cea

Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2017

Technology and Design

Unit 2:
Systems and Control
Element 2: Mechanical and
Pneumatic Control Systems

[GTD22]

GTD22

THURSDAY 8 JUNE, AFTERNOON

TIME

1 hour.

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 **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

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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 $= \dfrac{\text{number of teeth on driven gear}}{\text{number of teeth on driver gear}}$

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   Mechanical Advantage $= \dfrac{Load}{Effort}$

3   Velocity Ratio $= \dfrac{Distance\ moved\ by\ effort}{Distance\ moved\ by\ load}$

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

[Turn over

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Answer **all** questions

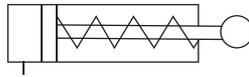**1** **(a)** **Fig.1** shows the symbol for a pneumatic cylinder.

Fig. 1

(i) Name the type of cylinder shown in **Fig. 1**.

_____ [1]

(ii) Name the type of valve used to control the direction of movement of this cylinder.

_____ [1]

(b) **Table 1** shows the symbols for three pneumatic valves.

Complete **Table 1** by inserting the correct name for each valve symbol.

Table 1

Symbol	Name of valve

[3]

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(c) The cylinder shown in **Fig. 1** is required to produce a clamping force of 150 N.

Force required to compress spring = 50 N

Air pressure = 0.5 N/mm^2

Calculate the required cross-sectional area of the piston.

_____

_____

_____

_____ [4]

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(d) A door in a cold store is operated by a pneumatic cylinder as shown in **Fig. 2**.

OPEN

CLOSE

Cylinder

Door
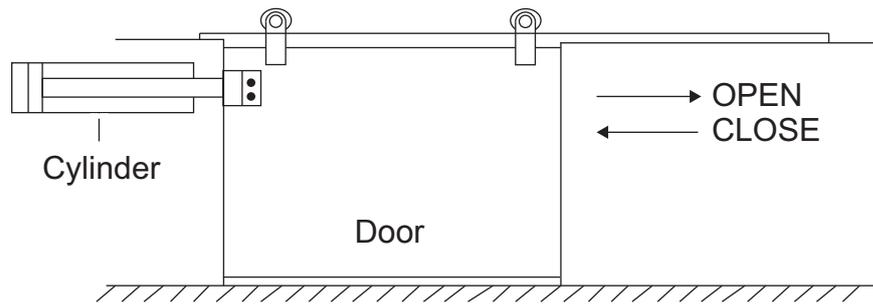
Fig. 2

Fig. 3 shows the pneumatic circuit needed to control the cylinder.

Start button

A   E   F
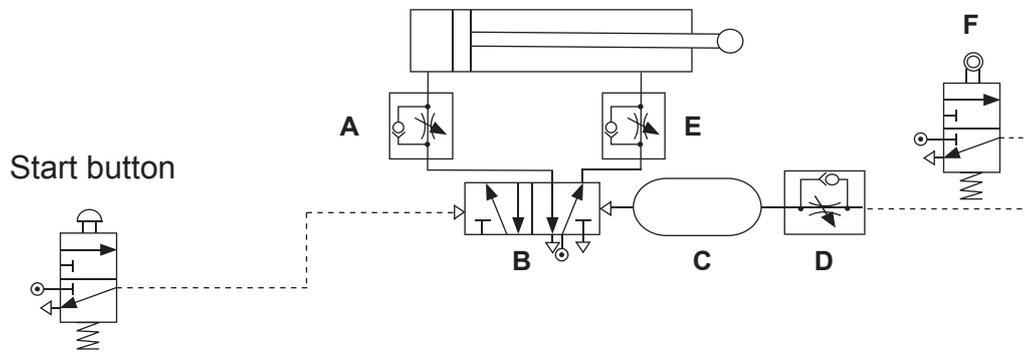
B   C   D

Fig. 3

(i) Describe briefly how the components **A, B, C, D, E** and **F** control the circuit when the start button is pressed for an instant.

_____

_____

_____

_____

_____

_____

_____

[6]

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(ii) Outline briefly how each of the following could be corrected:

- The force produced by the cylinder was too small.

[2]

- The time the door remained open was too short.

[2]

- The distance the door opened was too small.

[2]

(iii) The circuit in **Fig. 3** is to be modified so that the door can be opened from inside or outside the store.

Show on **Fig. 3** the connecting pipes and additional valves needed to achieve this modification. [6]

(e) **Fig. 4** shows the plan view of a conveyor system.

Package Moved to Position 2

Conveyor

Cylinder B
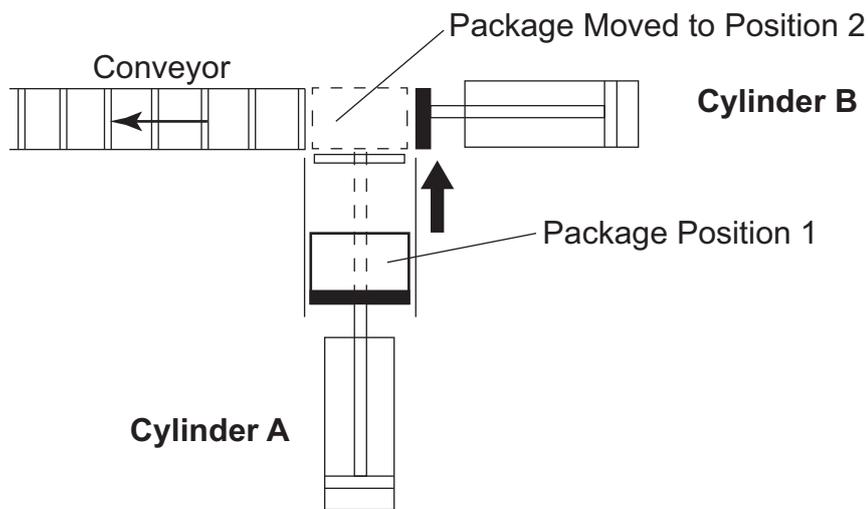
Package Position 1

Cylinder A

Fig. 4

When a start button is pressed for an instant, Cylinder **A** moves a package from position 1 to position 2 as shown.

Cylinder **A** remains outstroked until the package is pushed onto the conveyor by Cylinder **B**.

Cylinder **A** then instrokes.

When **A** is fully retracted Cylinder **B** instrokes.

(i) State the sequence in which the cylinders operate.

_____ [1]

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(ii) **Fig. 5** shows part of the pneumatic circuit used in the conveyor system shown in **Fig. 4**.

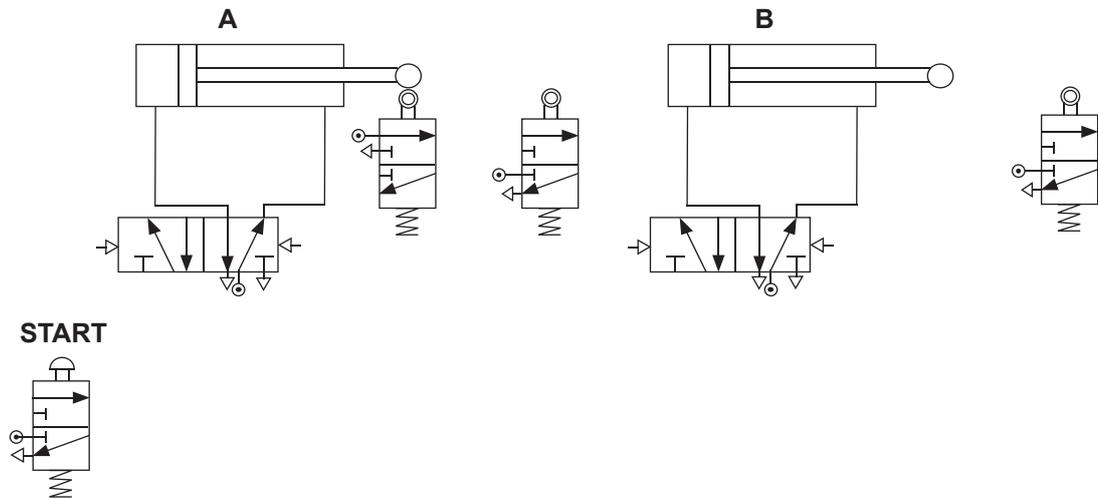A   B

START

Fig. 5

Complete the circuit in **Fig. 5** to give the required sequence described for the conveyor system. [8]

(iii) The circuit is to be modified so that after the package is pushed onto the conveyor, both cylinders retract at the same time.
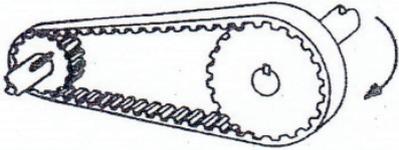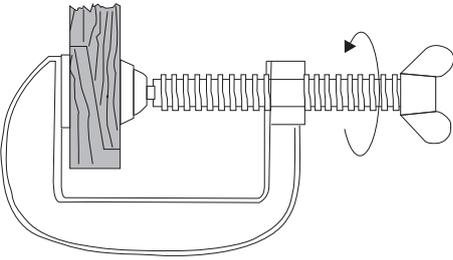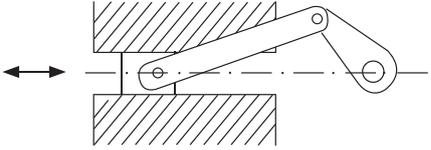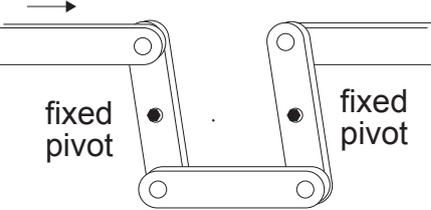
Explain briefly how this could be achieved.

[4]

[Turn over

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2 **(a)** **(i)** **Table 2** shows four different mechanisms. The input motion in each mechanism is shown by an arrow. Complete **Table 2** by inserting the correct name for each mechanism and its type of output motion.

Table 2

Mechanism	Name	Output Motion
fixed pivot fixed pivot		

[8]

(ii) In some mechanisms the input and output motions cannot be reversed.

Which **one** of the mechanisms in **Table 2** cannot be reversed?

_____ [1]

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(b) **Fig. 6** shows a footbrake system with the brake applied.
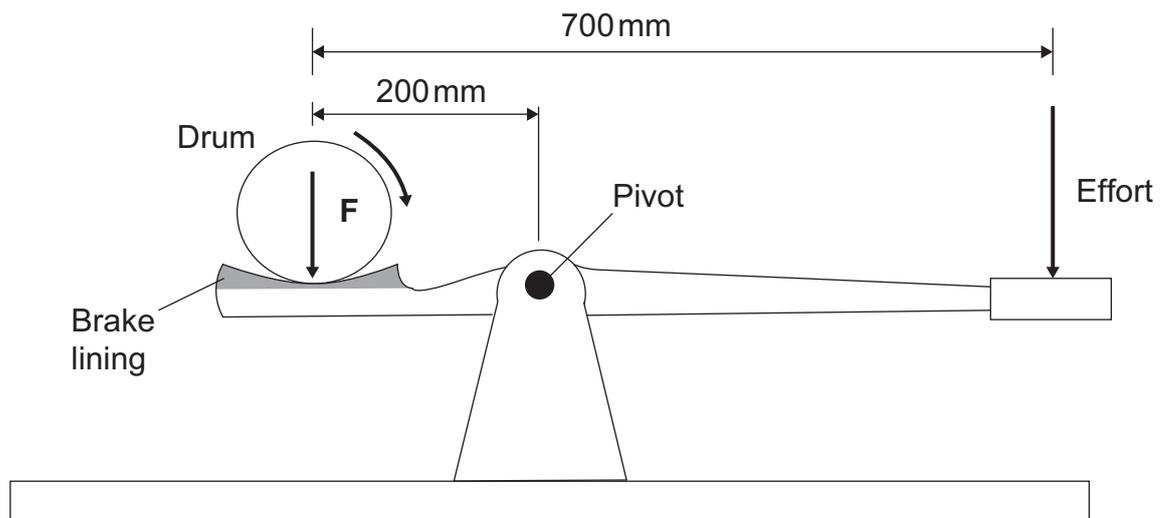
Fig. 6

(i) Calculate the effort required to produce a force **F** of 1200N at the drum.

_____

_____

_____

_____ [4]

(ii) Show on **Fig. 6** how a spring could be fitted to release the brake from the drum when the effort is removed.   [1]

(iii) State the effect this would have on the effort required to produce force **F**.

_____ [2]

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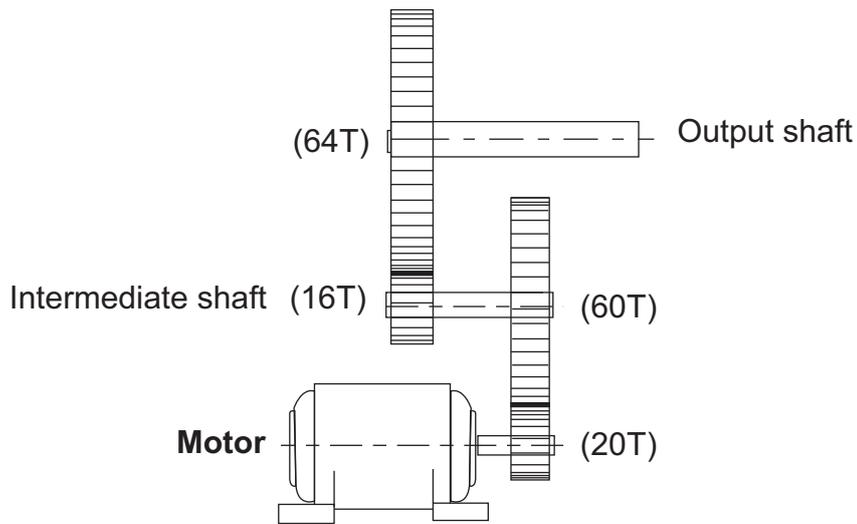**(c) Fig. 7** shows a gear system with the number of teeth **T** shown.

Fig. 7

(i) Name the type of gear system shown.

_____ [1]

(ii) The motor runs at 720 rev/min.

Calculate:

- The speed of the intermediate shaft.

_____

_____ [2]

- The speed of the output shaft.

_____

_____ [2]

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(iii) Calculate the total gear ratio for the system.

_____

_____

_____ [3]

(d) **Fig. 8** shows a mechanism which is used on a machine to produce linear motion and move a load.

Load

Handle
300 mm long

Effort

Rack
6 mm pitch

Pinion
30 teeth
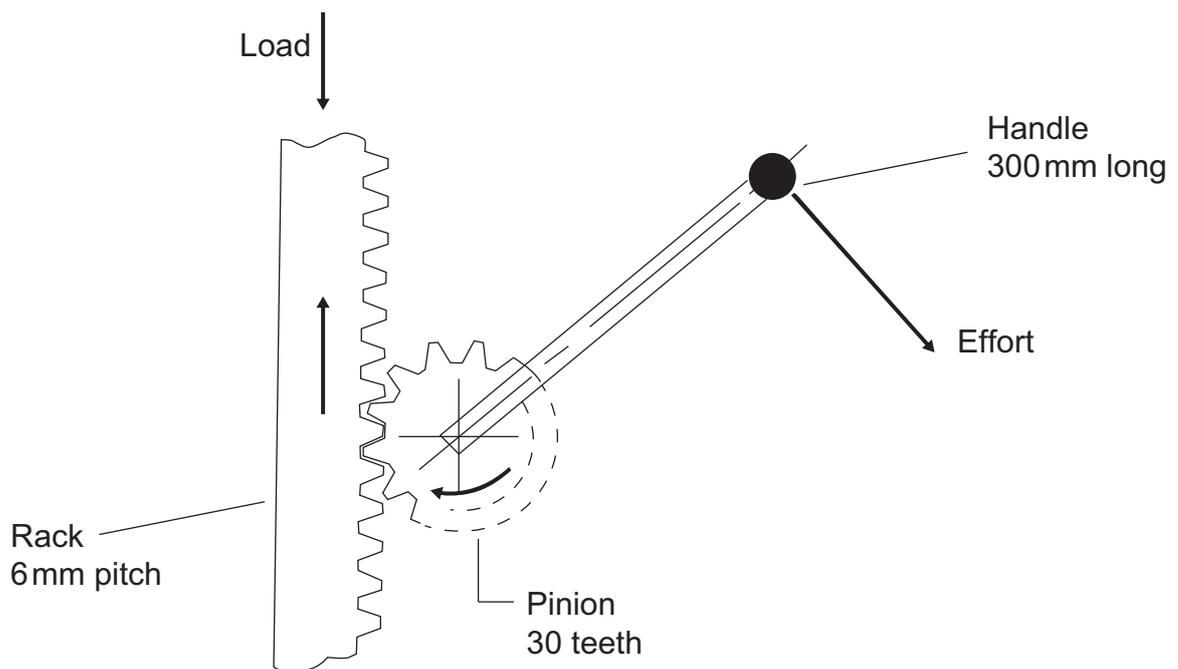
Fig. 8

(i) Name the mechanism shown in **Fig. 8**.

_____ [1]

(ii) Give **one** application for this type of mechanism.

_____ [1]

[Turn over

(iii) If the load is required to move 30 mm, calculate the angle through which the handle must be moved.

[6]

(iv) Calculate the velocity ratio of the mechanism.

[4]

(v) Suggest **two** ways in which the mechanism could be modified to increase the velocity ratio.

1.

2. [4]

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