OCR
Oxford Cambridge and RSA

# Monday 16 May 2022 – Afternoon

## AS Level in Design and Technology: Design Engineering

**H004/01** Principles of Design Engineering

**Time allowed: 1 hour 45 minutes**

*8 2 0 9 2 3 9 6 9*

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

*H 0 0 4 0 1*

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 **20** pages.

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

Answer **all** the questions.

**1** **Fig. 1.1** shows **two** images of an electric hole punching machine used to make two holes in a piece of paper.


**Fig. 1.1**

**(a)** **Fig. 1.2** shows the symbols which are marked on the base of the electric hole punching machine.

**Fig. 1.2**

State **one** benefit to the consumer of having these symbols on the electric hole punching machine.

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..... **[1]**

**Fig. 1.3** shows a simplified diagram of the electric hole punching machine mechanism, in particular how the motor drives the mechanism which connects to the lever and pins. All dimensions are shown in mm.

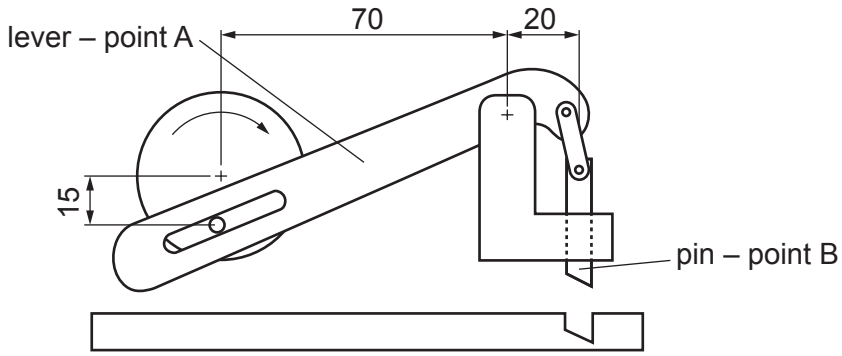


**Fig. 1.3**
(not to scale)

**(b) (i)** Explain why the designer decided that the motor should rotate in a clockwise direction on the electric hole punching machine.

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

The motor moves the mechanism one full revolution every time it is activated.

**(ii)** Identify the type of motion at lever point A and pin point B.

Motion at lever point A .....

Motion at pin point B .....

**[2]**

On **Fig. 1.1** a reverse button is labelled. This is pressed when the electric hole punching machine gets jammed so the user can reverse the motor and eject the pins from the paper.

**Fig. 1.4** shows an example of a motor reversal circuit.

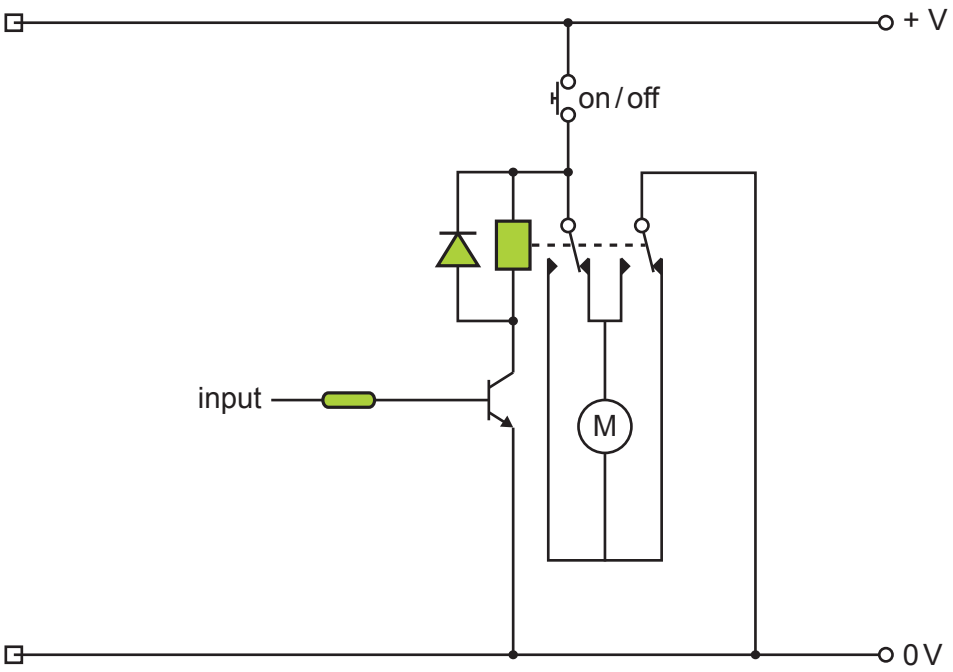


**Fig. 1.4**

**(c)** Describe how the circuit shown in **Fig. 1.4** operates.

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..... **[5]**

**(d)** The outer clear casing of the electric hole punching machine shown in **Fig. 1.1** is made from a thermoplastic material.

**(i)** Name a suitable thermoplastic material for the outer clear casing.

..... **[1]**

**(ii)** State **two** properties of the thermoplastic material you have identified in **part (d)(i)** that make it suitable for the outer clear casing.

Justify **each** of your answers.

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2 .....

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**[4]**

**(iii)** Name a suitable manufacturing method for the outer clear casing.

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**(iv)** State **two** reasons why the manufacturing method you have identified in **part (d)(iii)** is suitable for manufacturing the outer clear casing.

Justify **each** of your answers.

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**[4]**

2 **Fig. 2.1** shows the amount of carbon produced **per person** when travelling **one way** between London and Edinburgh. This carbon footprint is based on the plane and train carrying the same number of passengers (300) and both modes of transport being full.

**Amount of carbon produced per person (kg) when travelling from London to Edinburgh**

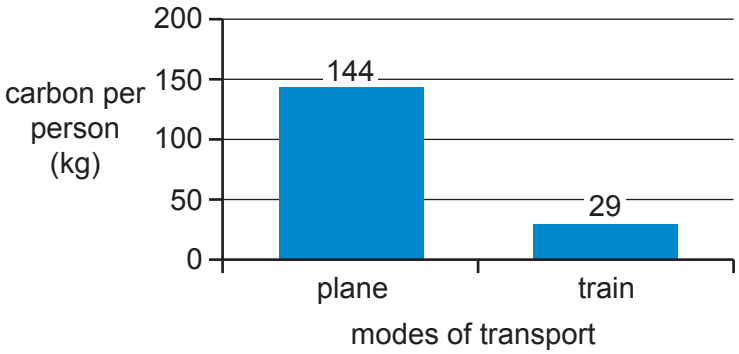


**Fig. 2.1**

**(a) (i)** The plane is only at **75% capacity**.

Calculate how much carbon in kg is produced **per person** when travelling **one way** by plane between London and Edinburgh. Show your working. **[4]**

Carbon ..... kg / per person

**(ii)** A mature tree on average can absorb 22 kg of carbon per year.

A person travels from London to Edinburgh **by plane**, then on the return journey **by train**.

Both modes of transport are at **75% capacity**.

Calculate how long it would take in years for 2 mature trees to absorb the amount of carbon produced by the person using the plane and the train to make the journey. Give your answer to **2** decimal places. Show your working. **[5]**

..... years

**(b)** To produce thin sheets of timber for plywood manufacture, a tree trunk (or log) is mounted on a large lathe. As the tree trunk rotates a long blade cuts a continuous thin sheet (veneer) as shown in **Fig. 2.2**.

A tree has a diameter of 1.8 m.

The tree trunk rotates for two revolutions around the lathe.

The thickness of each veneer sheet is 4 mm.

Calculate how long the veneer sheet would be in metres if the tree trunk was rotated around the lathe in this way. Give your answer to **2** decimal places. Show your working.

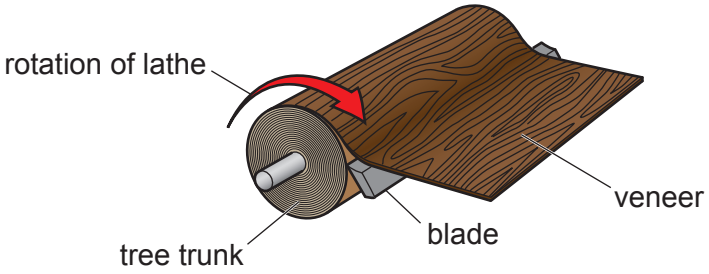


**Fig. 2.2**

**[5]**

Veneer sheet length ..... m

**3** **Fig. 3.1** shows a pair of glasses which can be used to correct poor eye sight when reading.

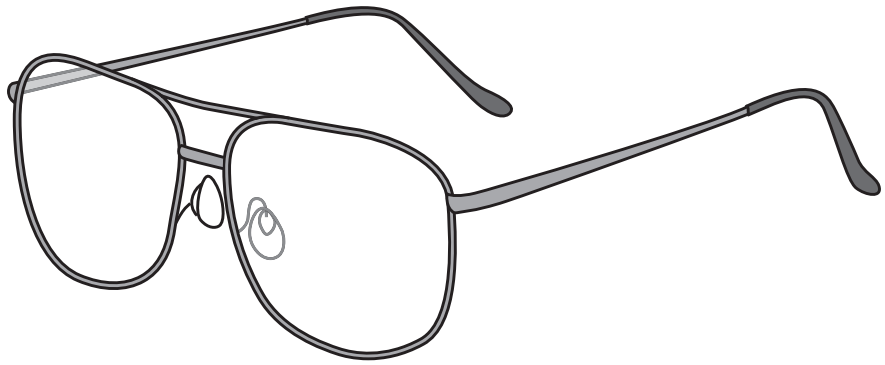

**Fig. 3.1**

Smart materials are used in many products in order to enhance function and/or aesthetics.

**(a)** Identify **two different** smart materials that could be used in the pair of glasses and for **each** smart material explain how it would enhance the function and/or aesthetics.

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**[6]**

**(b)** The material selection chart in **Fig. 3.2** shows the different material groups and how they compare in terms of Density and Young's Modulus.

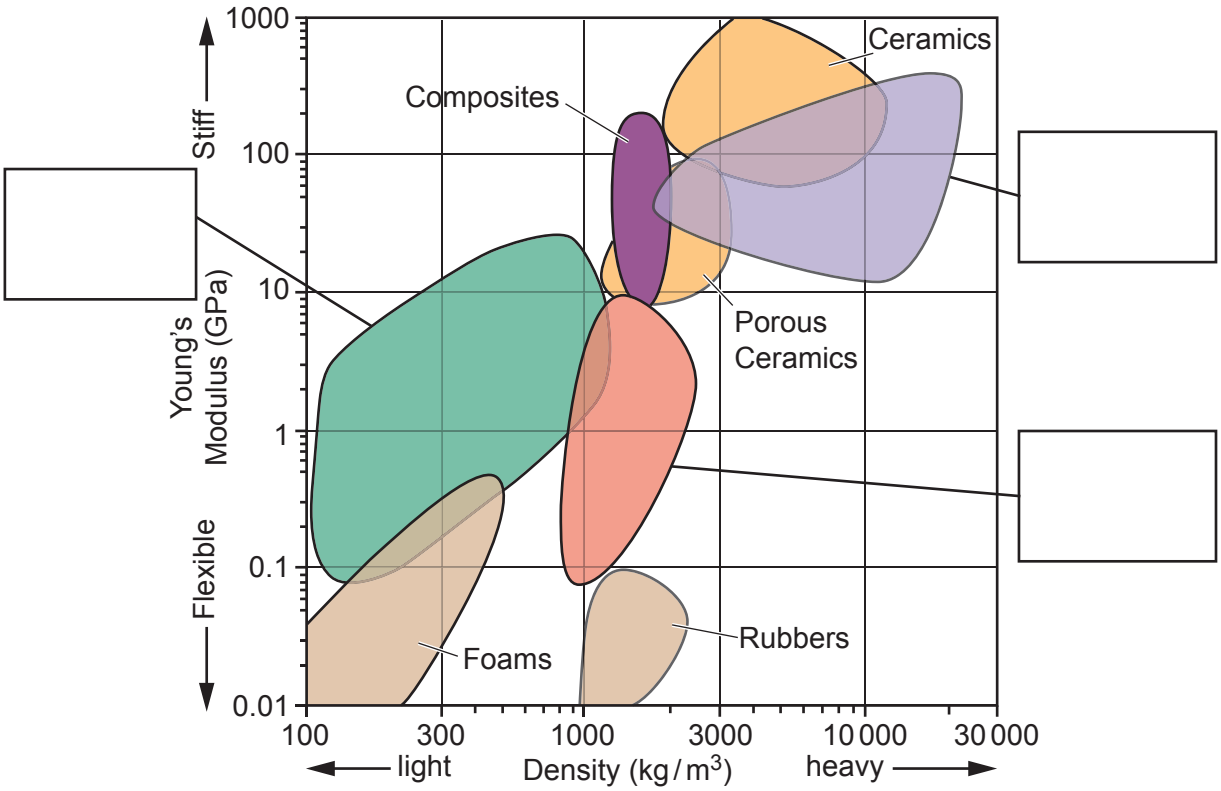


**Fig. 3.2**

**(i)** Complete the **three** missing material groups in **Fig. 3.2** above. **[3]**

**(ii)*** Discuss the importance to design engineers of studying material properties and characteristics when designing a product or component.

Refer to specific examples of products or components in your answer.

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4 **(a)** **Fig. 4.1** shows a conveyor system used to sort different boxes using a single acting pneumatic cylinder.

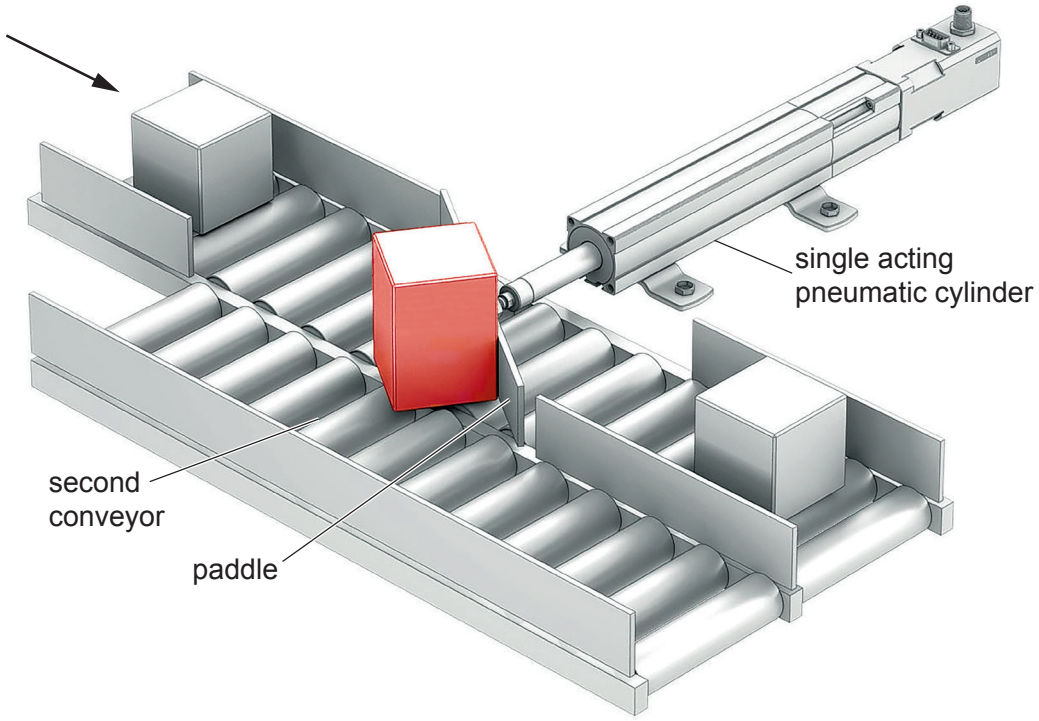


**Fig. 4.1**

**(i)** Identify **two** advantages of using a single acting pneumatic cylinder compared to a double acting pneumatic cylinder to push boxes to a second conveyor as shown in **Fig. 4.1**.

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**[2]**

**Fig. 4.2** shows a cut-away view of a single acting pneumatic cylinder with the formula showing how to work out the area of the piston head.

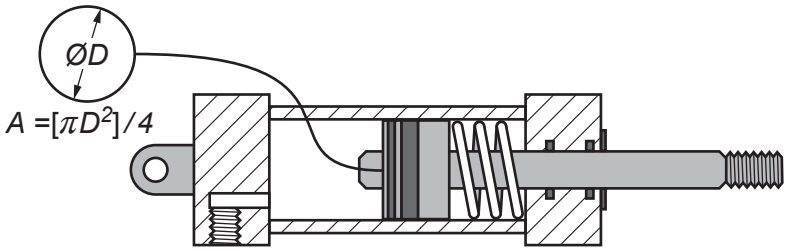



**Fig. 4.2**

**(ii)** The pressure within the cylinder is 0.3 MPa which exerts a force of 21.2 N onto the piston head.

Calculate the diameter of the piston head in mm to **2** decimal places. Show your working. **[4]**

Diameter of the piston head ..... mm

**(b)** Before the boxes reach the sorting area of the conveyer there is an LDR which has a laser shining on it.

When a box above a height of 450 mm travels past the LDR, the beam is broken and the LDR has no light shining on it.

This extends the single acting pneumatic cylinder which waits until the box has moved past it onto the second conveyor.

The paddle then returns to its original position waiting for the next tall box.

**(i)** Complete the circuit diagram in **Fig. 4.3** to reflect the process above.

Ensure the 3/2 value symbol is complete and when activated it receives 4.5 V. **[3]**

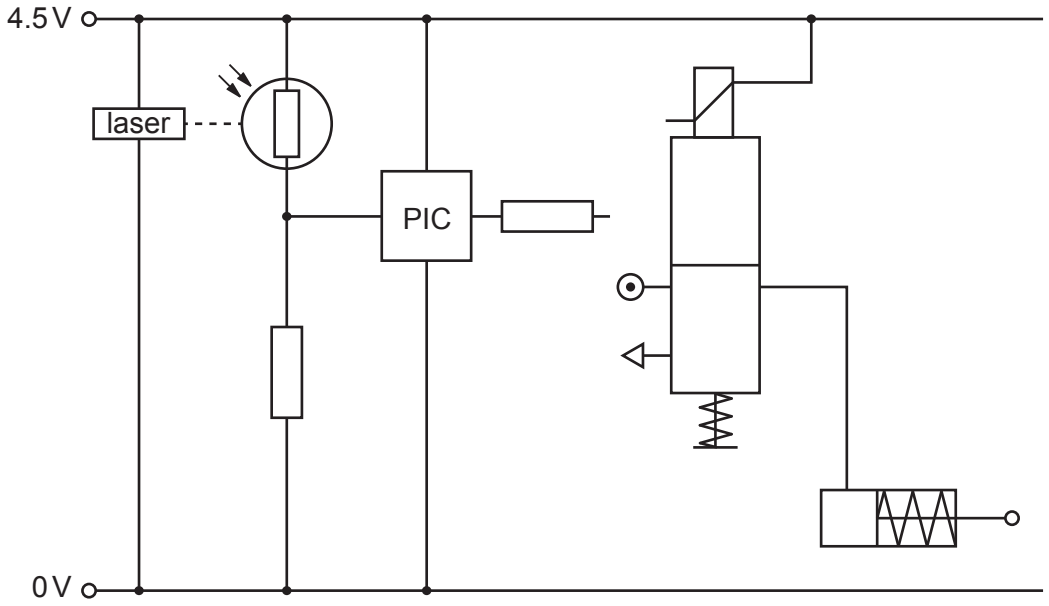
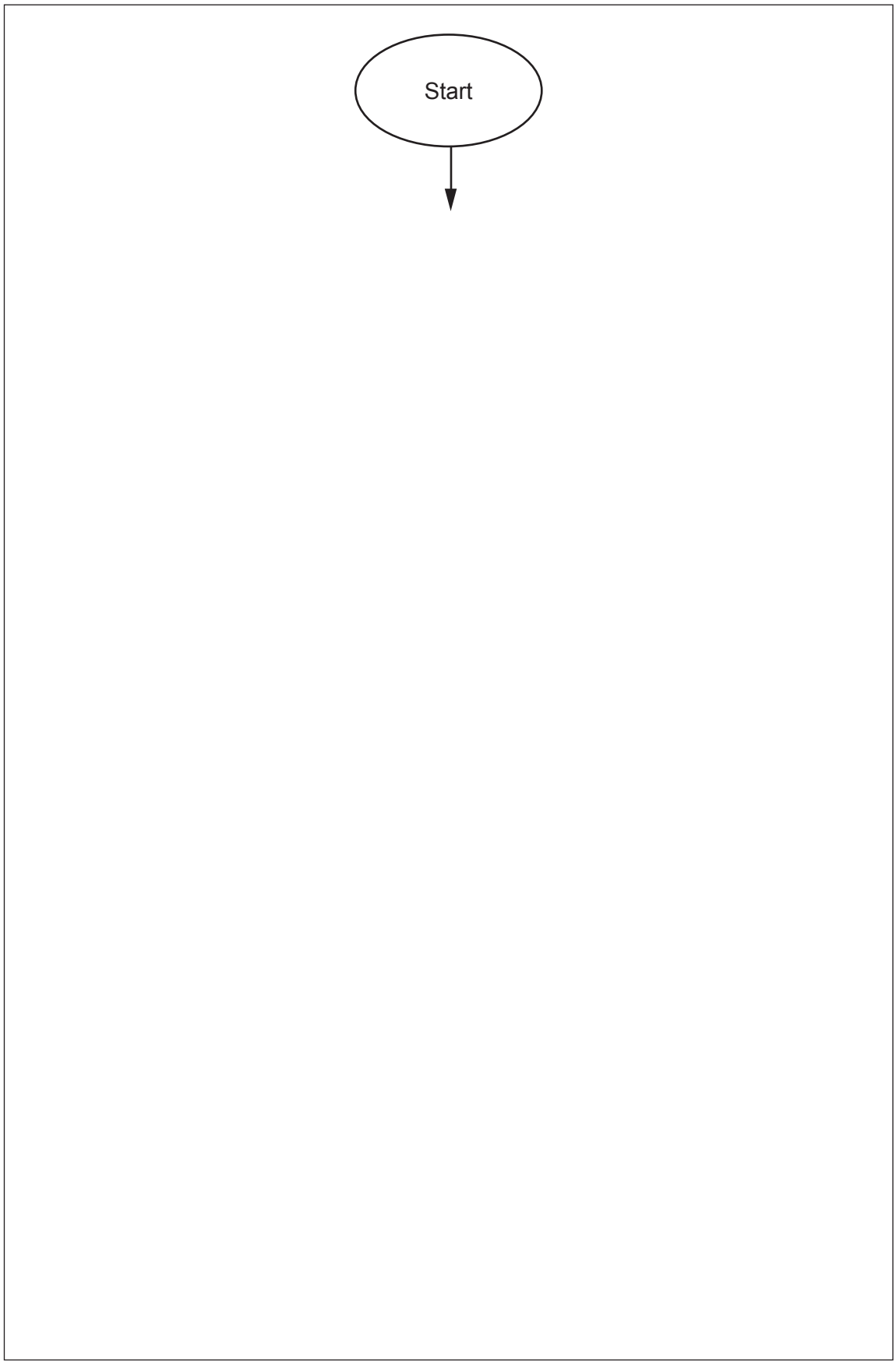



**Fig. 4.3**

**(ii)** Complete the flowchart to show how the system operates as described on the **previous page**. **[5]**

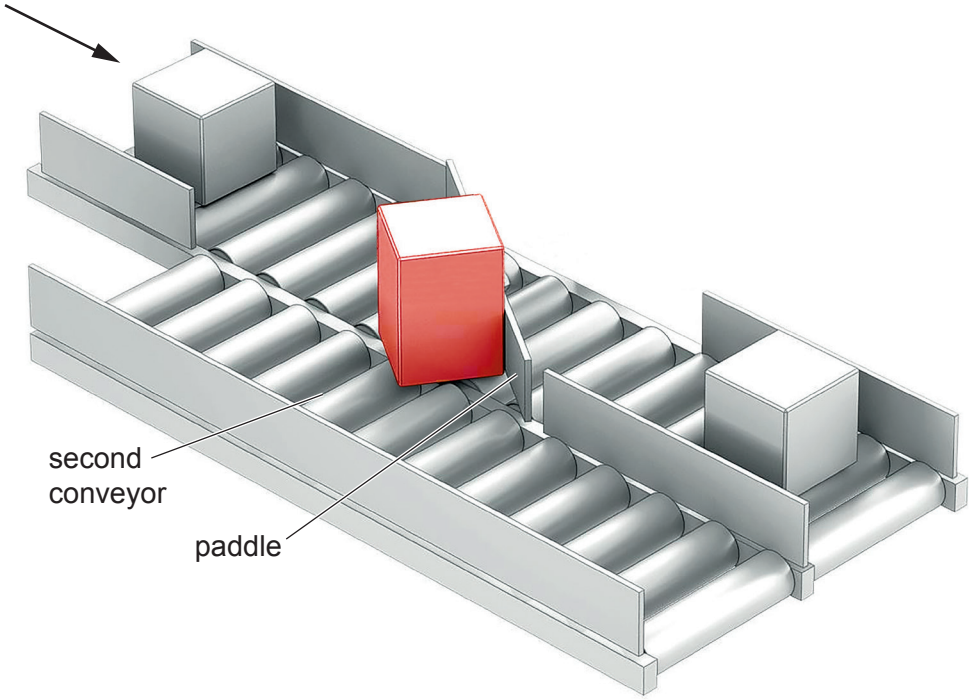


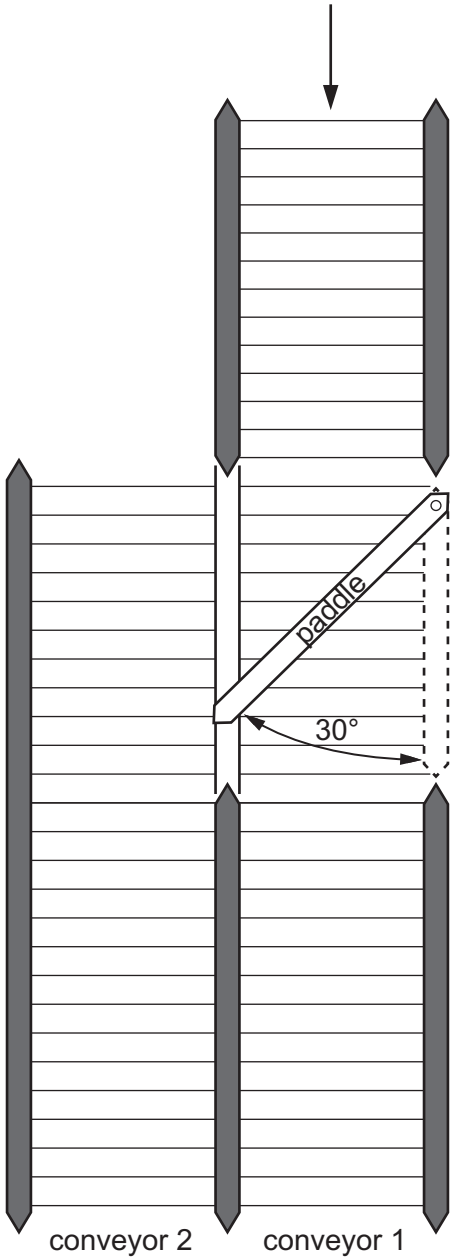
**(c)** In the box on **page 17** use annotated sketches and/or notes to show how an alternative method other than pneumatics or hydraulics could be used to control the paddle in order to move boxes from one conveyor to another.

Your answer must take account of the following:

- the ability to move the paddle +/– 30 degrees
- the attachment(s) on the paddle must be secure and also be able to be removed easily by an operator when needed
- the material(s)/component(s) to be used.

As a reminder here is **Fig. 4.1**: **[8]**





**(d)** Use **Fig. 4.4** to calculate the length of the throw of the paddle *t* in m to **2** decimal places. Show your working.

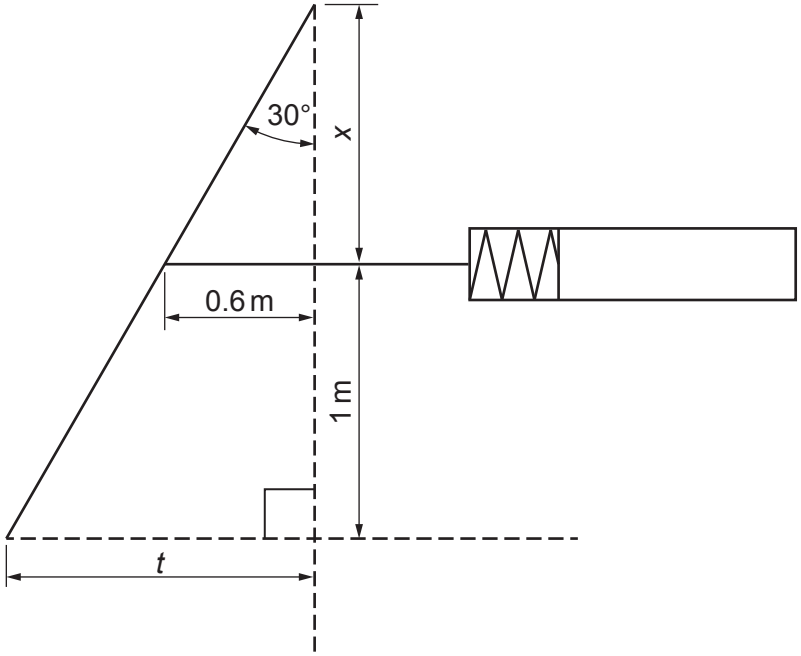



**Fig. 4.4**
(not to scale)

**[5]**

*t* ..... m

Some companies are starting to develop smaller factories based in inner cities and are moving away from having very large factories to manufacture their products.

**5** **(a)*** Discuss the relative advantages to the manufacturer and the consumer of manufacturing products in smaller factories located in inner cities compared to much larger factories in rural areas.

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Companies use different systems to increase efficiency and reduce costs. One of these systems is just-in-time.

**(b)** Identify and explain **one** advantage and **one** disadvantage of using a just-in-time system to produce engineered products such as electric cars.

Advantage .....

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Disadvantage .....

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**[4]**

**END OF QUESTION PAPER**