics for the slender sections (1) which will be more suited to the dynamic loads involved in walking (1). • Titanium alloys have good hardness properties (1) making them more appropriate than plastics for impact protection if the leg was to get knocked (1). • In the interest of balance, having both legs the same weight would lead to the patient's gait being more natural looking (1). A metal alloy is likely to be heavier than a plastic or carbon fibre alternative making it possible to balance the weight of the legs (1). • Had the prosthetic leg been made from plastic or carbon fibre it would tend to be flexible (1). The use of a metal alloy would reduce this flexibility and make the leg more stable (1). • Metal alloys are generally more durable and harder wearing than plastic or carbon fibre (1) and would provide a longer product lifespan (1). • The materials in metal alloys are more abundant in the earth's crust (1), than the materials used for synthetically made materials such as plastic and carbon fibre (1). • Any other valid suggestion.	4	In each case: Up to two marks for explaining why a metal alloy is an appropriate material for the prosthetic leg. Specific reference to the context in the question is needed for marks to be awarded. Candidates do not need to give an example of a specific metal alloy.
(d)	Possible health and safety issues may include: • Inhalation of chemical vapors / fumes / vocs during operation (1). • Whether it is possible to access the hot nozzle (1). • Burn to users when removing prints / contact with heated parts (1). • Contact with moving parts (1). • Musculoskeletal injuries caused by lifting and moving 3D printers (1).	2	In each case: One mark for identifying a health and safety issue which needs to be

Question	Indicative Content	Marks	Guidance
	- Stereolithography (SLA) and Digital Light Processing (DLP) printers require eye protection. This is due to the potential for UV light exposure and resin splatters to cause harm to the eyes (1). - Any other valid suggestion.		risk assessed when using a 3D printer. Specific reference to the context in the question is needed for marks to be awarded.
(e)	$\tan(x) = \text{opp/adj}$ [1] $\tan(x) = 5 / 8$ $x = \tan^{-1}x (5/8)$ [1] $= 32.00538321$ [1] $= 32$ [1]	4	Award four marks as follows: One mark for recalling correct trigonometry formula. One mark for manipulation of trigonometry formula. One mark for calculating $\tan x$. One mark for calculating angle x to 2 significant figures. If correct answer is given without working out shown award full marks.

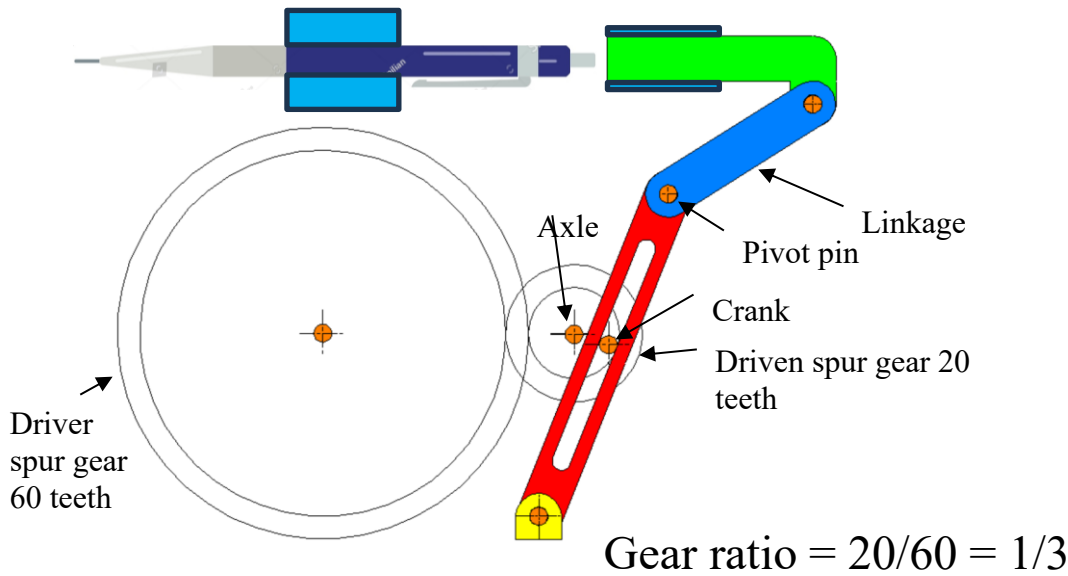
Question		Indicative Content	Marks	Guidance
				Where an incorrect answer is given working out should be used to credit appropriate marks.
4	(a)		6	1 mark for pull down resistor and value 1 mark for correct connections of PTM switch and resistor to 5V rail, 0V rail and microcontroller 1 mark for connecting microcontroller to 5v and 0v rails. 1 mark for use of MOSFET – this may be N-Channel or P-Channel. Note: diagram shows N-Channel MOSFET 1 mark for correct connections to gate, drain and source

Question		Indicative Content	Marks	Guidance
				1 mark for diode and correct direction in parallel with motor
	(b)(i)	Ring and pinion gear system (1).	1	One mark for identifying the gear system. Specific reference to the context in the question is needed for marks to be awarded.
	(ii)	Possible responses may include: • Due to the arrangement of the “ring” and “pinion” gears, all pinion gears will move at the same rate (1). This means that the pencil will be sharpened evenly (1). • This mechanism allows the pencil to be positioned on the central axis (1) allowing it to be held stationary by the user while it is sharpened (1). • A number of helical sharpening blades are possible, one per pinion gear (1) providing force from the cutting blades onto the pencil from more than one direction towards the central axis, thus keeping the pencil on the central axis during cutting (1). • The ring and pinion gear system is compact and can fit into a small space (1) while providing a high gear ratio (1). • Any other valid suggestion.	2	Up to two marks for explaining why this gear system would be used in product. Specific reference to the context in the question is needed for marks to be awarded.

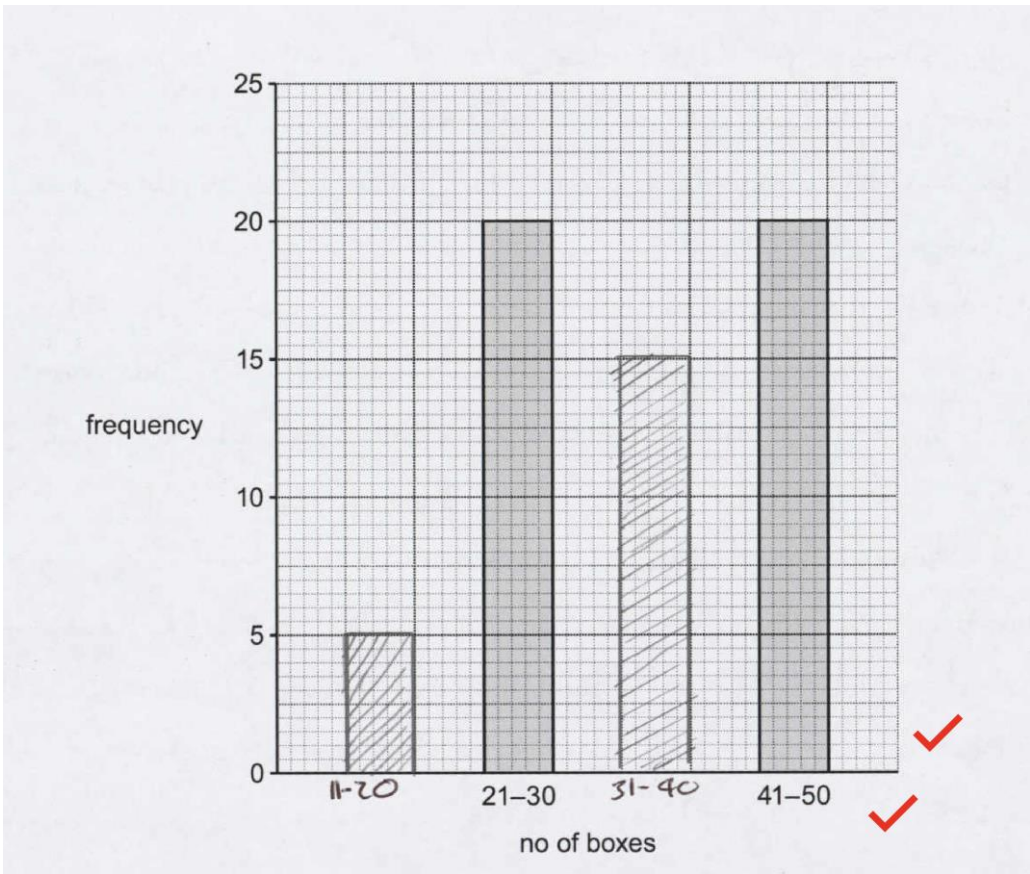
Question	Indicative Content	Marks	Guidance
(c)	Indicative content: Blades manufactured from hardened steel bar using a CNC lathe: 1. Face-off end of bar. 2. Drill end with centre-drill. 3. Drill hole through the bar for central pivot pin to locate. 4. Support bar with running centre. 5. Flutes rough cut in a spiral using a computer guided grinding wheel. 6. Sharp cutting blades cut by a second grinding wheel or a dovetail milling cutter. 7. Part-off the blade.  The sketches show the following steps: Step 1: A bar is held in a CNC lathe chuck. A left-hand cutting tool is used to face-off the end of the bar. Step 2: A centre drill is used in a drill chuck to create a centre hole in the bar. Step 3: A drill bit is used in a drill chuck to drill a hole through the bar for a pivot pin.	6	Level 3 [5-6 marks] The candidate has demonstrated a thorough understanding of the process needed to manufacture the metal helical sharpening blades 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. Level 2 [3-4 marks] The candidate has demonstrated a sound understanding of some aspects of the process needed to manufacture the metal helical sharpening blades with reasonable use of technical terms and some consideration of any equipment, machinery and materials required. Sketches, if

Question	Indicative Content	Marks	Guidance
	 4/5) live centre Grinding wheel moves along length of bar. Grinding wheel rough cuts flutes Roughly ground flutes 6) Cross-section of bar dovetail milling cutter cuts fluted blades sharp. Steel cut away by cutter. - dovetail cutter is moved along length of bar. Bar rotates Sharply cut by dovetail milling cutter.		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. Where candidates have used die casting, award a maximum of 4 marks (Level 2) for a thorough response. Level 1 [1-2 marks] The candidate has demonstrated a limited knowledge of the process, applying knowledge in a basic way to show how to manufacture the metal helical sharpening blades 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

Question	Indicative Content	Marks	Guidance
	Alternatively, the blades could be made from a mild steel bar and then hardened: 1. Turned on a lathe to create the basic shape. 2. Thread rough cut using a shaped cutting tool that is driven into the thread shape by engaging the lead screw. 3. Blade smoothed using a grinding machine. 4. Tips of the blade case hardened by heating the edges of the cutting blade with a carbon rich flame. 5. The steel absorbs the carbon, and this raises its hardness if the cutter is then quenched in oil. 6. Further heating of the blade to temper the cutting edge to remove potential brittleness. Any other valid suggestion.		not exist and if anything is basic in nature. 0 marks No response or no response worthy of credit.

Question	Indicative Content	Marks	Guidance
(d)	Indicative Content:  Gear ratio = $20/60 = 1/3$	5	One mark for use of appropriate drive system e.g. gears, pulleys. One mark for representing correct gear ratio of 1:3. One mark for large driver gear and smaller driven gear. One mark for use of a linkage and pivot pin. One mark for use of a crank.

Question	Indicative Content	Marks	Guidance
(e)	$f = ma$ (Newton's 2nd Law of Motion) = [1] $m = 0.02 \text{ kg}$, $a = 0.01 \text{ m/s}^2$ $f = 0.02 \times 0.01$ $f = 0.0002^* \text{ N}$ [1] $= 2 \times 10^{-4} \text{ N}$ [1]	3	Award three marks as follows: One mark for recalling Newton's formula. One mark for calculating force in Newtons. One mark for displaying answer in scientific notation. 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.

Question		Indicative Content			Marks	Guidance
	(f)(i)	No of Boxes	Tally	Frequency	1	One mark for completing chart correctly. Award mark for 15 bar gates or total
		10-20		5		
		21-30		20		
		31-40		15		
		41-50		20		
	(ii)				2	Award two marks as follows: One mark for correct labels on axes. One mark for completion of bar chart. Note: allow for ECF carried forward from fi when drawing second bar. 1) Accept clear intention of bar chart but do not accept vertical line. 2) Bars should be the same width. 3) Bars should not be touching.

Question	Indicative Content	Marks	Guidance
5	(a)* Indicative content: Material handling systems: Benefits • Low labour cost. • Low production cost through economies of scale. • No production loss through disputes. • Consistent quality. • Very efficient stock-control system enables JIT manufacture. • System checks and modifications are easy to carry out. • Any other valid suggestion. Limitations • Expensive initial layout. • System breakdown is costly. • Specialised workforce requires regular training. • Protocols of all systems may not communicate. • Some flexibility in processing is required to enable manufacture of different products. • Any other valid suggestion. Robot arms: Benefits • Decreased cost per unit – throughput speeds increase, which directly impacts production rates and results in lower costs per unit. • Improved quality – tasks are performed with accuracy and precision every time and the amount of raw material used can be reduced, decreasing costs on waste. • Increased safety – robots increase workplace safety and can perform dangerous applications in hazardous settings. They can undertake lifting operations and tasks that humans find tedious.	8	Level 3 [6-8 marks]: The candidate has a clear understanding of computer controlled machinery used during industrial production. They produce a thorough discussion in relation to the question by explaining the benefits and limitations of using computer-controlled machinery during industrial production. The explanation is clear and well-developed and the two bullet points will be used effectively to exemplify the points being made. <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> Level 2 [3-5 marks]: The candidate has a reasonable

Question	Indicative Content	Marks	Guidance
	• Adaptable – they can be reprogrammed to carry out new tasks once an operation is completed. • Accuracy monitoring – they may be fitted with sensory feedback enabling them to check production quality and self-rest as necessary. • Any other valid suggestion. Limitations • Expensive to produce and program. • System breakdown is costly. • Reduced workforce. • Specialised programmers and maintenance workforce require training. • Routine maintenance is required to keep optimal operation. • Any other valid suggestion.		understanding of computer controlled machinery used during industrial production. They produce a sound discussion in relation to the question by explaining the benefits and/or limitations of using computer-controlled machinery during industrial production The explanation is sufficient although one or two opportunities are missed in terms of using either bullet point on offer. <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> Level 1 [1-2 marks] The candidate has a basic knowledge of the use of computer controlled machinery. Any reference to either

Question	Indicative Content	Marks	Guidance
			benefits or limitations is largely descriptive in nature. The response makes limited use of either bullet point if any and contains no analysis or evaluation. <i>The information has some relevance and is presented with limited structure or detail. The information is supported by limited evidence.</i> 0 marks No response or no response worthy of credit.
(b)	Possible inspection checks for ensuring consistent accuracy and quality of products may include: Visual checks (1). • Surface finishes can be checked against examples (1). • The quality of fit of components can be checked with gauges (1). • Quality of finish checks (1). Detailed data comparisons against the specification (1). • The weight of the product can be checked (1). • Select 1 in 100 products or components to check dimensional tolerances (1). Process control. By planned maintenance (1). • Machines are serviced and maintained on a scheduled or planned basis, therefore the	4	In each case: One mark for identifying a method of ensuring consistent accuracy and quality of products during commercial manufacture. One mark for explaining method given.

Question		Indicative Content	Marks	Guidance
		possibility of the machine becoming less accurate is eliminated (1). Accuracy-of-dimensions checks (1). • Using go / no-go gauges (1). Any other valid suggestion.		

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