



General Certificate of Secondary Education

Centre Number

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Candidate Number

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Technology and Design

Unit 2

Option B:
Mechanical and Pneumatic
Control Systems



[GTY22]

GTY22

Assessment

TIME

1 hour 30 minutes.

Assessment Level of Control:

Tick the relevant box (✓)

Controlled Conditions	
Other	

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Questions which require drawing or sketching should be completed using an H.B. pencil.

All other questions must be completed using black ink only.

Do not write in pencil or with a gel pen.

Answer **both** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.

Quality of written communication will be assessed in Question **2(f)**.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

The Formula sheet is on page 2.

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Formulae for GCSE Technology and Design

You should use, where appropriate, the formulae given below when answering questions which include calculations.

1 Gear ratio of a simple gear train = $\frac{\text{number of teeth on driven gear}}{\text{number of teeth on driver gear}}$

For a compound gear train:

Total Gear ratio = the product of the gear ratios of all the subsystems

i.e. $GR_T = GR_1 \times GR_2 \times GR_3 \dots$

2 Velocity Ratio = $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$ or $\frac{\text{Diameter of driven}}{\text{Diameter of driver}}$

3 Mechanical Advantage = $\frac{\text{Load}}{\text{Effort}}$

4 Efficiency (%) = $\left(\frac{\text{mechanical advantage}}{\text{velocity ratio}} \right) \times 100$

5 Force = Pressure \times Area ($F = P \times A$)

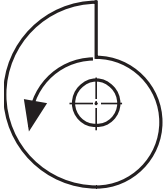



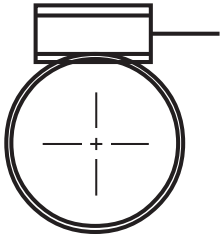
6 Circumference of a circle = $\pi \times \text{diameter}$

7 Area of a circle = πR^2



1 (a) Complete **Table 1** by naming the mechanical symbols.

Table 1

Mechanical	Name of Symbol
	
	
	
	
	

[5]

[Turn over



(b) Fig. 1 shows a hand drill.



Fig. 1

Source: Principal Examiner

(i) Name the input motion and the output motion of the hand drill.

Input motion: _____ [1]

Output motion: _____ [1]

(ii) Name the type of gears that are used in the hand drill.

_____ [1]

(iii) In the space below, draw the mechanical symbol for the gears used in the hand drill in Fig. 1.

[1]



(iv) Outline how the mechanism of the hand drill works in terms of input-process-output and speed. Your answer should make reference to:

- the input,
- the process,
- the output and speed of the hand drill.

[3]

(v) Give **two** reasons why carbon steel would be a suitable metal for the gear wheels in **Fig. 1**.

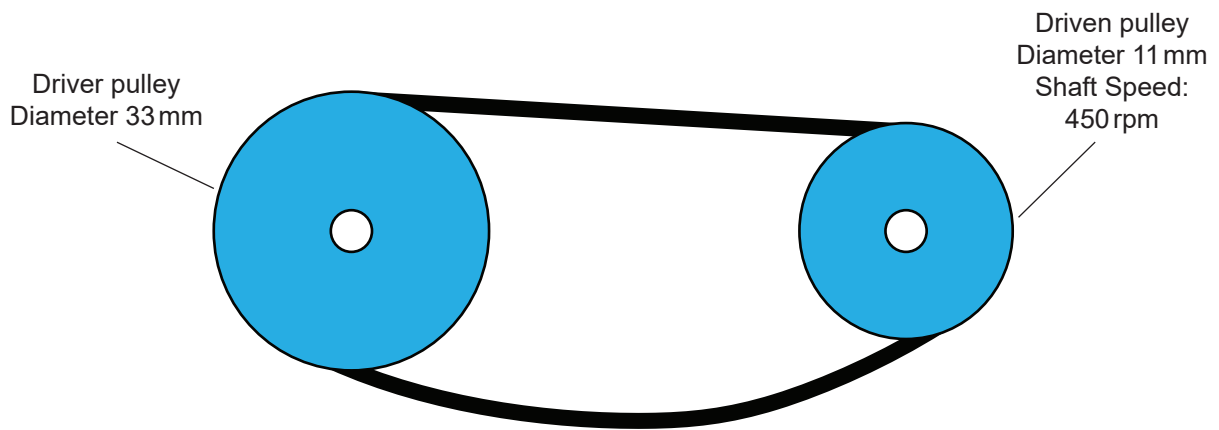
1. _____
2. _____ [2]

(vi) What heat treatment would be applied to the gear wheels?

[2]



(c) Fig. 2 shows a pulley system used to transmit motion.



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Fig. 2

- (i) If a pulley system is loose as shown in Fig. 2, what major problem is likely to arise when it is used to drive a machine?

_____ [1]

- (ii) Draw a jockey pulley in the space below and explain how this could be used to fix the problem in Fig. 2.

_____ [5]



(iii) Calculate the Velocity Ratio of the pulley system in **Fig. 2**.

Answer _____ [2]

(iv) Calculate the speed of the driver pulley in **Fig. 2**.

Answer _____ [2]

(v) Why would a toothed belt be unsuitable for the pulley system in **Fig. 2**?

_____ [2]

(vi) Name **two** suitable belts that could be used in the pulley system shown in **Fig. 2**.

1. _____

2. _____ [2]



(vii) Explain **two** factors that influence the choice of a toothed belt system instead of the standard pulley system shown in **Fig. 2** for a particular application.

1. _____

2. _____

_____ [4]

(viii) Name **two** products which use a toothed belt system and give a different reason in each case for their use for that specific product.

1. _____

Reason: _____

2. _____

Reason: _____ [4]





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(d) Fig. 3 shows a pulley system used to lift heavy objects.

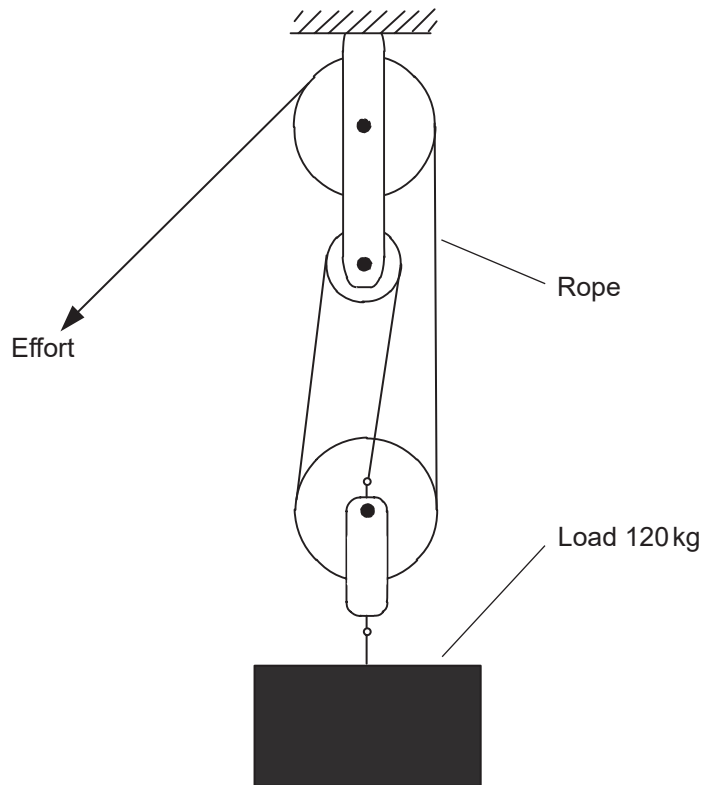


Fig. 3

- (i) Calculate the distance moved by the effort when the load is lifted through a distance of 1.5 metres.

Answer _____ [2]





(ii) Give **two** reasons why the pulley system in **Fig. 3** is not 100% efficient.

1. _____

2. _____ [2]

(iii) Sketch a new pulley system that only has one fixed pulley and one moveable pulley to lift the same load as shown in **Fig. 3**.

[4]

(iv) Other than the number of pulley wheels and the issue of cost, compare the pulley system shown in **Fig. 3** with the pulley system you have drawn in **(d)(iii)** and discuss **two** major differences between the two systems.

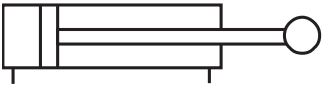

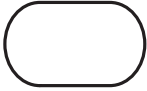

_____ [4]

[Turn over



2 Table 2 shows the symbols for some pneumatic components.

Table 2

Symbol	Name of Symbol
	
	
	
	

[4]

(a) Complete Table 2 by inserting the correct name for each symbol from Table 3.

Table 3

Unidirectional Flow Restrictor
Single Acting Cylinder
Shuttle Valve
Five Port Valve
Double Acting Cylinder
Reservoir
Bidirectional Flow Restrictor



(b) Look at **Fig. 4**. It shows a pneumatic circuit which could be used in a student's project.

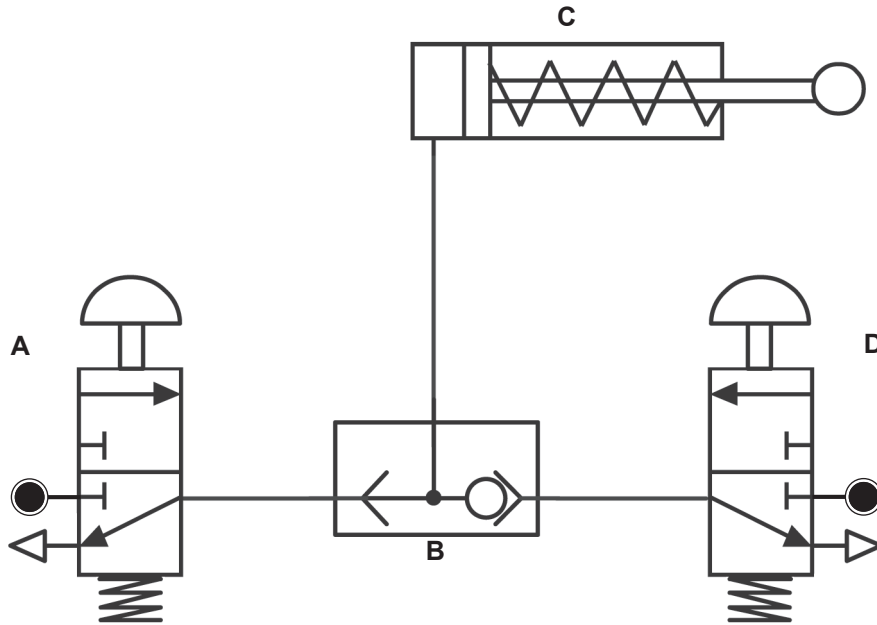


Fig. 4

(i) Write down the names of components **A**, **B** and **C**.

A _____

B _____

C _____ [3]

(ii) Explain how component **B** functions.

_____ [2]

[Turn over



(c) Fig. 5 shows a pneumatic machine that is used for printing a company logo onto envelopes.

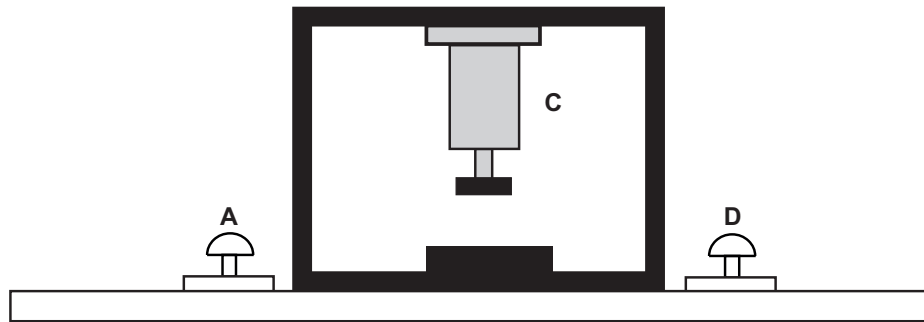


Fig. 5

Fig. 6 shows the circuit which operates the machine.

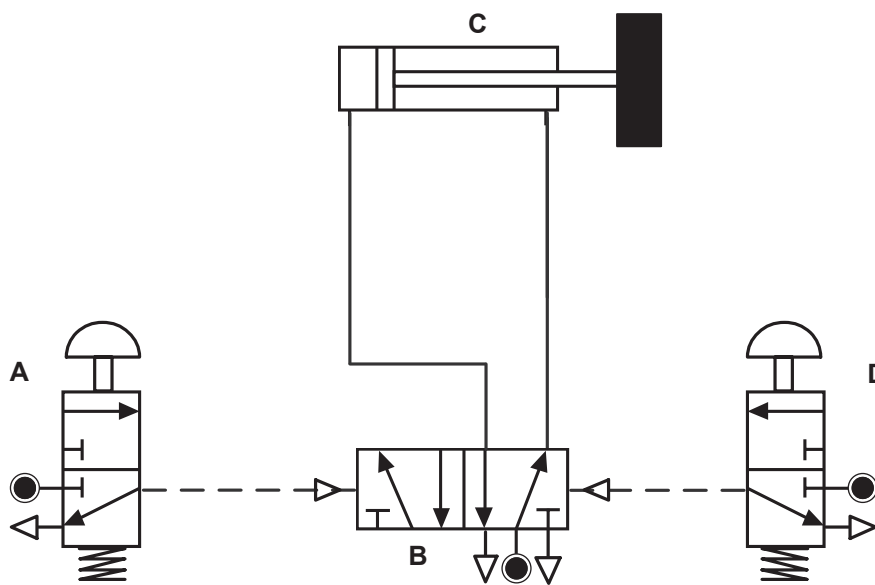


Fig. 6

(i) Explain how the circuit operates the pneumatic printing machine.

[2]



(ii) Name the valve that would be needed in the circuit to slow down the outstroke of component **C**.

_____ [1]

(iii) Draw, on **Fig. 6**, the symbol for the valve that would be needed in the circuit to slow down the outstroke of component **C**. [3]

(iv) Explain why it would be necessary to slow down the outstroke of component **C**.

_____ [1]

(v) Explain a potential hazard and its cause when using this pneumatic machine, other than the speed of component **C**, in **Fig. 5**.

_____ [2]

(vi) Explain how both the pneumatic machine and the circuit could be modified to overcome this safety issue.

Machine: _____

Circuit: _____
_____ [2]

[Turn over



(d) Fig. 7 shows part of a pneumatic circuit which is used to glue two parts together.

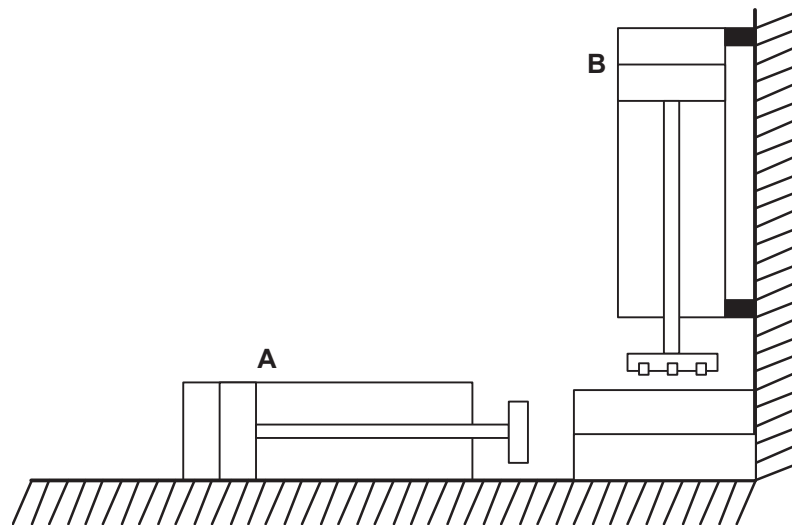


Fig. 7

- (i) Component **B** needs to exert a clamping force of 210 N to successfully join the two parts. Calculate the cross-sectional area required for component **B** if the supply pressure is 0.6 N/mm^2 .

Answer _____ [3]

- (ii) What is the purpose of component **A** in Fig. 7?

_____ [2]



(e) Fig. 8 shows the layout of a pneumatic control circuit.

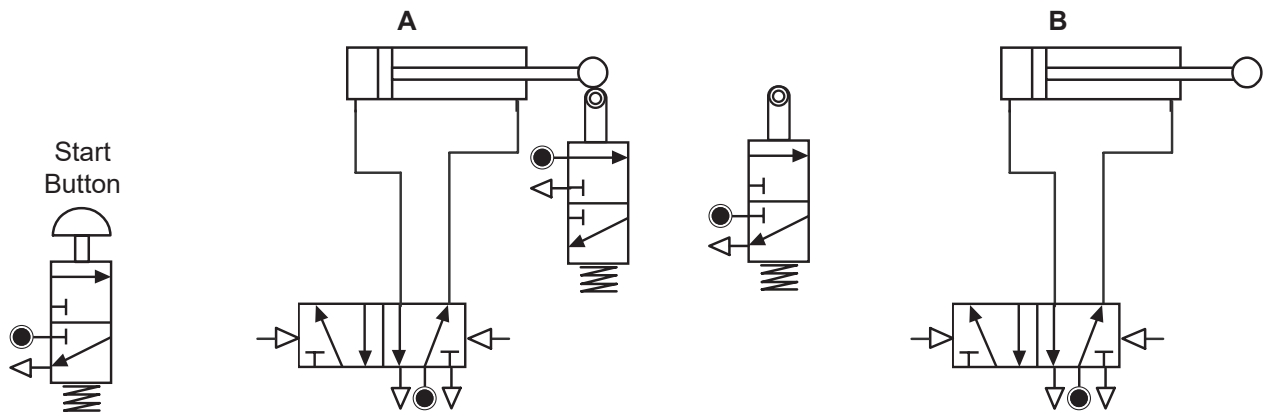


Fig. 8

When complete, the sequence of operations should be:

- 1: Start button is pressed and released.
- 2: Component A outstrokes.
- 3: Then component B outstrokes and component A instrokes.
- 4: After component A instrokes, component B will instroke.

(i) Complete the circuit in Fig. 8 by adding the pipework to give the required sequence of operation. [8]

(ii) State the operating sequence for the above circuit. [3]

(iii) Explain how a time delay could be achieved between steps 2 and 3 in Fig. 8. [2]

[Turn over



- (f) Describe and discuss **three** applications of the use of pneumatics in dangerous working environments.

Quality of written communication will be assessed in this question.

1. _____

2. _____

3. _____

_____ [12]

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Question Number	Marks
1	
2	

Total Marks	
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Examiner Number

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