



General Certificate of Secondary Education  
2022

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\*

**THURSDAY 16 JUNE, AFTERNOON**

## TIME

1 hour 30 minutes.

## 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 in 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(e)**.

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 3.

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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 =  $\pi \times \text{diameter}$

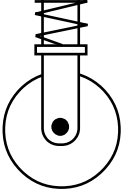
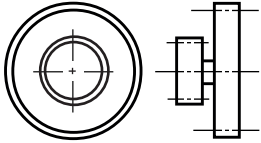
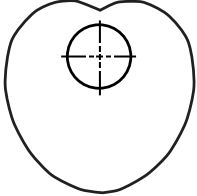
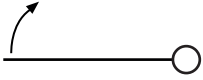
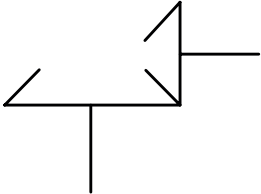
7 Area of a circle =  $\pi r^2$

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- 1 (a) Complete **Table 1** by naming each of the mechanical symbols and insert the appropriate letter from the list opposite to describe its function. Each letter may be used only once.

**Table 1**

Mechanical Symbol	Name of Symbol	Function
		
		
		
		
		

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## Function

- A** To provide a mechanical advantage to lift heavy loads.
- B** To change the direction of rotation through 90 degrees.
- C** To increase the tension in a belt system.
- D** To make large speed changes.
- E** To enable the output to rise and fall at a constant speed.

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(b) Fig. 1 shows the symbols for three types of mechanical components.

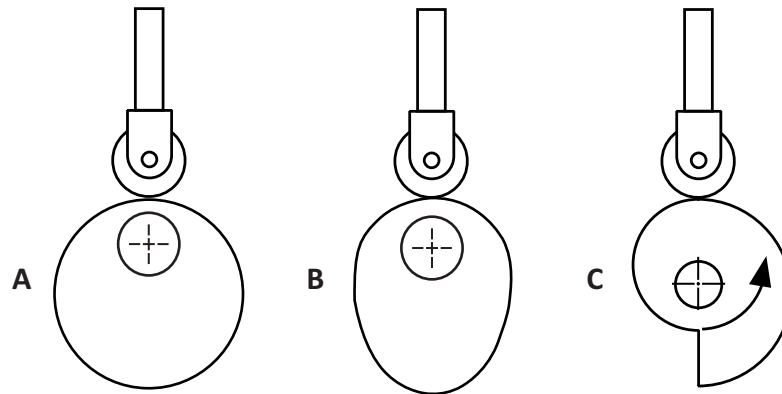


Fig. 1

(i) State the correct name for each of the mechanical symbols labelled **A**, **B** and **C** in Fig. 1.

**A** \_\_\_\_\_

**B** \_\_\_\_\_

**C** \_\_\_\_\_ [3]



(ii) Select the appropriate mechanical component **A**, **B** or **C** from **Fig. 1** which will provide:

- A steady rise, a steady fall followed by a dwell period.

\_\_\_\_\_ [1]

- A steady rise and a quick return.

\_\_\_\_\_ [1]

- A steady rise and a steady fall.

\_\_\_\_\_ [1]

(iii) Which **one** of the mechanical components in **Fig. 1** can only function in one direction?

\_\_\_\_\_ [1]

(iv) Outline **two** reasons why a roller follower is used in preference to a flat follower.

1. \_\_\_\_\_

2. \_\_\_\_\_ [2]

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- (c) Fig. 2 shows the layout of a gearbox which has four gear wheels. The number of teeth on each gear wheel is shown. The driving shaft rotates at 600 rev/min (rpm).

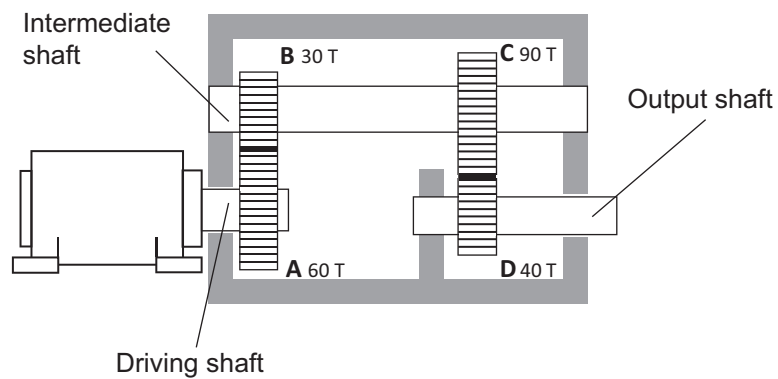


Fig. 2

- (i) State the type of gear train shown in Fig. 2.

\_\_\_\_\_ [1]

- (ii) State **one** advantage of this type of gear train.

\_\_\_\_\_  
 \_\_\_\_\_ [1]

- (iii) Calculate the gear ratio of the gearbox in Fig. 2. Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [3]



- (iv) Calculate the speed of the output shaft in **Fig. 2**.  
Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [3]

- (v) The gearbox in **Fig. 2** is to be changed to give an output speed of 3000 rpm by changing gear wheels **C** and **D** only. The following gear wheels are available: 30T, 45T, 60T, 75T. Select the appropriate gear wheels for **C** and **D** and calculate the speed of the output shaft using the selected gear wheels to show that this will achieve the desired output speed of 3000 rpm.

Gear **C** selected = \_\_\_\_\_ Gear **D** selected = \_\_\_\_\_

Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [4]

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(d) Fig. 3 (a) shows a mechanism used in a winch system for raising loads and Fig. 3 (b) shows the symbol for this mechanism.

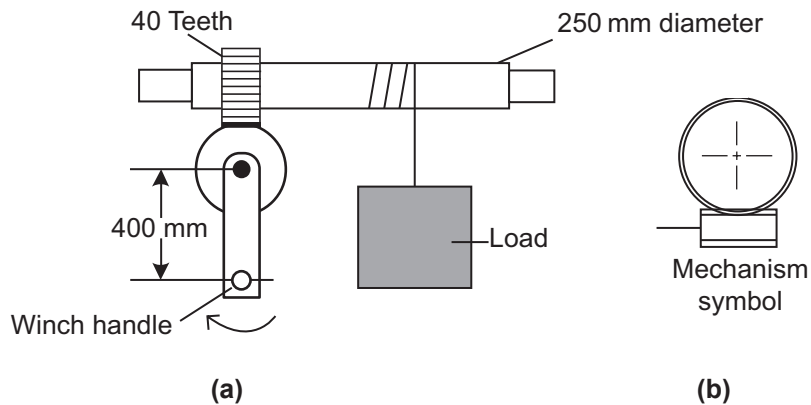


Fig. 3

(i) Name the winch mechanism symbol shown in Fig. 3 (b).

\_\_\_\_\_ [2]

(ii) The mechanical advantage of the winch is 40.  
Calculate the effort required to raise a load of 3.6 kN.  
Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [5]



(iii) If the crank handle is turned through one revolution how far will the load rise?

Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [6]

(iv) Calculate the velocity ratio of the winch mechanism.

Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [4]

(v) The winch is to be modified so that the velocity ratio is increased.

Suggest **two** ways in which this could be achieved.

1. \_\_\_\_\_

\_\_\_\_\_

2. \_\_\_\_\_

\_\_\_\_\_ [2]

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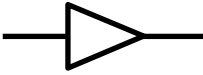
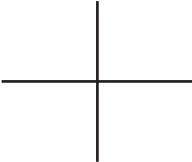

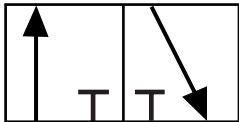


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2 Table 2 shows some pneumatic symbols.

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

Table 2

Symbol	Name of Symbol
	
	
	
	
	

[5]



**Table 3**

Unidirectional Flow Restrictor
Three Port Valve
Pilot/Signal
Single Acting Cylinder
Pipeline Not Connected
Spring Return
Five Port Valve
Pilot Pressure
Roller Trip
Pressure Source

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(b) Sheets of paper are to be trimmed to size using a pneumatic guillotine as shown in Fig. 4.

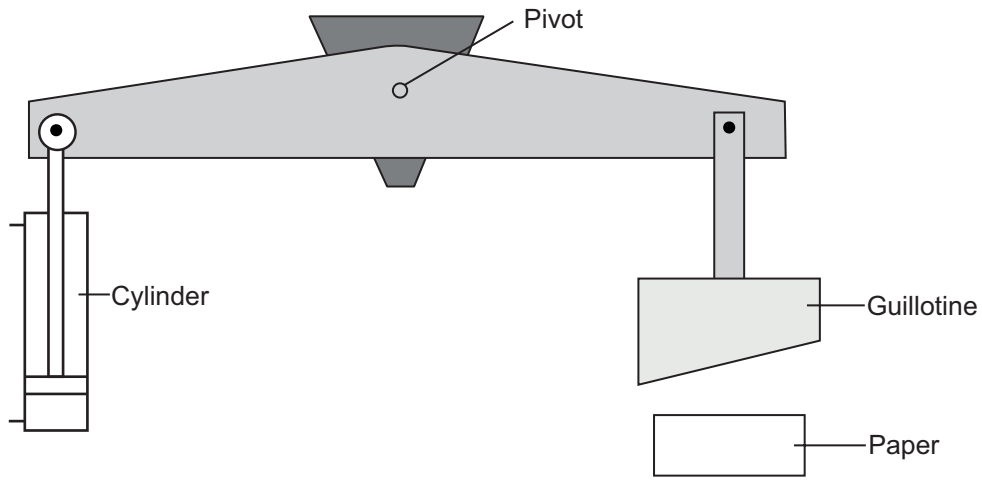


Fig. 4

(i) Name the type of cylinder shown in Fig. 4.

\_\_\_\_\_ [1]

(ii) What class of lever is used in the paper guillotine?

\_\_\_\_\_ [1]



- (iii) The cylinder is required to supply an outstroke force of 300 N.  
Supply pressure =  $0.4 \text{ N/mm}^2$ .  
Calculate the cross-sectional area of the piston.  
Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [3]

- (iv) If the cross-sectional area of the piston rod =  $113 \text{ mm}^2$   
calculate the diameter of the piston rod.  
Candidates need to show their working out in the space below.

Answer \_\_\_\_\_ [3]

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(c) Fig. 5 shows a pneumatic circuit that is used for slicing the paper in the pneumatic guillotine.

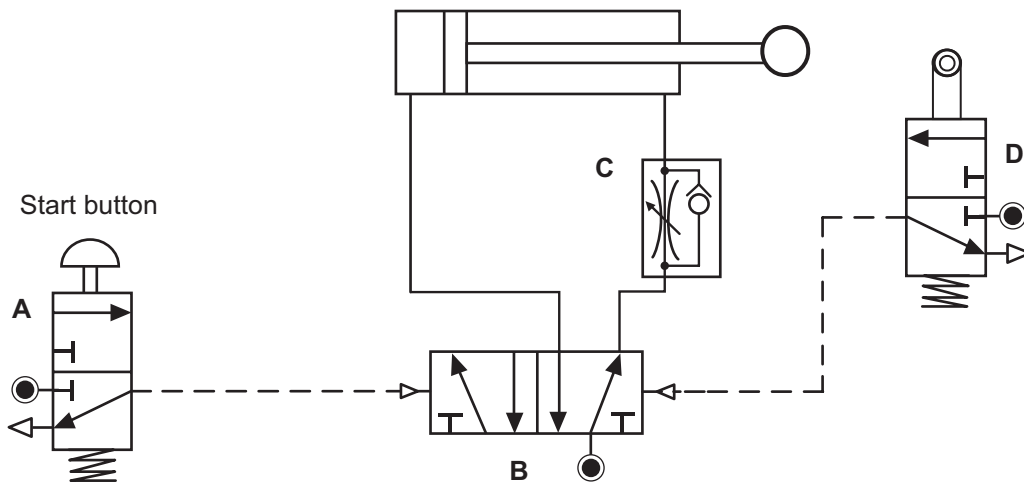


Fig. 5

(i) Name the components labelled **B** and **C** in the circuit shown in **Fig. 5**.

**B** \_\_\_\_\_

**C** \_\_\_\_\_ [2]





(d) Fig. 6 shows a lifting device for packages. When a start button is operated for an instant, the package is lifted by Cylinder A. Cylinder B then pushes the package onto a conveyor belt. Both cylinders then return to their original position.

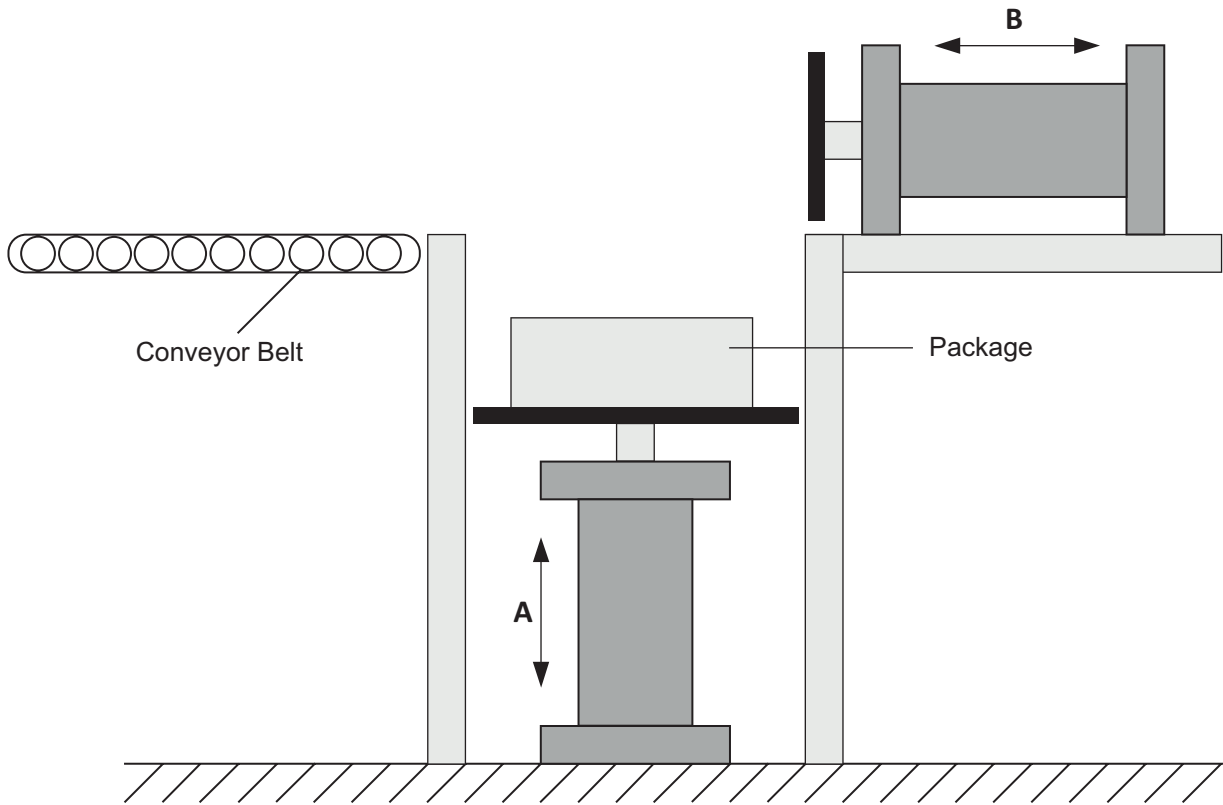


Fig. 6

(i) State the logic sequence for the above circuit.

\_\_\_\_\_ [3]



(ii) Fig. 7 shows the incomplete circuit for the package lifting system shown in Fig. 6. Complete the circuit in Fig. 7 by adding the pipework to give the required sequence of operation. [8]

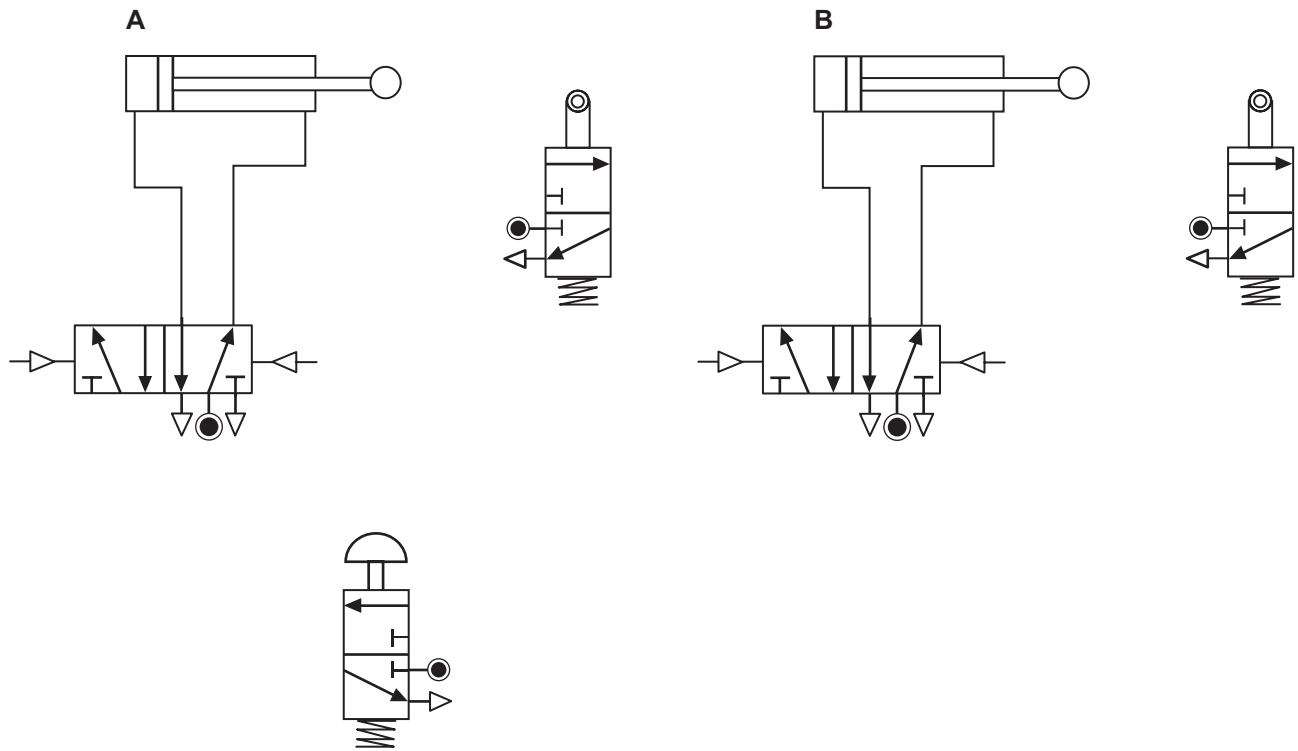


Fig. 7

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<b>Question Number</b>	<b>Marks</b>
1	
2	
<b>Total Marks</b>	

**Examiner Number**

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