cea Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
January 2019

Technology and Design

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

[GTD22]

GTD22

FRIDAY 11 JANUARY, 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 ($F = P \times A$)

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Answer **all** questions

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

_____ [1]

Fig. 1

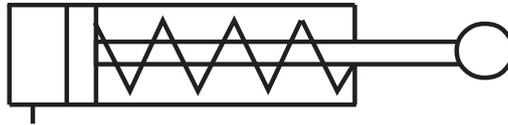**(ii)** Name the valve used to control the movement of the cylinder in **Fig.1**.

_____ [1]

(iii) Give **one** use for this type of pneumatic cylinder.

_____ [1]

(iv) Calculate the force that the cylinder in **Fig. 1** can exert if the cylinder area is $250\,mm^2$ and the air pressure is $0.5\,N/mm^2$.

Answer _____ [2]

[Turn over

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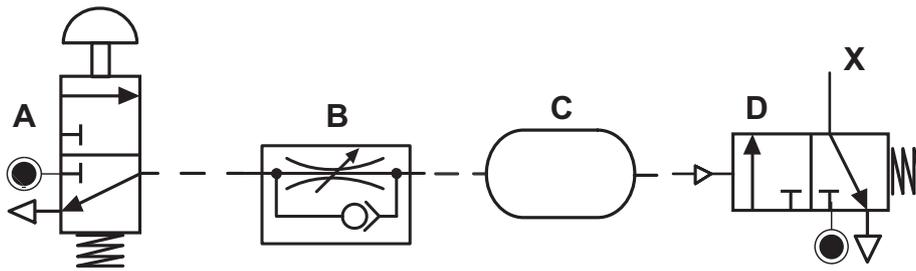**(b)** **Fig. 2** shows part of a pneumatic circuit.

Fig. 2

(i) Name the following components. For components **A** and **D**, include the method of operation.

Component **A** _____ [1]

Component **B** _____ [1]

Component **C** _____ [1]

Component **D** _____ [1]

(ii) For the pneumatic circuit in **Fig. 2** complete **Table 1** below:

Table 1

Name an alternative method of actuating valve **A**	
Name the method of resetting valve **A**	
How do you adjust valve **B**?	

[3]

(iii) Explain how the circuit operates, including how each of the components functions, to produce a signal at **X**. Your answer should make reference to each of the labelled components.

_____

_____

_____

_____

_____

_____ [8]

(iv) Fig. 2 has been reproduced below and is shown as **Fig. 3**. Complete this circuit to control cylinder **Y** so that it operates slowly in both directions.
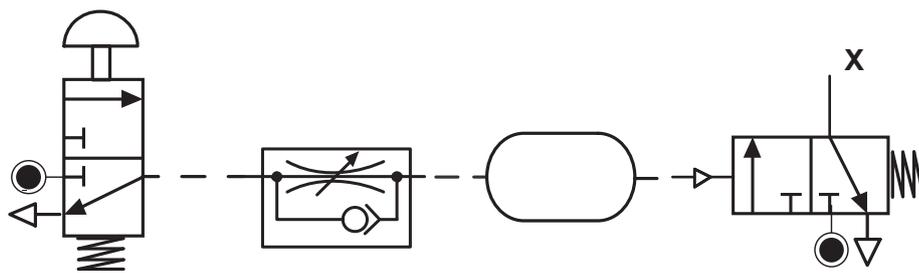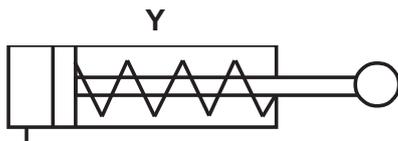

Fig. 3

[5]

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(c) **Fig. 4** shows a pneumatic cylinder **C** which is used to push parcels on to a delivery chute leading to a conveyor belt.
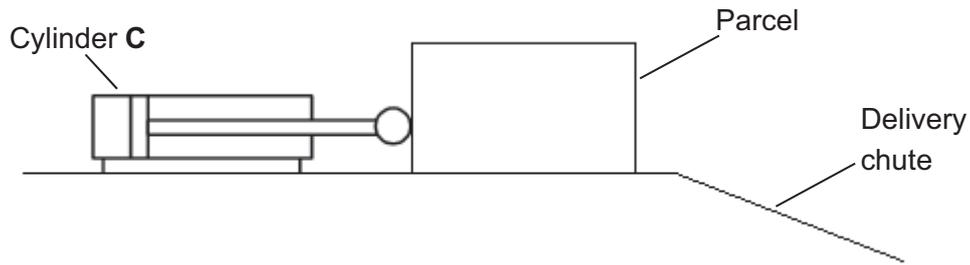

Fig. 4

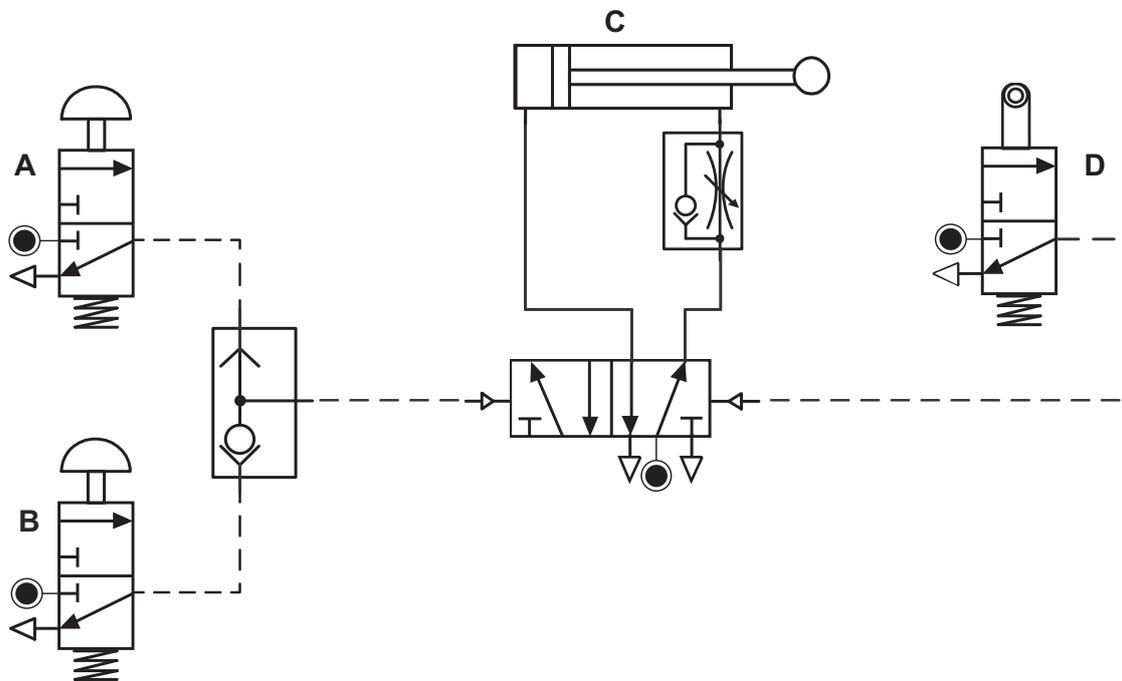Look at **Fig. 5** below. It shows the pneumatic circuit used to control cylinder **C**.

Fig. 5

(i) What **two** features should be considered in selecting cylinder **C**?

1. _____

2. _____ [2]

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(ii) Valves **A** and **B** are used in **Fig. 5** to start the circuit.

State the logic combination used here.

_____ [1]

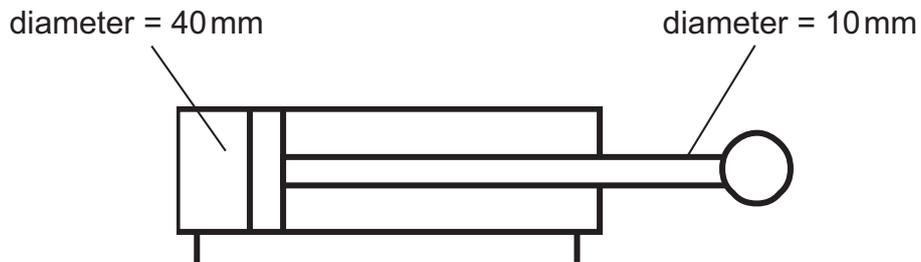The pressure available to operate the cylinder shown in **Fig. 6** is 0.5 N/mm^2.

diameter = 40 mm   diameter = 10 mm

Fig. 6

(iii) Calculate the force of the cylinder outstroke.

Answer _____ [4]

(iv) Calculate the force of the cylinder instroke.

Answer _____ [6]

[Turn over

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(v) Explain why there is a difference between the two forces.

_____

_____

_____

_____ [2]

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2 **(a)** **Fig. 7** shows three types of cams and followers.
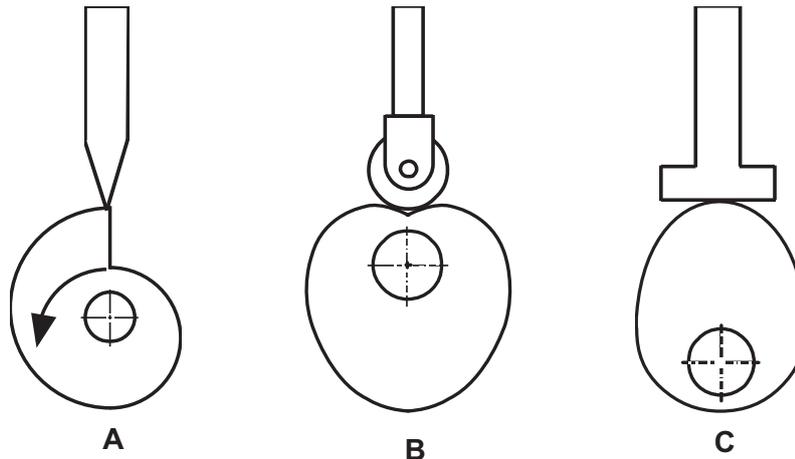

Fig. 7

(i) State the correct name for each of the cams shown in **A**, **B** and **C**, in **Fig. 7**.

A _____

B _____

C _____ [3]

(ii) State the correct name for each of the followers shown in **A**, **B** and **C**, in **Fig. 7**.

A _____

B _____

C _____ [3]

[Turn over

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(iii) Look at **Fig. 7** and select the appropriate cam to produce the following types of motion when rotated.

A steady rise and steady fall.

A quick fall followed by a steady rise.

A steady fall, a period of dwell or rest, followed by a steady rise.

[3]

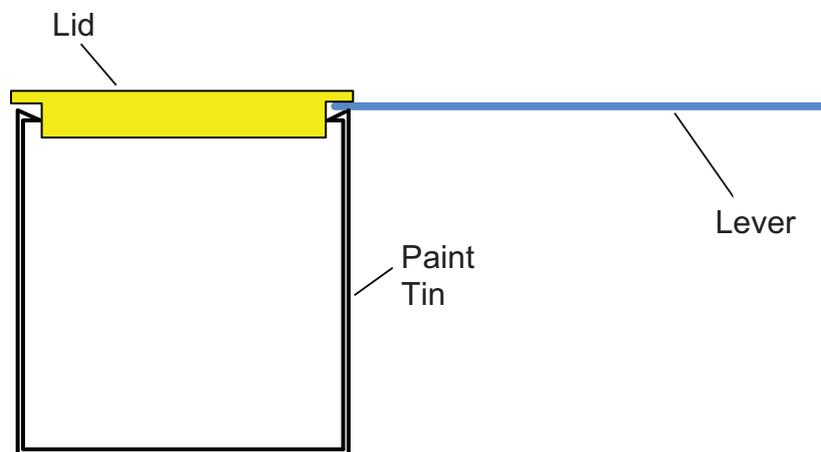**(b)** **Fig. 8** shows a lever being used to open the lid of a paint tin.

Fig. 8

(i) What class of lever is being demonstrated in **Fig. 8**?

[1]

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

Lever material: [1]

Reason: [2]
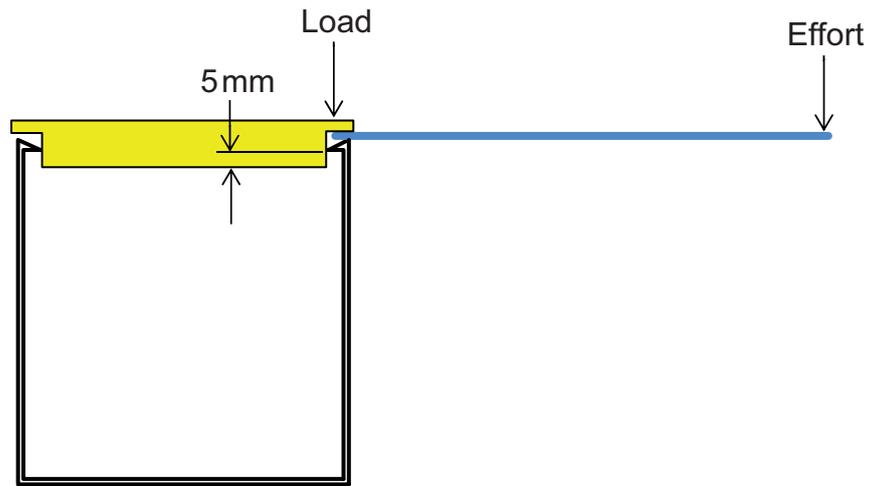
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(iii) Look at **Fig. 9**.

Fig. 9

If the effort needs to move a distance of 50 mm in order to open the lid, calculate the velocity ratio of the lever system shown in **Fig. 9**.

Answer _____ [4]

(iv) In **Fig. 9**, an effort of 20 N is applied to the lever 150 mm from the fulcrum. If the fulcrum is 5 mm from the load, calculate the load force required to open the lid.

Answer _____ [6]

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(c) **Table 2** shows four different mechanisms. Complete **Table 2** by inserting the correct name for each mechanism and the appropriate letter from the list below to describe its function. Each letter can only be used once.

Table 2

Mechanism	Name	Function
 © Roman Sotola / iStock / Thinkstock		
 © HarryHuber / iStock / Thinkstock		
 © Sky_Blue / iStock / Thinkstock		
 © Waldemarus / iStock / Thinkstock		

[8]

Function

A   To make large speed changes between parallel shafts.
B   To change the direction of movement through 90°.
C   To transform rotary motion into linear motion.
D   To produce a large torque and transmit rotary motion through 90°.

[Turn over

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(d) A compound gear train shown in **Fig. 10** has four gears. Gear **A** has 20 teeth, gear **B** has 40 teeth, gear **C** has 20 teeth and gear **D** has 30 teeth. The driver gear **A** rotates at 240 RPM.
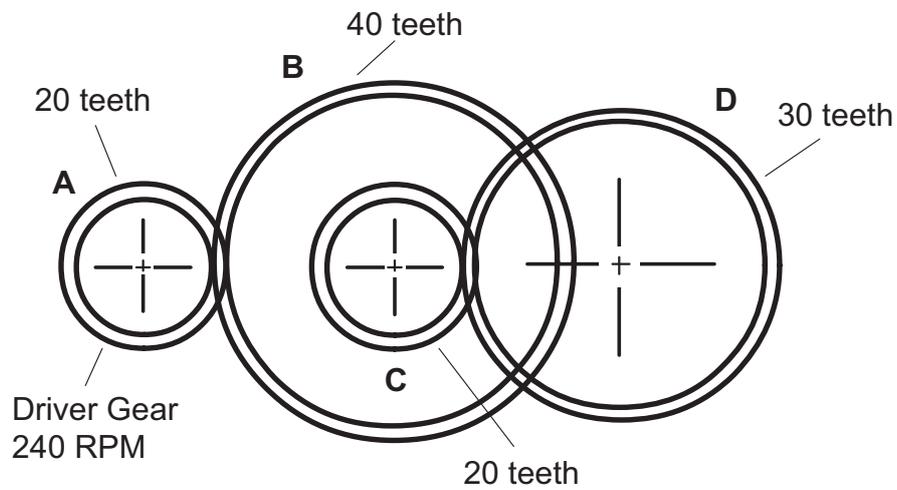
40 teeth

B

20 teeth

A

D   30 teeth

Driver Gear
240 RPM

C

20 teeth

Fig. 10

(i) Calculate the gear ratio of the gear train.

Answer _____ [6]

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(ii) What is the output speed of the gear train?

Answer _____ [3]

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