OCR
Oxford Cambridge and RSA

Monday 12 May 2025 – Afternoon

AS Level in Design and Technology: Design Engineering

H004/01 Principles of Design Engineering

Time allowed: 1 hour 45 minutes

You can use:
- a ruler (cm/mm)
- a scientific calculator
- geometrical instruments

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **90**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

1 **Fig. 1.1** shows a games console from the 1980's.

Fig. 1.2 shows a modern games console.

Fig. 1.1

Fig. 1.2

(a) Identify and describe **two** technological advances which have influenced the evolution of games consoles.

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[4]

(b) Stakeholder feedback is important as it informs product development.

Identify and explain **one** way in which stakeholder testing could inform the development of games consoles.

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..... **[2]**

(c)* The rise in online gaming has led to an increase in the number of gaming accessories available to consumers. Examples of gaming accessories include steering wheels and pedals, controllers, headsets and external storage devices.

Discuss the possible implications of this growth on **energy sources** and the **environment**.

Use examples of products in your answer.

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Fig. 1.3 shows a games controller.

Fig. 1.3

Fig. 1.4 shows the outer shell of the games controller after disassembly.

Fig. 1.4

(d) Games controllers need to be structurally strong and durable.

Use **Fig. 1.4** to identify **two** features of the games controller that the designer has included to improve strength and durability.

Justify **each** of your chosen features.

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[4]

(e) Physical testing is essential during product development.

Identify **three** physical tests that could be undertaken on a games controller to meet the following criteria:

Accuracy .....

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Functionality .....

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Performance .....

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[3]

(f) During the physical testing of game controllers, there is a probability of 0.04 that a functional fault will occur and a probability of 0.024 that an accuracy fault will occur. Assume the two types of fault occur independently of one another.

Calculate the probability of **both** a functional fault and an accuracy fault occurring. Show your working. **[2]**

Probability .....

2 **Fig. 2.1** shows a jewellery holder in the shape of a hand that is manufactured using a 3D printer.

Fig. 2.1

(a) An important consideration is how much energy is used when printing one jewellery holder.

(i) The 3D printer prints for the **first 30 mins** at a power of **105 watts**.

1 watt = 1 Joule per second.

Calculate how much energy is used in the first 30 mins. Give your answer in Joules (J) and show your working. **[3]**

Energy ..... J

(ii) The 3D printer continues to print for a further **3 hr 22 mins** at **48 watts**.

Calculate how much energy is used in the remaining time. Give your answer in kilojoules (kJ) and show your working. **[3]**

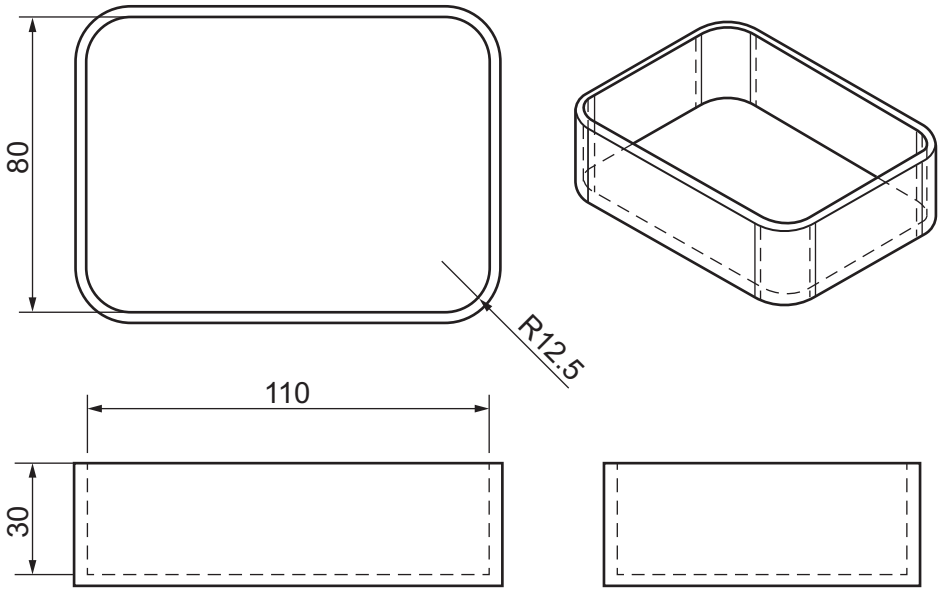
Energy ..... kJ

(b) Due to the success of the hand-shaped jewellery holder, the company is designing a trinket tray to store items such as earrings.

Fig. 2.2 shows the internal length and width of the trinket tray. The trinket tray has curved corners.

The internal height of the trinket tray is 30 mm. All other dimensions are shown in mm.

Fig. 2.2



(not to scale)

The volume of the cuboid section of the trinket tray is 264 000 mm^3.

The volume of the cylindrical section of the corners of the trinket tray is 14726.22 mm^3.

Calculate the volume of the space of the trinket tray. Give your answer in mm^3 to **1** decimal place and show your working. **[4]**

Volume ..... mm^3

(c) The hand-shaped jewellery holders and trinket trays will be despatched in appropriately sized containers.

The volume of the container for the trinket trays is 1872 cm^3.

The dimensions of the trinket tray container to the jewellery holder container are in a ratio of 3:5.

Calculate the volume of the larger container. Give your answer in cm^3 to **0** decimal places and show your working. **[3]**

Volume ..... cm^3

3 **Fig. 3.1** shows images of a type of exoskeletal 3D printed prosthetic leg.

Fig. 3.1

(a) Identify **two** different methods of computer-aided engineering (CAE) that could have been used to develop the design of the 3D printed prosthetic leg. **Ignore the ankle and knee joints as shown in Fig. 3.1.**

Justify **each** of your chosen methods.

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[4]

(b) The prosthetic leg is made bespoke for individual users.

Identify a **different** product that is manufactured using a one-off method of production. Justify your answer.

Product .....

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[2]

(c) The prosthetic leg is made from a metal alloy.

Explain **two** reasons why a metal alloy is a more appropriate material for the prosthetic leg than plastic or carbon fibre.

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[4]

(d) Identify **two** health and safety issues when using a 3D printer that should be included in a risk assessment.

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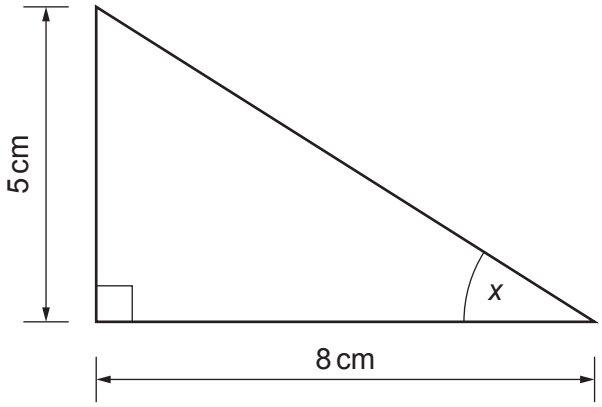
[2]

(e) The designer has used triangulation to increase the strength of the prosthetic leg.

Fig. 3.2 shows one of the triangles used.

Fig. 3.2



(not to scale)

Calculate angle *x*. Give your answer in degrees to **2** significant figures and show your working. **[4]**

x ..... °

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4 **Fig. 4.1** shows an electric pencil sharpener.

The electric pencil sharpener operates when a pencil is inserted and the user presses a push-to-make button switch on the top of the device for one second. The device then sharpens the pencil automatically before it comes to a stop.

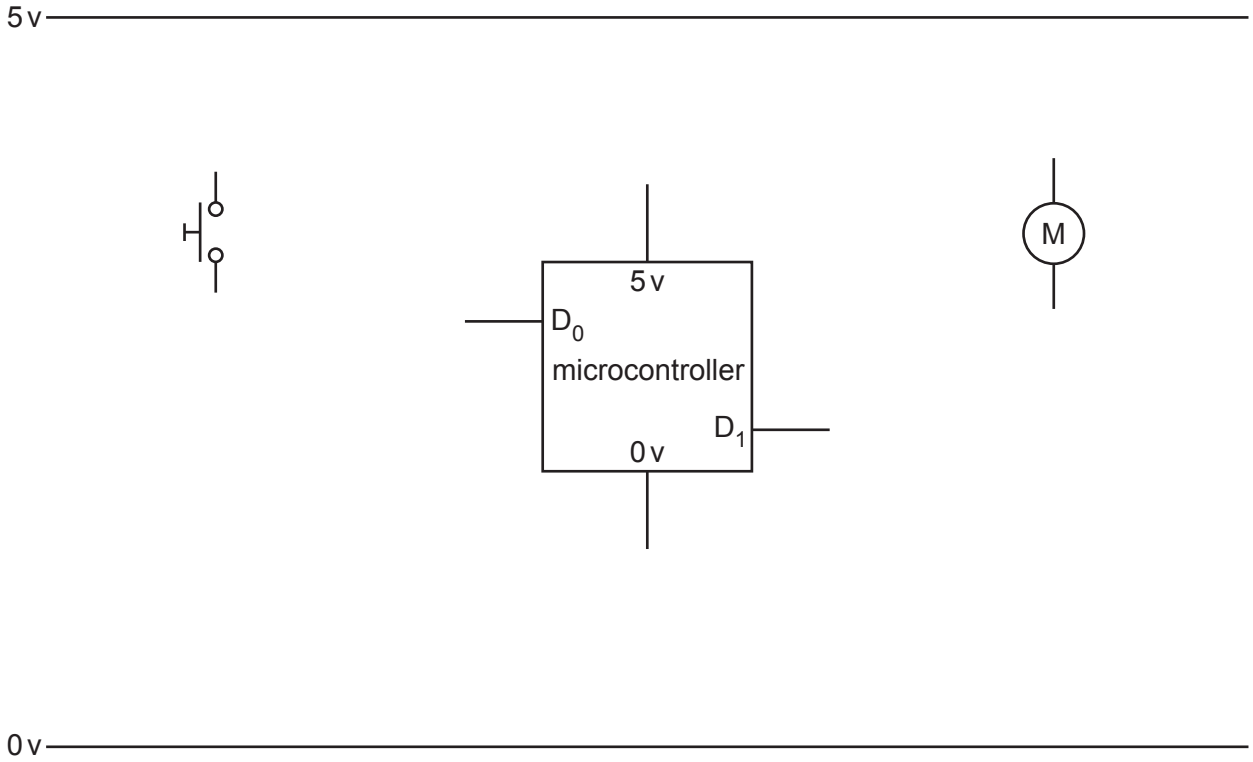
Fig. 4.1

(a) Complete the **electronic circuit below** for the electric pencil sharpener.

The electronic circuit should include the following functions:

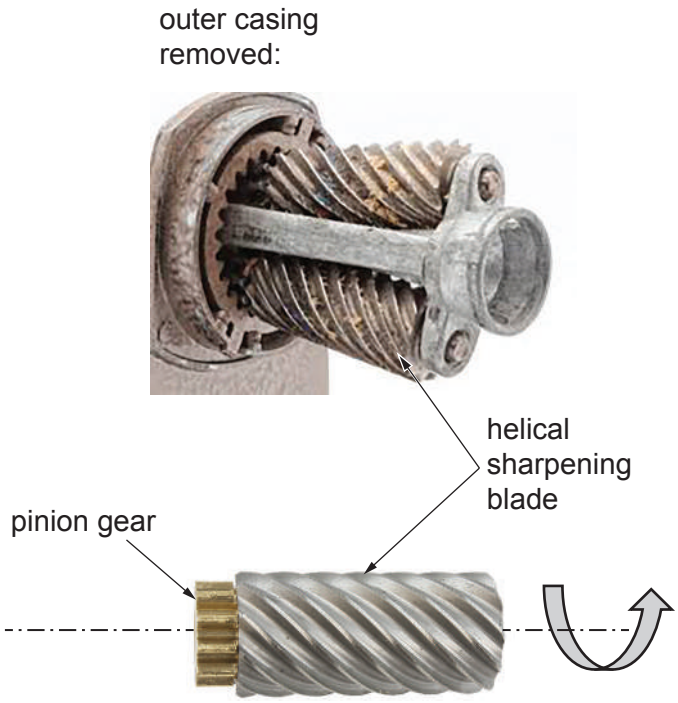
- input signal from the push-to-make button switch to the microcontroller
- power to the microcontroller
- output signal from the microcontroller to turn the motor.

[6]



(b) **Fig. 4.2** shows the sharpening mechanism and one of the metal helical sharpening blades that is used in the electric pencil sharpener.

Fig. 4.2



(i) Identify the gear system that is used in the electric pencil sharpener.

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(ii) Explain **one** reason why this gear system would be used.

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(c) Use annotated sketches and/or notes to show how the manufacturer would make a batch of 1000 metal helical sharpening blades as shown in **Fig. 4.2**.

Ignore the pinion gear in your answer.

Include any relevant equipment, machinery and materials. **[6]**

(d) Pencils come in many varieties. One type of pencil is a propelling pencil as shown in **Fig. 4.3**.

A propelling pencil involves the user pushing the button on one end of the pencil and the lead coming out of the other end. The button springs back when the user releases it.

Testing of this mechanism is important to the overall manufacturing process.

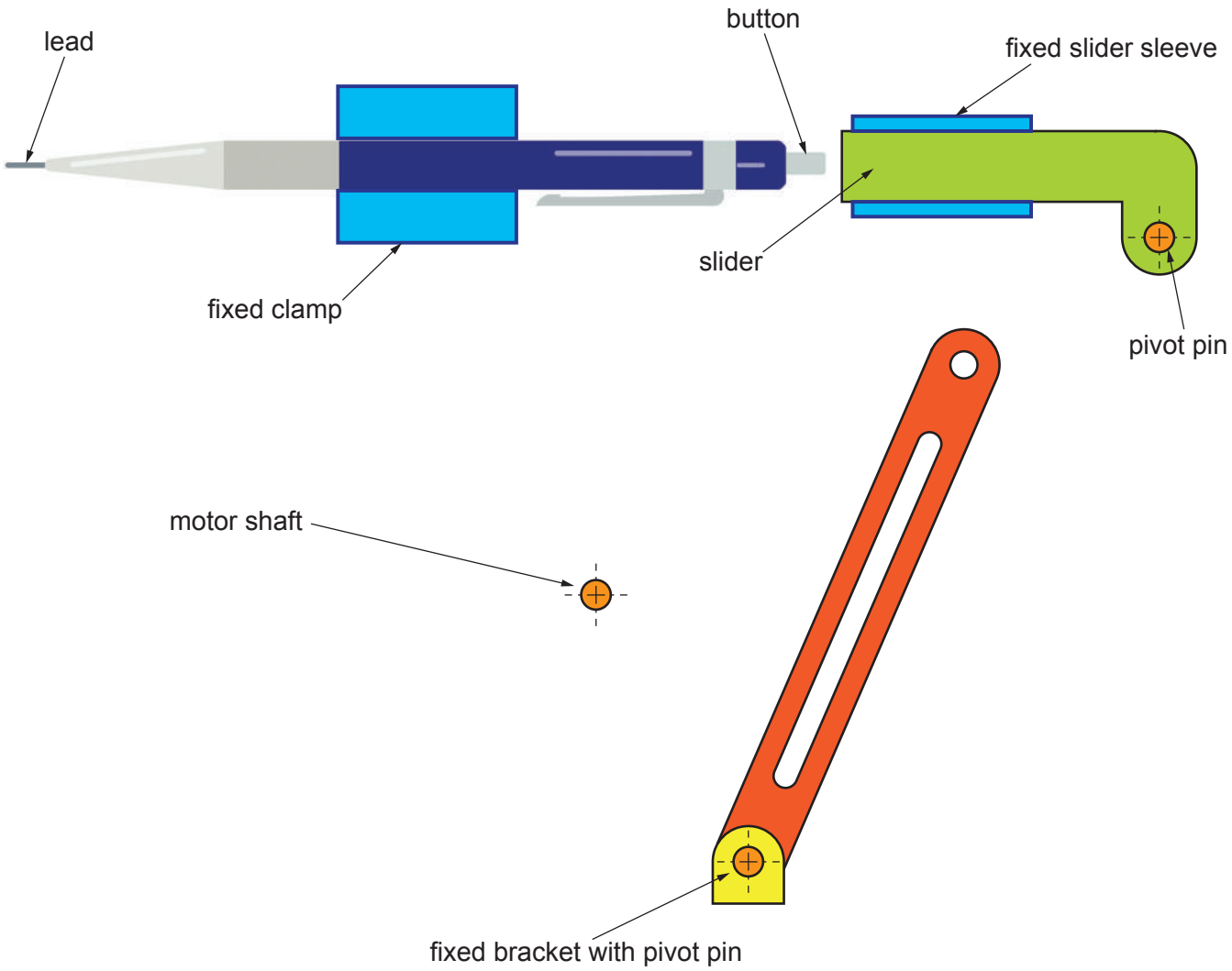
Fig. 4.3

Use annotated sketches and/or notes to complete the mechanical system for the test rig **on the page opposite**.

The mechanical system should meet the following requirements:

- convert **rotational motion** from the motor shaft to **reciprocating motion** of the slider
- the slider should push the button in and allow it to spring back out
- for **each revolution** of the motor shaft, the button of the propelling pencil should be pressed **three times**.

The propelling pencil is clamped in place to prevent movement of the body of the pencil. The slider moves inside a fixed sleeve. **[5]**


lead
button
fixed slider sleeve
fixed clamp
slider
pivot pin
motor shaft
fixed bracket with pivot pin

(e) The lead of a propelling pencil has a mass of 0.02 kg and moves with an acceleration of 0.01 m / s^2 when the button is pressed.

Calculate the force in Newtons (N). Give your answer in standard form and show your working. **[3]**

Force ..... N

(f) Market research has been carried out on the sales of the propelling pencil over a 60-day period. A record has been kept of how many hundreds of boxes of propelling pencils have been sold each day.

The information was recorded in the following table:

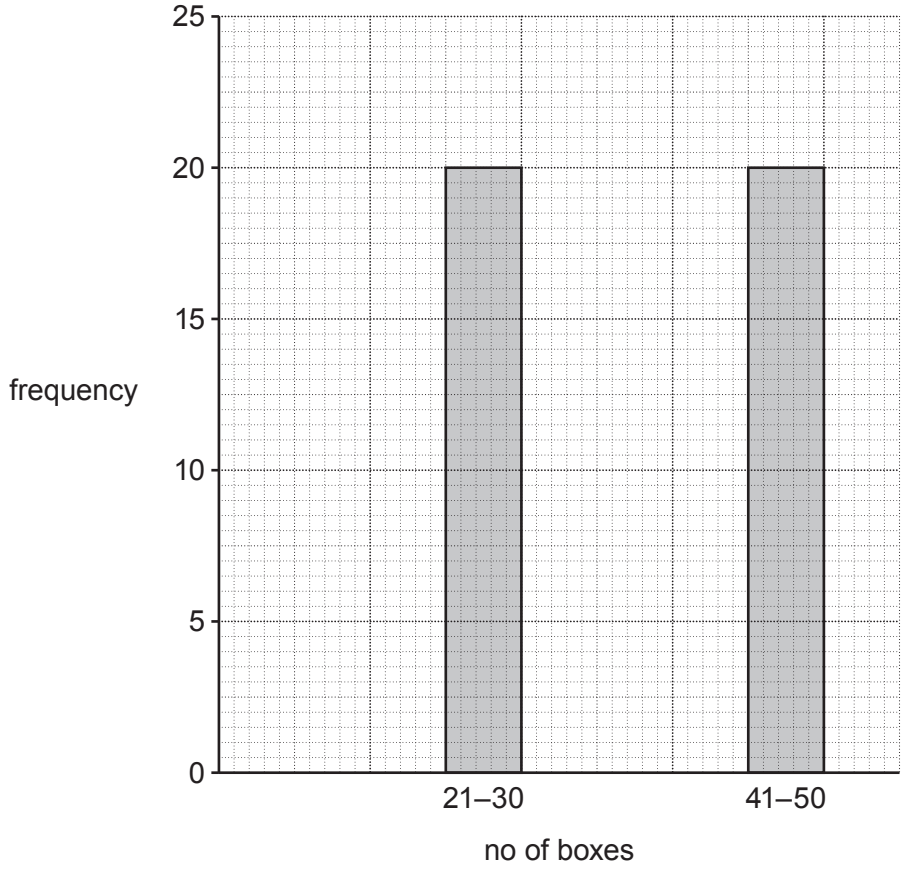
11	30	27	39	28	40
50	24	35	49	49	23
33	31	50	28	16	48
21	42	32	46	41	36
31	25	14	50	25	50
43	47	21	32	43	29
23	37	43	26	27	39
34	25	26	49	36	42
19	34	44	27	47	18
41	25	36	27	22	48

(i) A frequency table has been partially completed.

No of Boxes	Tally	Frequency
11–20	𝍸	5
21–30	𝍸 𝍸 𝍸 𝍸	20
31–40		
41–50	𝍸 𝍸 𝍸 𝍸	20

Complete the remaining entries in the frequency table. **[1]**

(ii) Use the graph paper **on the page opposite** to complete the bar chart provided. **[2]**



5

(a)* Discuss the benefits and limitations of using computer-controlled machinery during industrial production.

In your answer you **must** make specific reference to:

- automated material handling systems
- robot arms.

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(b) Products undergo checks during manufacture to confirm that they meet the technical specification and satisfy manufacturing tolerances.

Identify and explain **two** methods of ensuring consistent accuracy and quality of products during commercial manufacture.

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[4]

END OF QUESTION PAPER

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