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CANDIDATE NAME

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8164929405

DESIGN & TECHNOLOGY **0445/43**

Paper 4 Systems & Control **October/November 2025**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **one** question.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Answer in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 50.
- The number of marks for each question or part question is shown in brackets [ ].
- All dimensions are in millimetres unless otherwise stated.

This document has **20** pages. Any blank pages are indicated.

Section A

Answer **all** questions in this section.

1 Fig. 1.1 shows two structures made from composite materials.

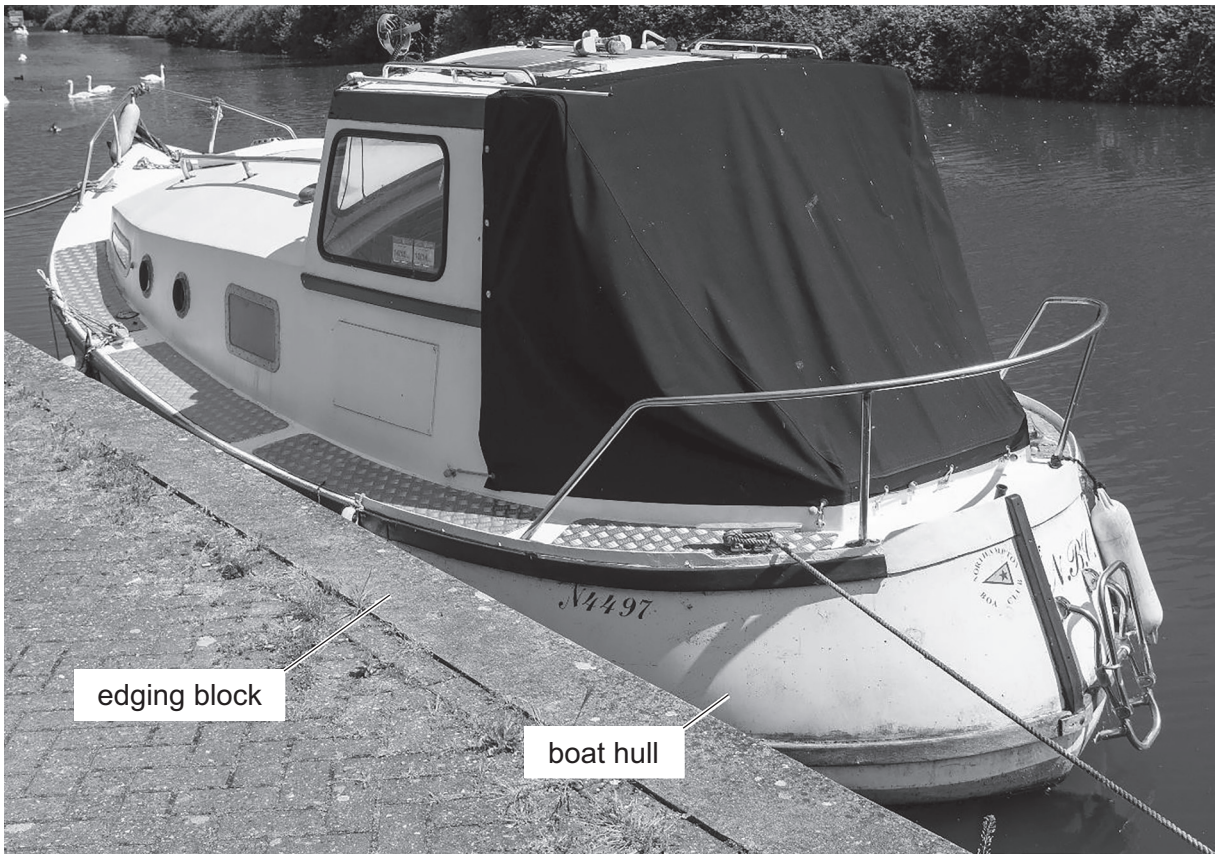


Fig. 1.1

(a) (i) Name a suitable composite material for the edging block.

..... [1]

(ii) Name **one** other composite material that can be used in a structure.

..... [1]

(b) Name the type of structure used for the boat hull.

..... [1]

2 Fig. 2.1 shows a rigid gate structure made from welded steel tubes.

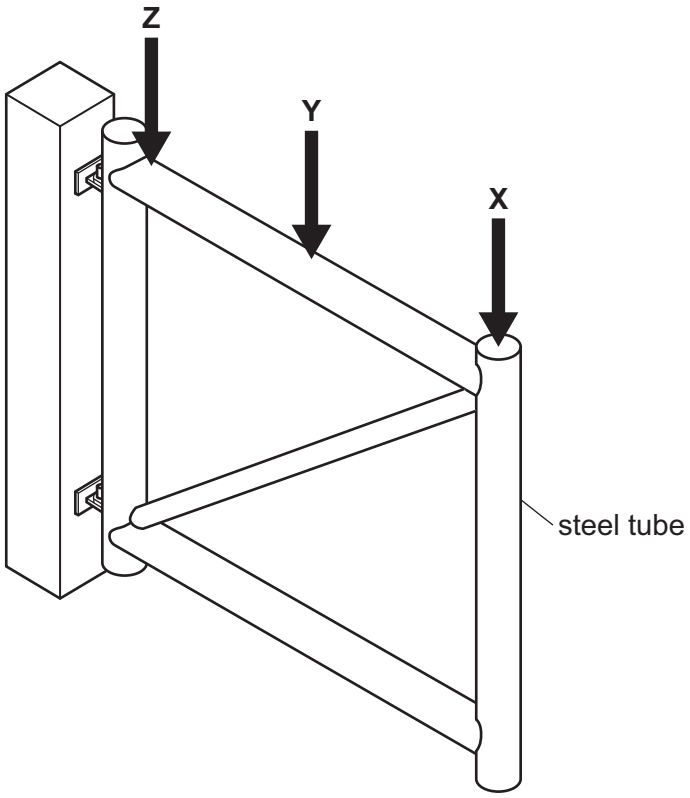


Fig. 2.1

(a) Explain why the structure in Fig. 2.1 will remain rigid when force **X** is applied.

.....

.....

..... [2]

(b) Name force **Y** in Fig. 2.1.

..... [1]

(c) Name force **Z** in Fig. 2.1.

..... [1]

3 **(a)** Give **two** benefits of using CAD/CAM in batch production manufacturing.

1 .....

2 .....

[2]

(b) Name **one** manufacturing machine that can be controlled by computer.

..... [1]

4 Fig. 4.1 shows three spur gears used to connect the drive shafts on gears **A** and **C**.

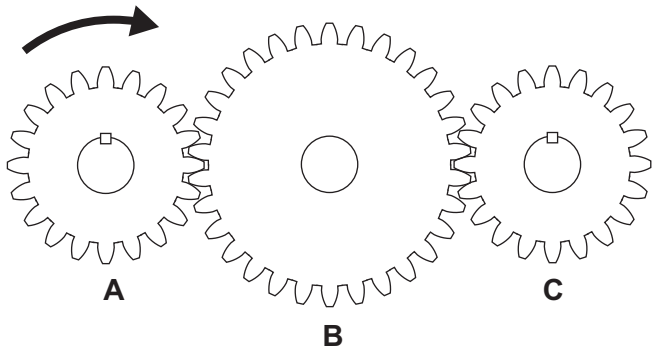


Fig. 4.1

(a) Add arrows to Fig. 4.1 to show the direction of rotation of gears **B** and **C**. [2]

(b) Explain why gears **A** and **C** are fixed to their shafts but gear **B** is free to rotate.

.....

.....

..... [2]

5 Give **two** reasons for using lubrication in a mechanism.

1 .....

2 .....

[2]

6 Draw the symbols used to indicate reciprocating motion and oscillating motion.

reciprocating motion oscillating motion

[2]

7 Fig. 7.1 shows part of an electronic circuit diagram.

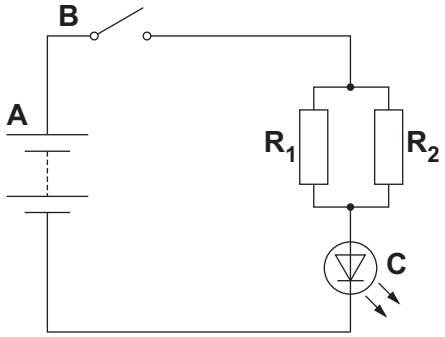


Fig. 7.1

(a) Name the following components shown in the circuit diagram.

A .....

B .....

C .....

[3]

(b) State the method of connection used for $\mathbf{R_1}$ and $\mathbf{R_2}$.

..... [1]

8 State what is meant by the term 'PTB' when used to describe a switch.

..... [1]

9 Give **two** reasons why it is difficult to recycle electronic components.

1 .....

.....

2 .....

.....

[2]

Section B

Answer **one** question from this section.

10 Fig. 10.1 shows a peg puller for removing large tent pegs from the ground.

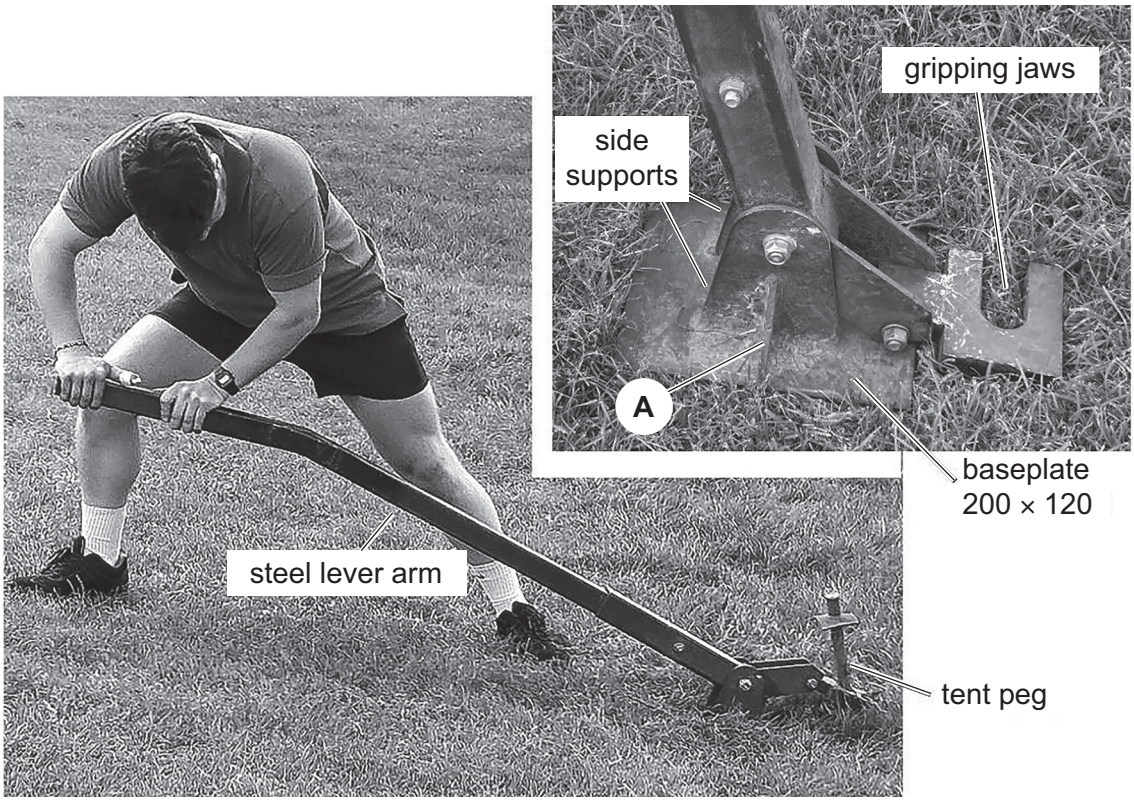


Fig. 10.1

(a) (i) State the order of lever used in the peg puller.

..... [1]

(ii) Give the name of feature **A** on the baseplate in Fig. 10.1.

..... [1]

(iii) State the purpose of feature **A**.

..... [1]

(iv) Explain why the base plate is needed at the point of contact with the ground.

.....

.....

..... [2]

(v) Name the force that will act on the ground beneath the base plate.

..... [1]

(vi) Fig. 10.2 shows a dimensioned view of the peg puller.

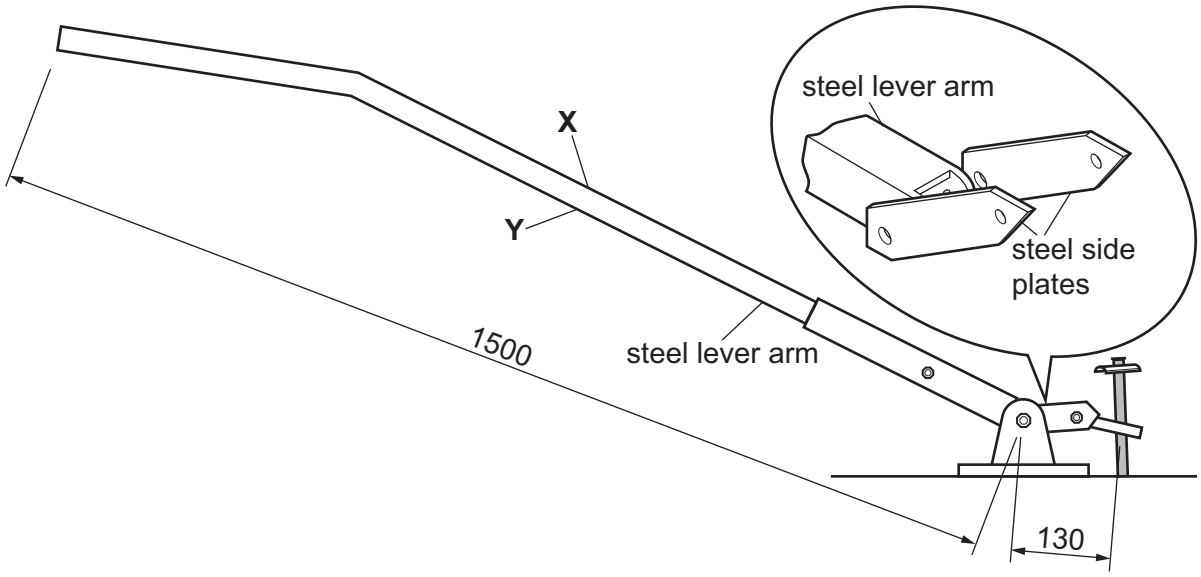


Fig. 10.2

Name the forces that will act on the upper surface **X** and the lower surface **Y** of the steel lever arm when it is operated.

X .....

Y .....

[2]

(vii) State **one** method that could be used to permanently join the steel side plates to the steel lever arm.

..... [1]

(viii) Calculate the approximate force that is available to pull the tent peg when an effort of 200 N is applied to the end of the lever arm.
Include units in your answer.

.....

.....

.....

..... [3]

(b) (i) Using sketches and notes, complete Fig. 10.3 to show a beam supported by walls **A** and **B**.

Fig. 10.3

[2]

(ii) Using sketches and notes, complete Fig. 10.4 to show a tie at joint **C**.

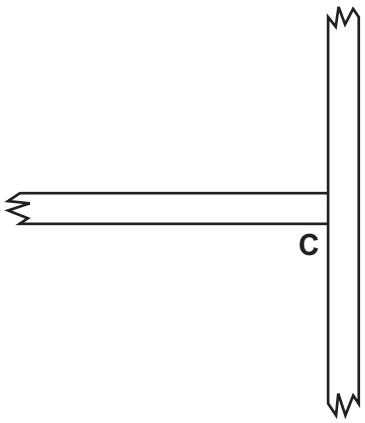


Fig. 10.4

[2]

(iii) Using sketches and notes, complete Fig. 10.5 to show a strut at joint **D**.

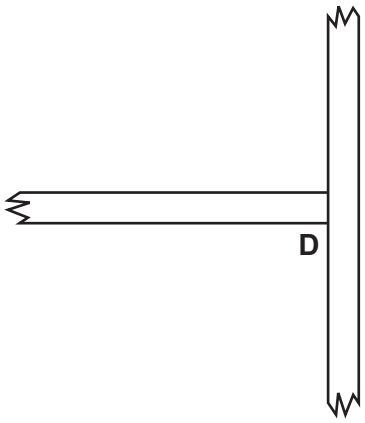


Fig. 10.5

[2]

(c) Fig. 10.6 shows the layout of timber in the base of a small wooden building.

Fig. 10.6

(i) Give **two** features of the timber used in the layout that will affect performance of the structure.

1 .....

2 .....

[2]

(ii) Give **two** reasons for using the spacing pieces in Fig. 10.6.

1 .....

2 .....

[2]

(iii) Use sketches and notes to show **one** way of securing the spacing pieces in position. List any fixings that will be used.

[3]

11 Fig. 11.1 shows an air compressor driven by an electric motor.

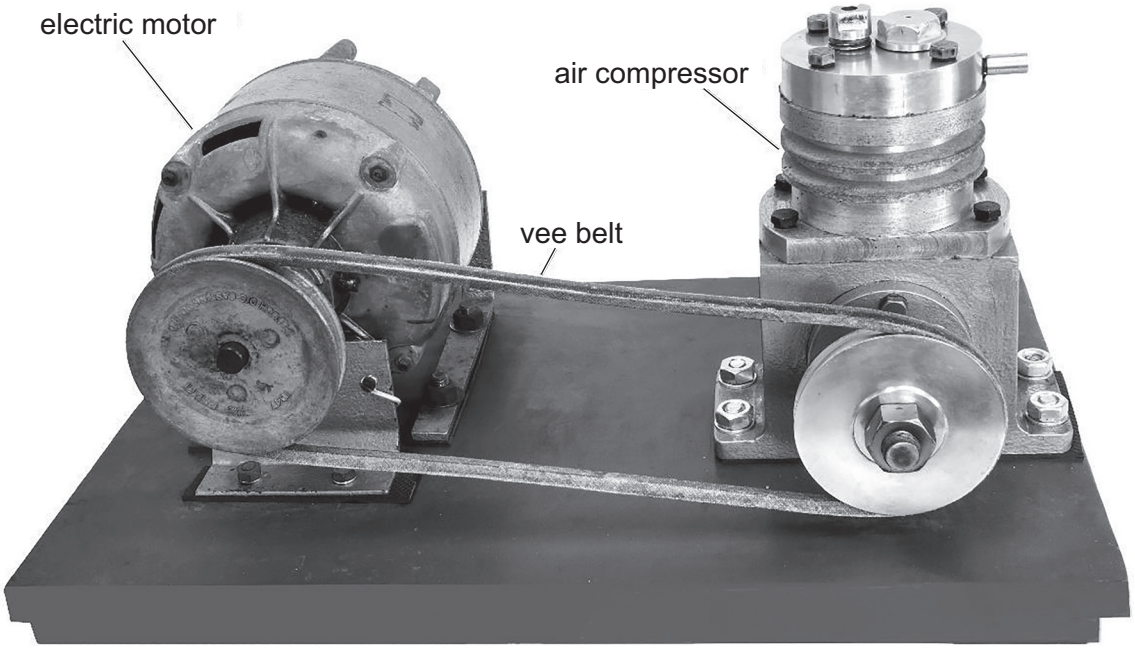


Fig. 11.1

(a) The electric motor uses a vee belt to connect to the air compressor.

(i) Name **two** other types of belt that could be used.

1 .....

2 .....
[2]

(ii) Explain why the vee belt is the most suitable method of connecting the electric motor to the air compressor.

.....

.....

..... [2]

(b) Fig. 11.2 shows the main moving parts of the air compressor.

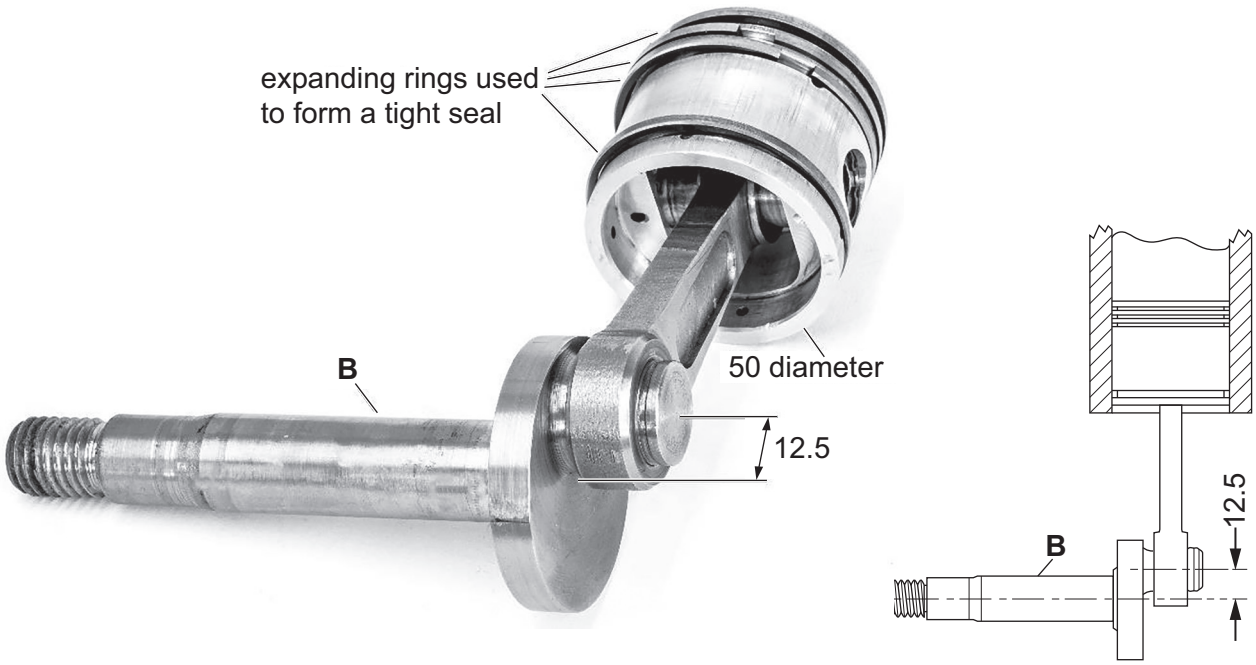


Fig. 11.2

(i) Use words from the list below to complete the description of the air compressor operating. Not all of the words will be used.

bearing connecting crankshaft cylinder gear piston pulley

The vee ..... transfers motion to the ..... causing it to rotate.

This in turn causes the ..... rod to move the..... .

[4]

(ii) Name the type of mechanism used to convert motion in the air compressor.

..... [2]

(iii) Calculate the volume of air that is displaced for each rotation of part **B**.
The formula for the area of a circle is $A = \pi r^2$.

.....

.....

.....

..... mm^3 [3]

(c) (i) Fig. 11.3 shows the small oil holes used to lubricate the plain bearings.

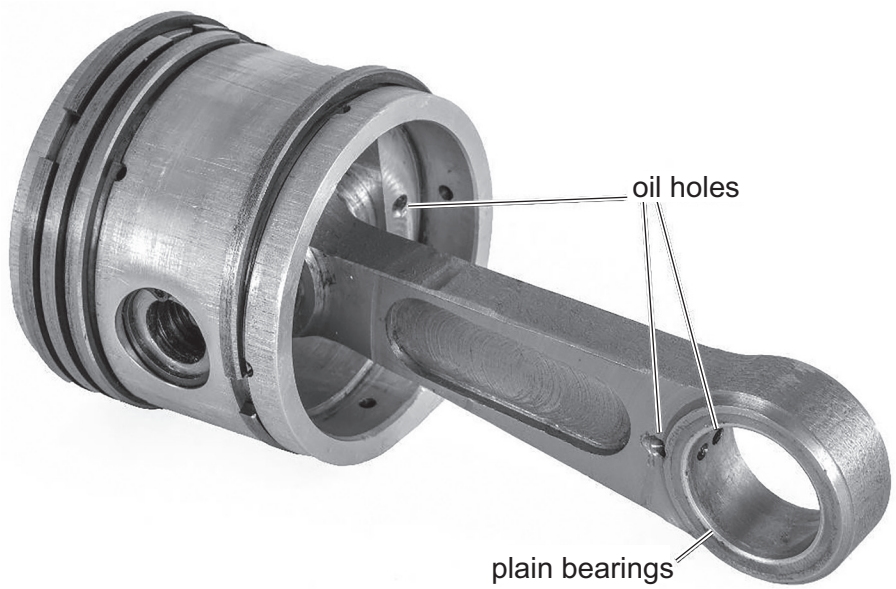


Fig. 11.3

Explain why grease would not be suitable for lubricating the plain bearings.

.....

.....

..... [2]

(ii) Name **two** alternative types of bearing that could have been used.

1 .....

2 .....

[2]

(iii) Give **one** practical benefit of using plain bearings in the compressor.

.....

..... [1]

(d) Fig. 11.4 shows two hexagonal head bolts of the same length, diameter and material.

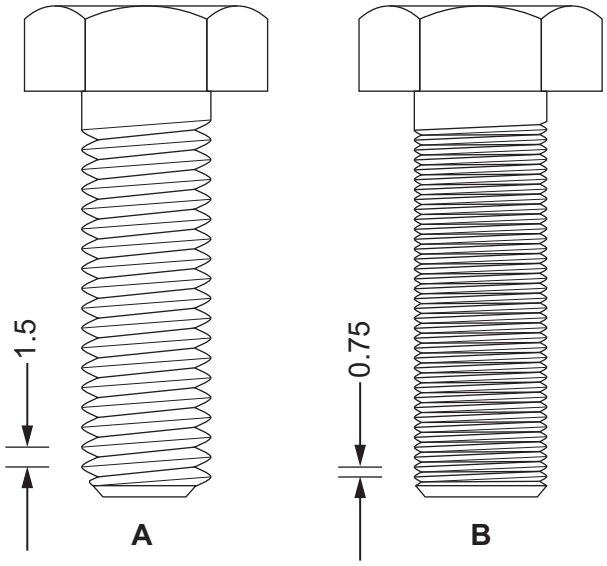


Fig. 11.4

(i) Give **one** difference that will be noticed when fitting the bolts into a threaded hole.

..... [1]

(ii) Explain why bolt **B**, which has a smaller thread pitch, will resist higher torque when being tightened.

.....

.....

..... [2]

(e) Fig. 11.5 shows a gear system.

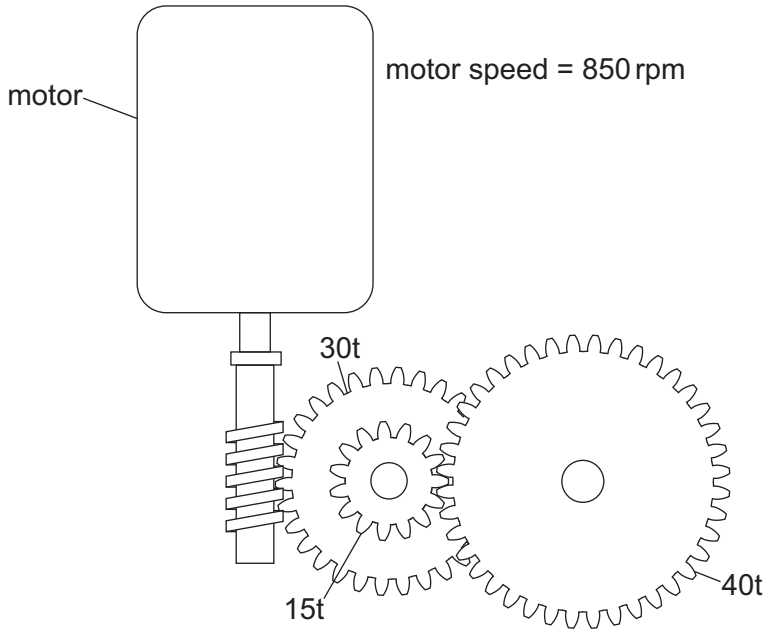


Fig. 11.5

(i) State the velocity ratio of the worm gear and 30t gear.

..... [1]

(ii) Calculate the speed of the 40t gear when the motor is turning.

.....

.....

.....

..... [3]

12 **(a)** Complete Table 12.1 by adding ticks (✓) to identify the type of material.
One has been completed for you.

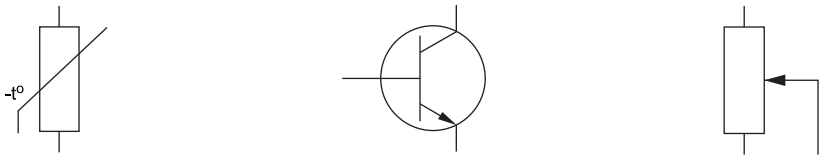
Table 12.1

material	conductor	insulator	semiconductor
aluminium			
germanium			
glass			
gold			
wood		✓	

[4]

(b) A cooling fan in a computer system has two heat sensors.
The cooling fan is switched on when either of the sensors show that a high temperature has been detected.

(i) Fig. 12.1 shows circuit symbols for some of the components in the circuit. Add the name to each circuit symbol.



A **B** **C**

....

[3]

Fig. 12.1

(ii) Describe how component **A**, a heat sensor, will react when exposed to different temperatures.

.....

.....

..... [2]

(iii) Fig. 12.2 shows a circuit diagram for one of the sensors used to detect a high temperature.

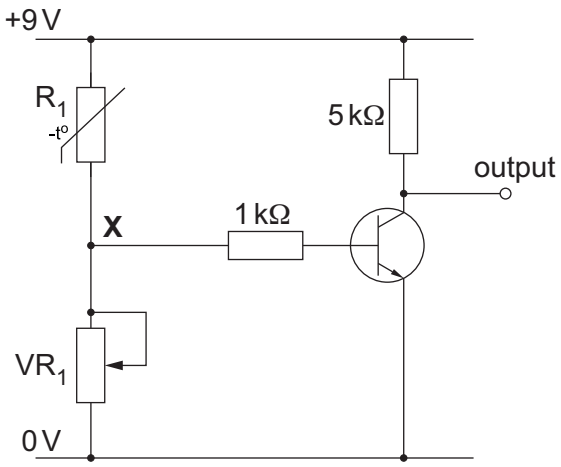


Fig. 12.2

Explain how the change in the sensor, as it heats up, is used to provide a signal at the output.

.....

.....

..... [3]

(iv) Calculate the voltage at **X** when R_1 is 5.45 kΩ and VR_1 is 422 Ω.

Use the formula $V_{out} = \frac{V_{in} \times VR_1}{(R_1 + VR_1)}$

.....

.....

.....

..... [3]

(v) State the purpose of the 5 kΩ resistor in Fig. 12.2.

..... [1]

(c) The signals from both sensors are sent to a logic integrated circuit (IC), where they are combined to give a signal that can operate the cooling fan.
Fig. 12.3 shows the logic gate arrangement.

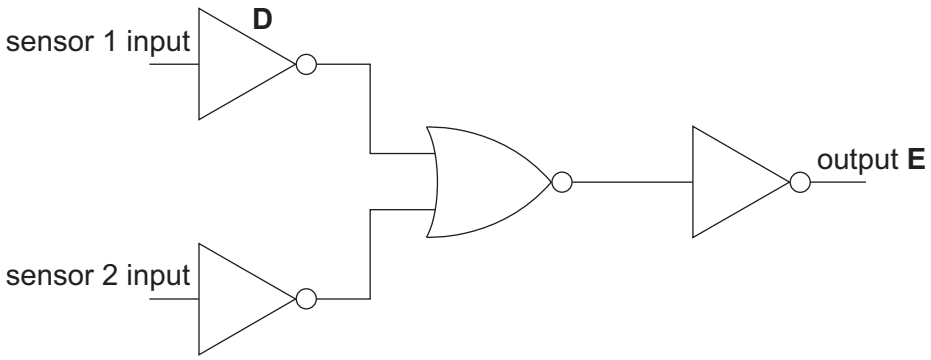
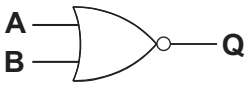


Fig. 12.3

(i) State the name of logic gate **D**.

..... [1]

(ii) Complete the truth table for a NOR gate.



A	B	Q
		1
		0
		0
		0

[2]

(iii) Draw the logic gate arrangement from Fig. 12.3 using only NOR gates.

[2]

(iv) Fig. 12.4 shows a Quad NOR gate IC.
Add connections to make the logic arrangement from Fig. 12.3.

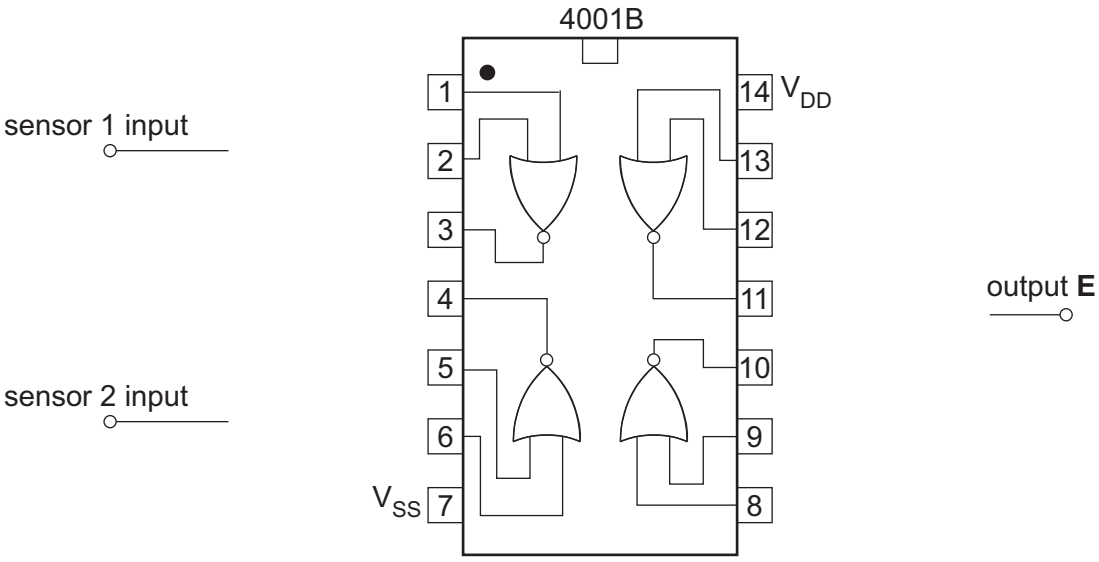


Fig. 12.4

[4]

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