Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2019

Technology and Design

Unit 2

Option B:
Mechanical and Pneumatic
Control Systems

[GTY22]

GTY22

FRIDAY 31 MAY, MORNING

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 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(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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You should use, where appropriate, the formulae given below when answering questior 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. $GR_T = GR_1 \times GR_2 \times GR_3 \ldots$

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 × Area ($F = P \times A$)

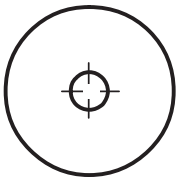
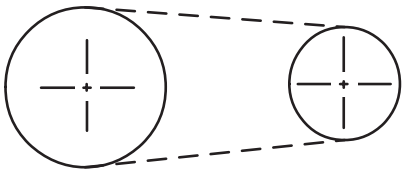
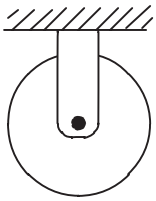
6 Circumference of a circle = $\pi \times$ diameter

[Turn over

Answer **all** questions

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

Table 1

Symbol	Name of Symbol
	
	
	
	

[4]

(b) **Fig. 1** shows a mechanism for transmitting power to a shaft.

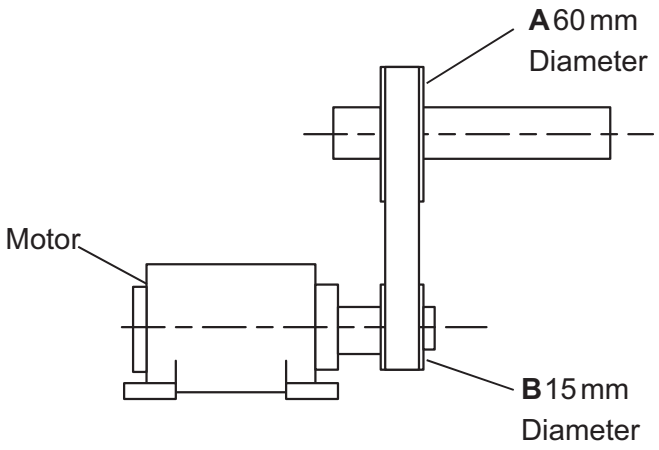


Fig. 1

(i) Name the mechanism shown in **Fig. 1**.

_____ [1]

(ii) Identify which one, **A** or **B**, is the input or the output of the system in **Fig. 1** shown above.

Input _____ [1]

Output _____ [1]

(iii) The motor in **Fig. 1** runs at 2200 rev/min. Calculate the output speed of this system.

Answer _____ [4]

[Turn over

(c) **Fig. 2** shows a different method for transmitting power to a shaft.

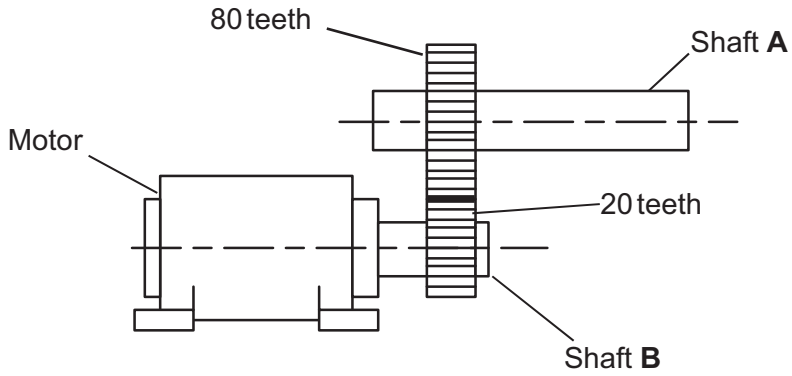


Fig. 2

(i) Name the mechanism shown in **Fig. 2**.

_____ [1]

(ii) Outline **one** advantage and **one** disadvantage of this method compared to that in **Fig. 1**.

Advantage: _____ [1]

Disadvantage: _____ [1]

(iii) Calculate the motor speed in **Fig. 2** if the speed of shaft **A** is 215 rev/min.

Answer _____ [4]

(iv) Explain how the transmission in **Fig. 2** could be changed so that shaft **A** and shaft **B** rotate in the same direction.

_____ [1]

(v) What effect would this change have on the output speed?

_____ [1]

(vi) **Fig. 1** and **Fig. 2** show two possible methods of transmitting power between two shafts. Suggest **one** other method that could be used.

_____ [1]

(vii) A large reduction of speed is required between the two shafts in **Fig. 2**. Suggest **one** suitable method to achieve this large reduction in speed.

_____ [1]

[Turn over

(d) **Fig. 3** shows a lever used to crush tin cans.

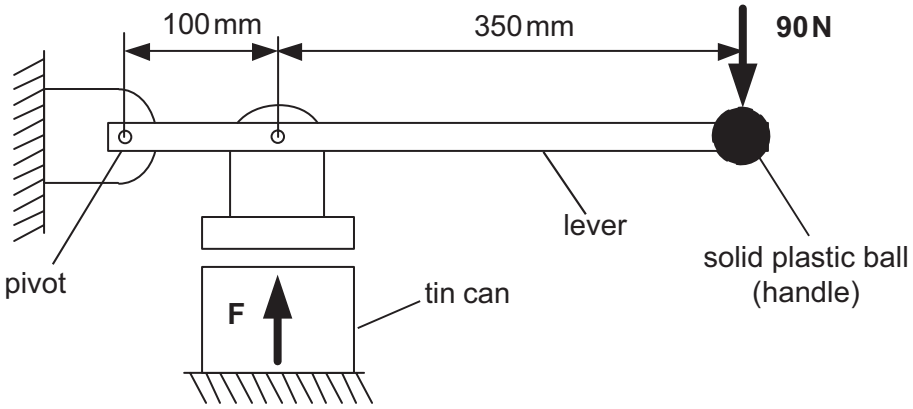


Fig. 3

(i) What class of lever is used in the tin can crusher?

_____ [1]

(ii) Suggest a suitable material for the lever. Give a reason for your answer.

Lever Material _____ [1]

Reason _____ [1]

(iii) Calculate the force **F** when a force of 90 N is applied to the handle.

Answer _____ [4]

(e) **Fig. 4** shows a mechanism used on a horizontal clamping machine in which the lever uses one form of motion to produce a different motion **M**.

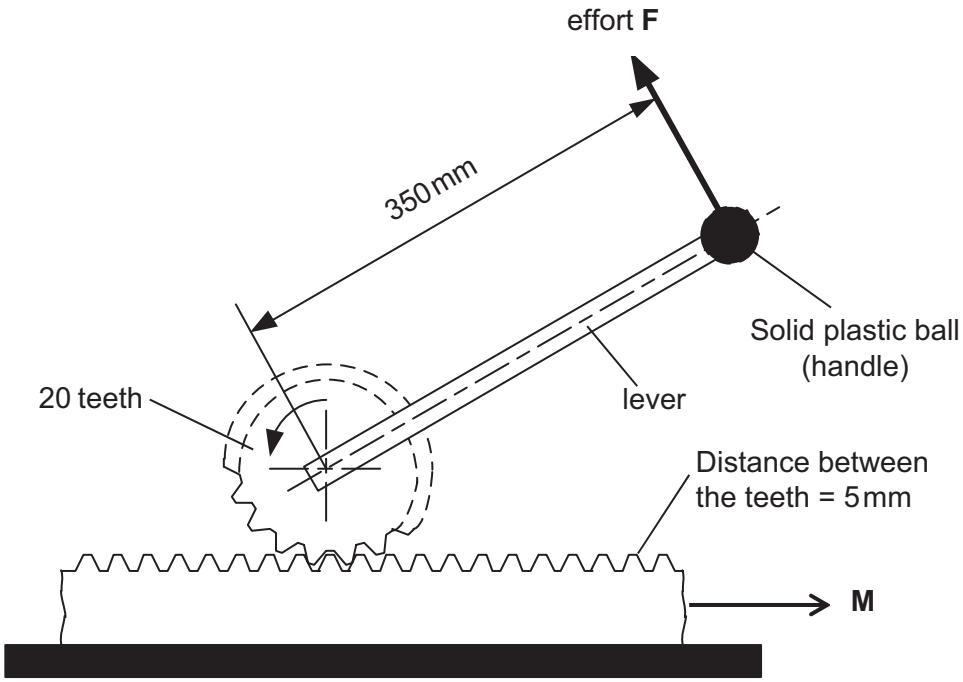


Fig. 4

(i) What is the name of the mechanism in **Fig. 4**?

_____ [1]

(ii) State the type of input and output motion for the mechanism.

Input _____ [1]

Output _____ [1]

(iii) How could this mechanism be maintained to help it run smoothly?

_____ [1]

[Turn over

(iv) The effort **F** is applied to the solid plastic ball at the end of the lever. If the lever is turned through 90 degrees calculate the distance moved by the effort **F** in **Fig. 4**.

Answer _____ [4]

(v) Calculate the distance moved by **M** in **Fig. 4**.

Answer _____ [4]

(vi) Calculate the velocity ratio for the mechanical system in **Fig. 4**.

Answer _____ [3]

(vii) Suggest **two** ways in which the design of the clamping mechanism in **Fig. 4** could be modified to increase the velocity ratio.

1. _____

2. _____ [2]

(viii) Use an annotated sketch to show a suitable method of attaching the solid plastic ball to the lever in **Fig. 4**.

[4]

[Turn over

2 (a) **Table 2** shows the symbols for different methods of operating pneumatic valves.

Table 2

Symbol	Name of Symbol
	
	
	
	

[4]

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

Table 3

Roller Trip
Pilot Pressure
Push Button
Lever
Exhaust
Plunger

(ii) Select the method from **Table 3** that would be used to operate:

- A valve to confirm the presence of a guard if it is correctly in place.

_____ [1]

- A valve to confirm the position of a piston rod.

_____ [1]

(b) **Fig. 5** shows the components used to create a time delay.

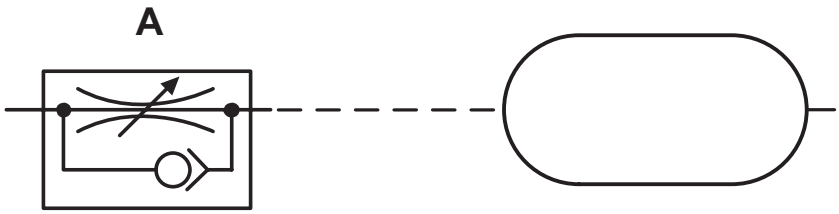


Fig. 5

(i) State the function of component **A** in the circuit.

_____ [1]

(ii) Describe **two** ways in which the time delay can be increased.

1. _____

_____

2. _____

_____ [4]

[Turn over

(c) **Fig. 6** shows a complete pneumatic circuit that uses a time delay to control a cylinder.

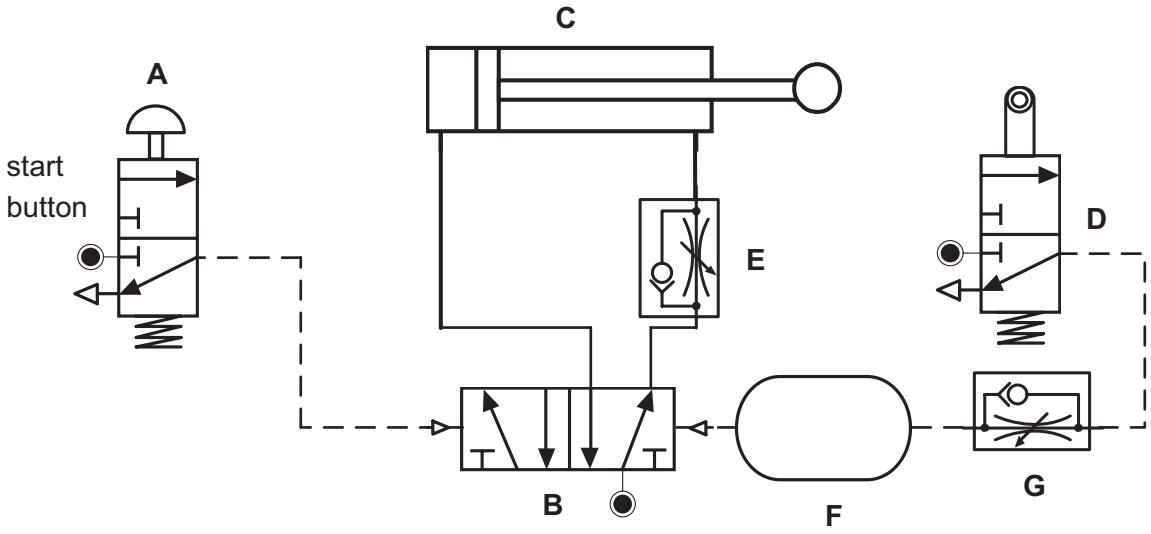


Fig. 6

(i) Describe how the circuit works when the start button is pressed for a brief moment.

_____

_____

_____

_____

_____ [5]

(ii) State how the speed of the outstroke could be changed.

_____

_____ [2]

(iii) The circuit in **Fig. 6** is to be modified so that the start signal can be given from either of two positions.

Show on **Fig. 6** the connecting pipes and additional valves needed to achieve this. [6]

(d) **Fig. 7** shows an incomplete pneumatic circuit.

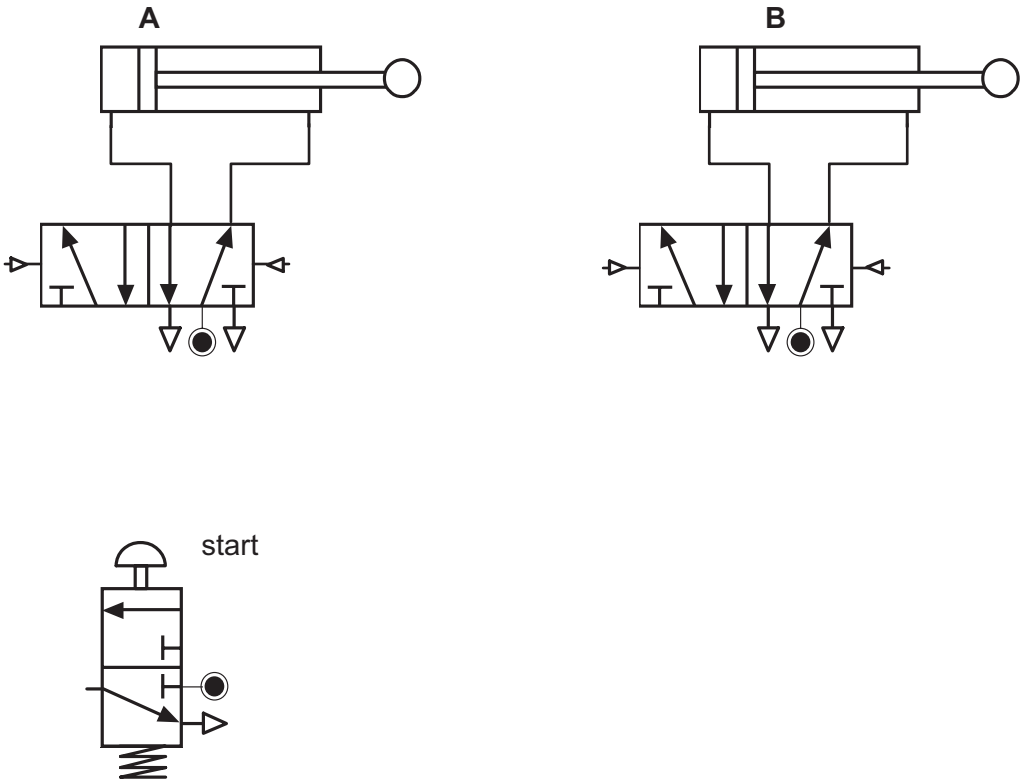


Fig. 7

(i) When the start button is pressed for a brief moment the cylinders are to move in the following sequence:

- Cylinder **A** and cylinder **B** outstroke at the same time.
- When the **outstroke** of cylinder **B** is confirmed cylinder **A** instrokes.
- When the **instroke** of cylinder **A** is confirmed cylinder **B** instrokes.

Complete **Fig. 7**, showing the connecting pipes and additional valves needed, for the circuit to operate in this sequence. [12]

[Turn over

(ii) The circuit is to be modified so that cylinder **A** cannot instroke until the outstroke of **both** cylinders is confirmed. Outline how this can be achieved.

[4]

(e) Discuss the importance of safety when working with pneumatics. Your discussion should focus on **five** important factors associated with pneumatic components and circuit building.

Quality of written communication will be assessed in this question.

[10]

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For Examiner's use only	
Question Number	Marks
1	
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