



Rewarding Learning

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

MV18

[GTY22]

THURSDAY 16 JUNE, AFTERNOON

Time

1 hour 30 minutes, plus your additional time allowance.

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 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.

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 at the end of each question 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. $\mathbf{GR_T = GR_1 \times GR_2 \times GR_3 \dots}$

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

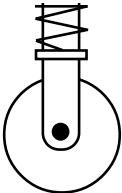
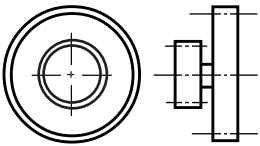
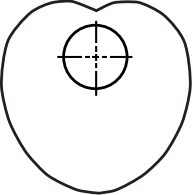
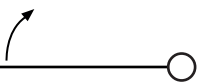
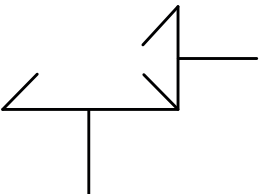
5 Force = Pressure \times Area ($F = P \times A$)

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

7 Area of a circle = πr^2

- 1 (a) Complete **Table 1** by naming 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. [10 marks]

Table 1

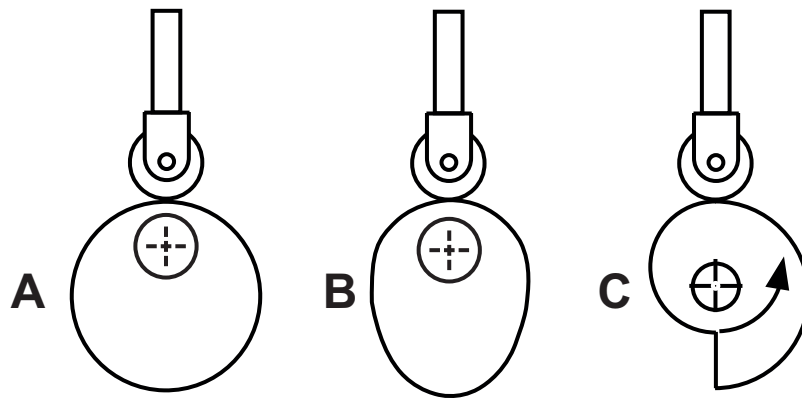
Mechanical Symbol	Name of Symbol	Function
		
		
		
		
		

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.

(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. [3 marks]

A _____

B _____

C _____

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

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

- A steady rise and a quick return.

- A steady rise and a steady fall.

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

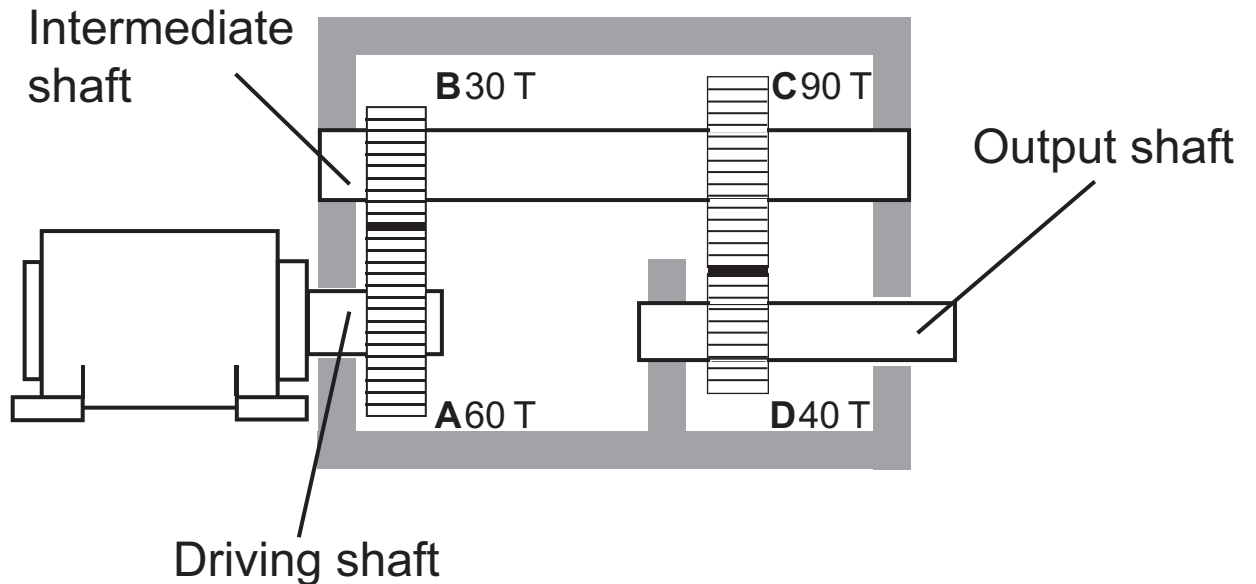
(iv) Outline **two** reasons why a roller follower is used in preference to a flat follower. [2 marks]

1. _____

2. _____

- (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 mark]

- (ii) State **one** advantage of this type of gear train.
[1 mark]

(iii) Calculate the gear ratio of the gearbox in **Fig. 2**.
Candidates need to show their working out in the
space below. [3 marks]

Answer _____

(iv) Calculate the speed of the output shaft in **Fig. 2**.
Candidates need to show their working out in the
space below. [3 marks]

Answer _____

(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. [4 marks]

Gear **C** selected = _____

Gear **D** selected = _____

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

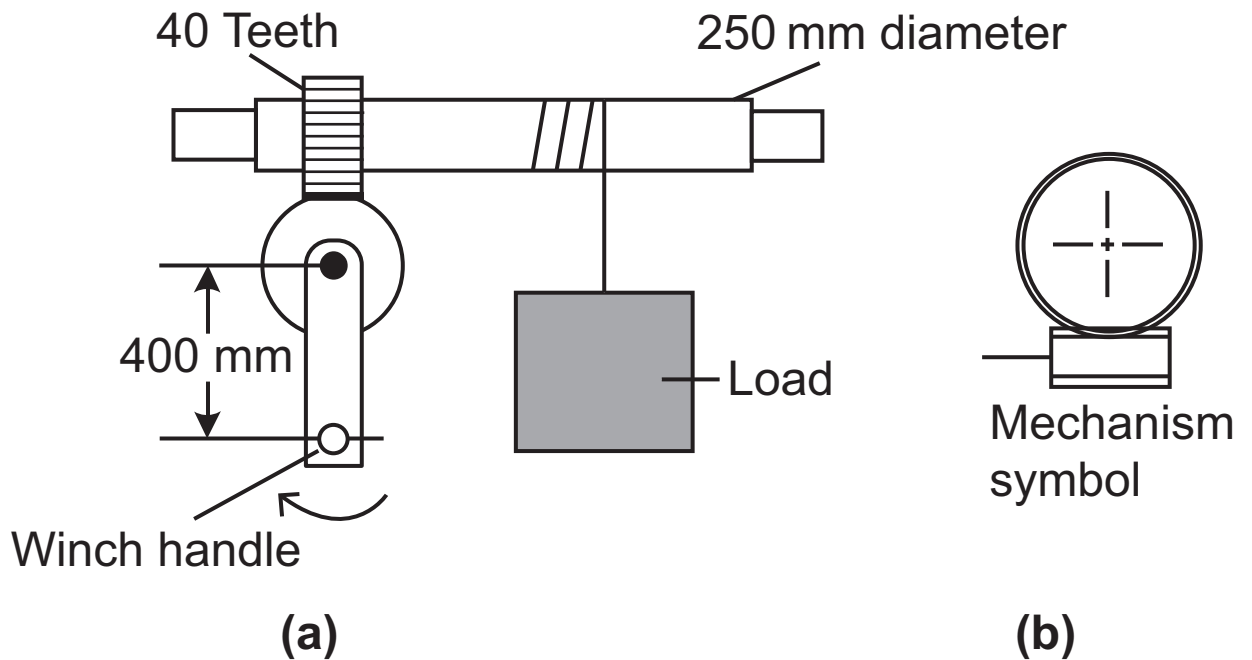
Answer _____

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(Questions continue overleaf)

(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 marks]

- (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. [5 marks]

Answer _____

- (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. [6 marks]

Answer _____

(iv) Calculate the velocity ratio of the winch mechanism.
Candidates need to show their working out in the
space below. [4 marks]

Answer _____

(v) The winch is to be modified so that the velocity ratio
is increased.
Suggest **two** ways in which this could be achieved.
[2 marks]

1. _____

2. _____

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(Questions continue overleaf)

2 **Table 2** shows some pneumatic symbols.

(a) Complete **Table 2** by inserting the correct name for each symbol from **Table 3**. [5 marks]

Table 2



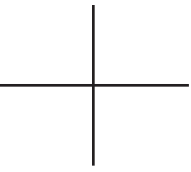


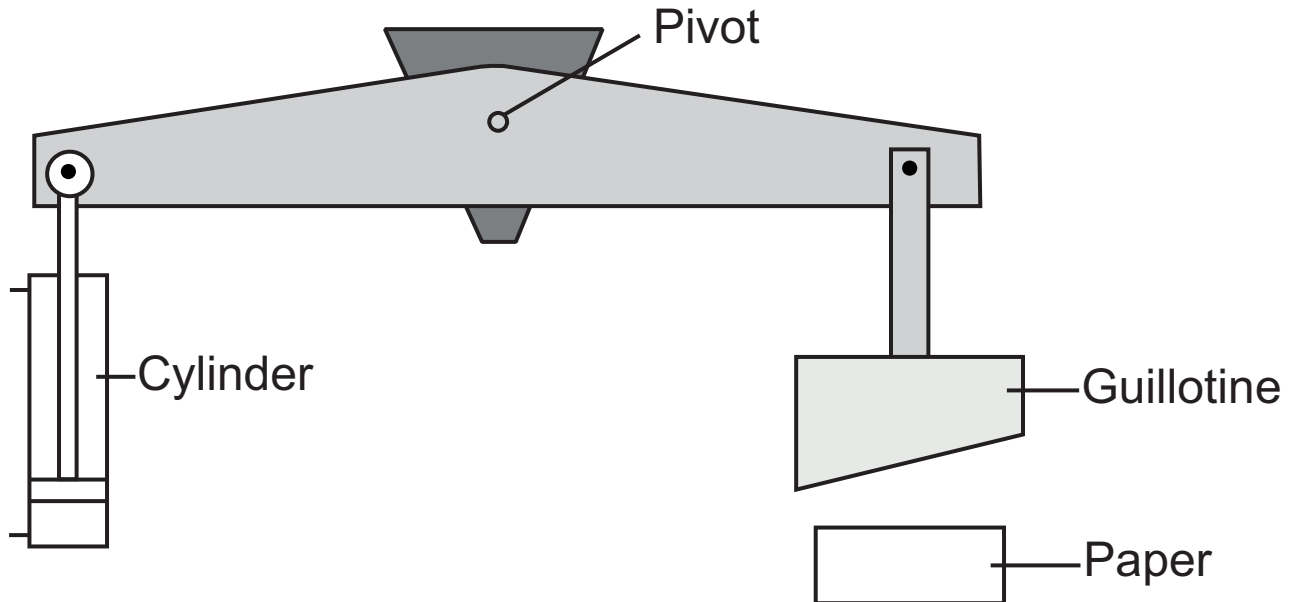
Symbol	Name of Symbol
	
	
	
	
	

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

(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 mark]

(ii) What class of lever is used in the paper guillotine?
[1 mark]

- (iii)** The cylinder is required to supply an outstroke force of 300 N.
Supply pressure = 0.4 N/mm^2 .
Calculate the cross-sectional area of the piston.
Candidates need to show their working out in the space below. [3 marks]

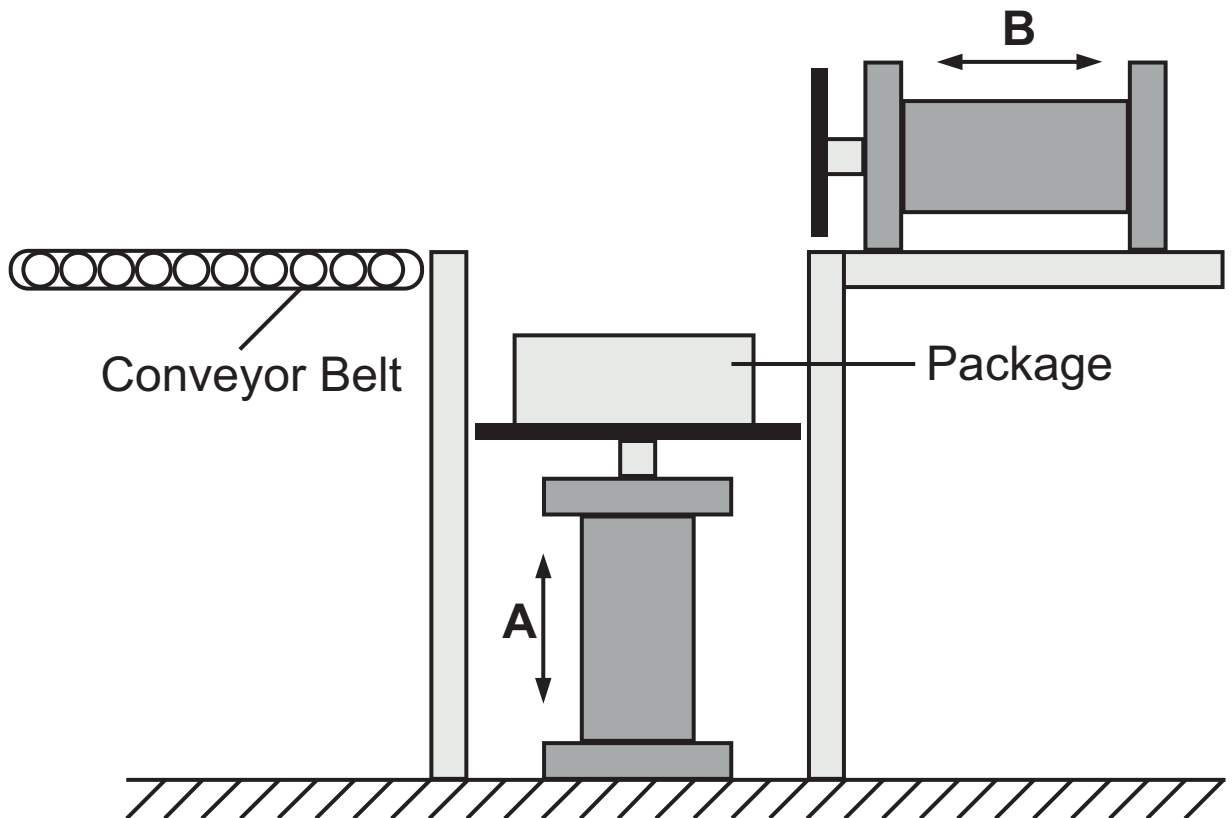
Answer _____

- (iv)** If the cross-sectional area of the piston rod = 113 mm^2 calculate the diameter of the piston rod.
Candidates need to show their working out in the space below. [3 marks]

Answer _____

(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 marks]

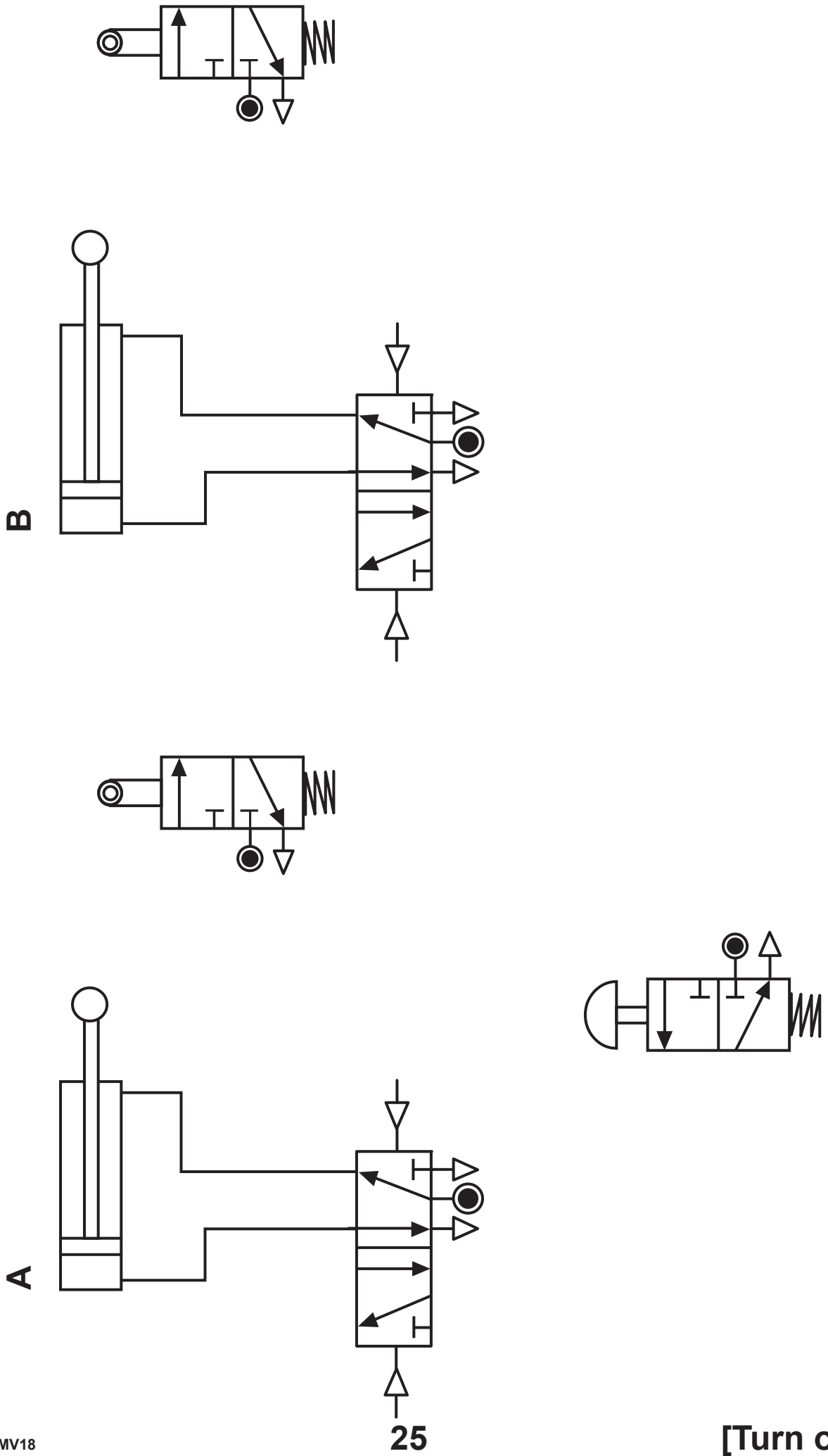
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(Questions continue overleaf)

(ii) **Fig. 7** opposite 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 marks]

Fig. 7

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[Turn over

This is the end of the question paper

For Examiner's use only	
Question Number	Marks
1	
2	

Total Marks	
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Examiner Number

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