



General Certificate of Secondary Education  
2009

## Technology and Design

Higher Tier

[G9502]

THURSDAY 21 MAY, MORNING



G9502

Centre Number  
71

Candidate Number

For Examiner's use only	
Question Number	Marks
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**TIME**

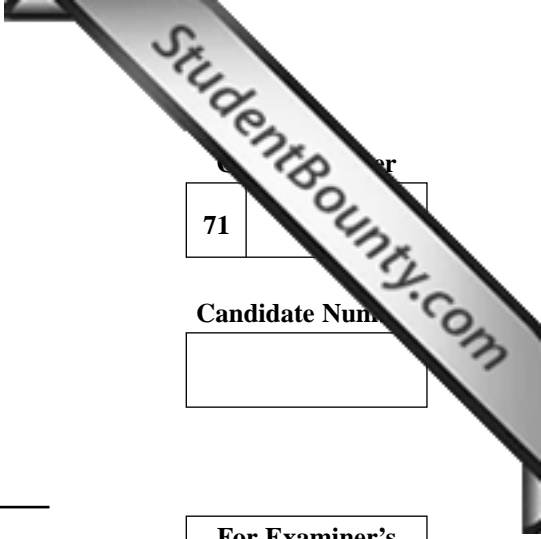
2 hours 30 minutes.

**INSTRUCTIONS TO CANDIDATES**

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.  
Write your answers in the spaces provided in this question paper.  
Answer **seventeen** questions.  
Answer all **fifteen** questions in **Part 1** and **any two** questions from **Part 2**.

**INFORMATION FOR CANDIDATES**

The total mark for this paper is 168, including a maximum of 8 marks for quality of written communication.  
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.  
You are advised to spend 1 hour 45 minutes on **Part 1** and 45 minutes on **Part 2**.



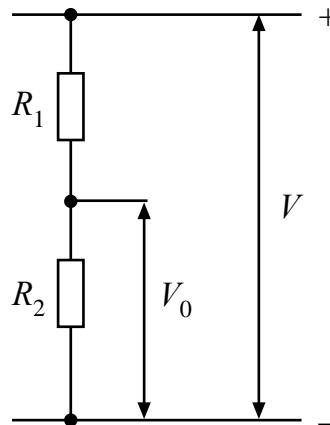
## Formulae for GCSE Technology and Design

You should use, where appropriate, the formulae given below when answering questions which include calculations.

1 Work done = force  $\times$  distance moved in the direction of the force ( $W = f \times d$ )

2 Potential Difference = current  $\times$  resistance ( $V = IR$ )

3 For potential divider  $V_0 = \frac{R_2}{R_1 + R_2} \times V$



4 Series Resistors  $R_{\text{Total}} = R_1 + R_2 + R_3$  etc

Parallel Resistors  $\frac{1}{R_{\text{Total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$  etc

5 Gear ratio of a simple gear train =  $\frac{\text{number of teeth on driven gear}}{\text{number of teeth on driver gear}}$   
(NB for a compound gear train)

Total Gear ratio = the product of the gear ratios of all the subsystems

i.e.  $G.R_T = G.R_1 \times G.R_2 \times G.R_3 \dots$

6 Mechanical Advantage =  $\frac{\text{Load}}{\text{Effort}}$

7 Velocity Ratio =  $\frac{\text{Distance moved by effort}}{\text{Distance moved by load}}$

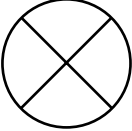
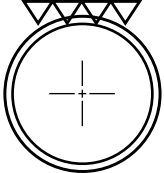

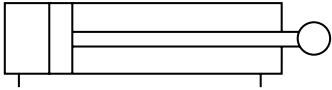
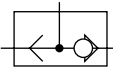
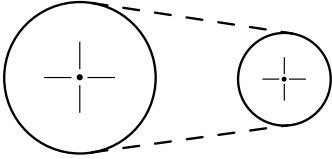
8 Pneumatics Force = Pressure  $\times$  Area ( $F = P \times A$ )

## Part 1

Examiner Only	
Marks	Remark

1 **Table 1** shows a number of different symbols. Using the first row as a guide, complete the table.

**Table 1**

Sketch of Symbol	Type of Symbol	Name of Symbol
	Electronic Control	Lamp
	Electronic Control	Motor
	Mechanical Control	
	Warning Sign	
	Pneumatic Control	
		Diode
		
		

[10]

- 2 Complete **Table 2** below by ticking (✓) the one correct box which relates to each material.

**Table 2**

<b>Material</b>	<b>Hardwood</b>	<b>Plastic</b>	<b>Ferrous metal</b>	<b>Manufactured board</b>	<b>Softwood</b>	<b>Non-ferrous metal</b>
Pine						
Mild Steel						
Chipboard						
Acrylic						
Aluminium						
Mahogany						

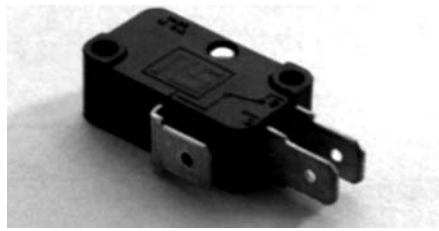
[6]

<b>Examiner Only</b>	
<b>Marks</b>	<b>Remark</b>

3 Four switches labelled (a), (b), (c) and (d) are shown in **Fig. 1**. Name each of the switches shown.



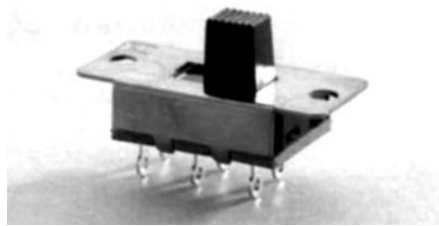
(a)



(b)



(c)



(d)

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**Fig. 1**

Switch (a) \_\_\_\_\_

Switch (b) \_\_\_\_\_

Switch (c) \_\_\_\_\_

Switch (d) \_\_\_\_\_ [4]

Examiner Only	
Marks	Remark

4 Woods are classified as hardwood, softwood or manufactured boards.

(a) Explain the term **manufactured board**:

\_\_\_\_\_

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

(b) Describe **one** advantage, other than cost, of manufactured boards compared to the other woods.

\_\_\_\_\_

\_\_\_\_\_

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

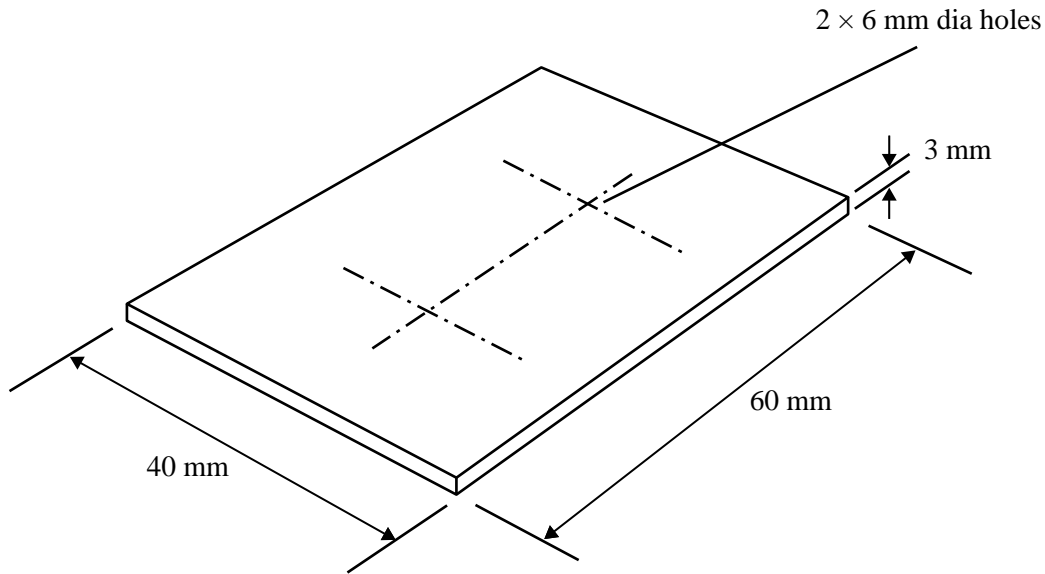
(c) Suggest **two** uses for manufactured boards.

Use 1: \_\_\_\_\_

Use 2: \_\_\_\_\_ [4]

Examiner Only	
Marks	Remark

- 5 A piece of 3 mm acrylic is shown in **Fig. 2**. Two 6 mm holes are marked out for drilling using a vertical drilling machine.



**Fig. 2**

- (a) Suggest **two** specific safety precautions that must be considered when drilling the holes in the acrylic.

(i) \_\_\_\_\_ [1]

(ii) \_\_\_\_\_ [1]

- (b) Name a tool or piece of equipment for holding the acrylic for drilling.

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

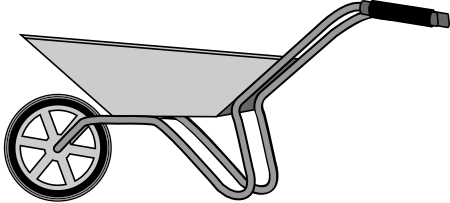
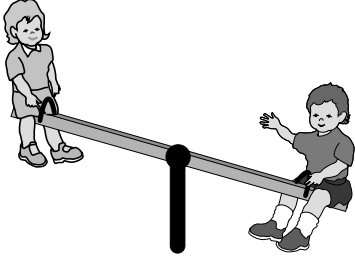

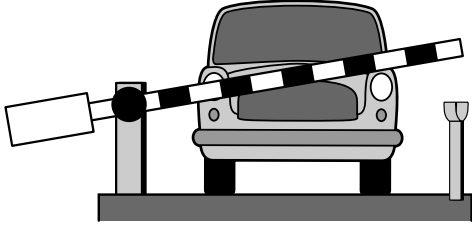
- (c) State **one** factor that must be considered during the drilling process of the acrylic.

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

Examiner Only	
Marks	Remark

6 There are **three** classes of levers. Complete **Table 3** by identifying the class of lever used in the following products.

**Table 3**

Name	Picture of product	Class
Wheelbarrow		
See-saw		
Tweezers		
Car park barrier		



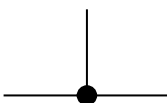
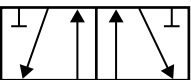
[4]

Examiner Only	
Marks	Remark



7 (a) **Table 4** shows a number of pneumatic symbols.

**Table 4**

Symbol	Name of symbol
	
	
	
	

Complete **Table 4** by inserting the correct name for each symbol from **Table 5**.

**Table 5**

5/2 valve
Shuttle valve
Pipeline junction
3/2 valve
Pressure source

[4]

Examiner Only	
Marks	Remark

(b) Fig. 3 shows a pneumatic circuit which is used to clamp parts during a bonding process.

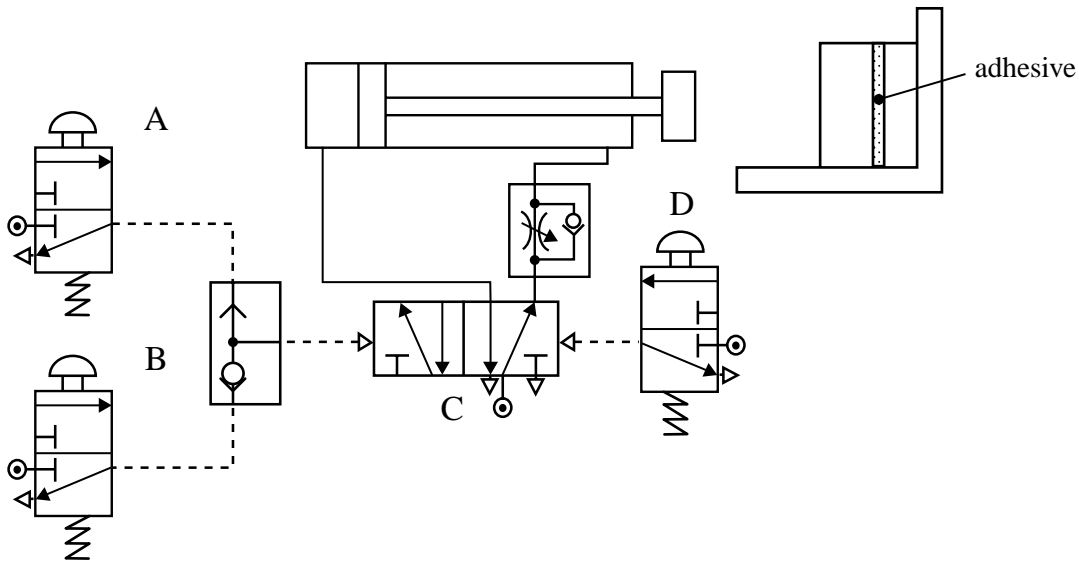


Fig. 3

Tick (✓) the correct box in each of the following cases:

(i) The parts are clamped by pushing:

Button A and B

Button A or B

(ii) The clamp is released:

Automatically

By pressing button D

(iii) The clamping speed is controlled

The speed of release is controlled

(iv) Valve C is:

Button actuated and button reset

Pilot air actuated and pilot air reset




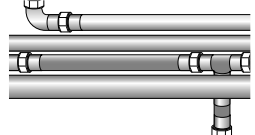
[4]

Examiner Only	
Marks	Remark

- 8 Four examples of the use of **metals** are shown in **Table 6** below.  
Complete **Table 6** by naming a suitable metal for each product giving a reason, other than cost, for your answer.

A different metal should be selected for each example.

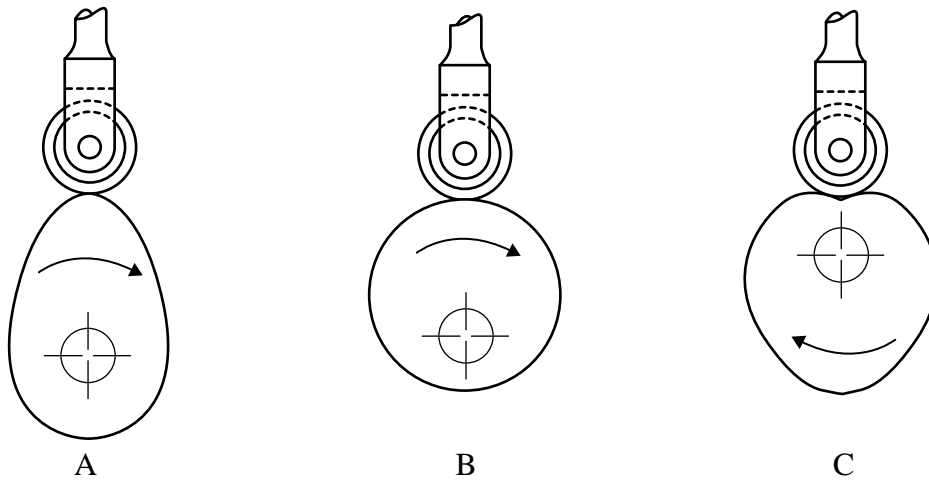
**Table 6**

Example of product	Name	Metal	Reason for choice
	Car body		
	Saucepan		
	Nameplate		
	Water pipes		

[8]

Examiner Only	
Marks	Remark

- 9 (a) Cams are used to change one type of motion into another. **Fig. 4** shows the front view of three types of cam.



**Fig. 4**

- (i) Select the correct names for the cams from the list given below.

**Eccentric**  
**Pear-shaped**  
**Heart-shaped**

A \_\_\_\_\_

B \_\_\_\_\_

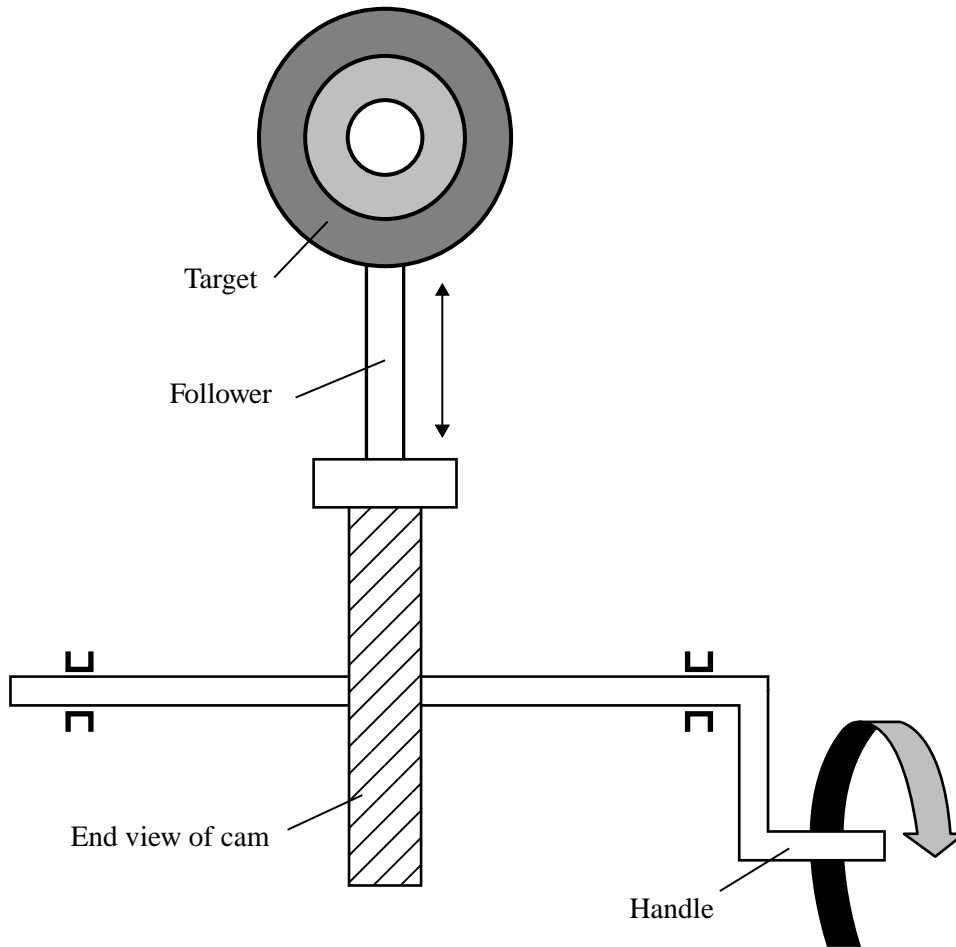
C \_\_\_\_\_ [3]

- (ii) Name the type of follower shown in **Fig. 4**.

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

Examiner Only	
Marks	Remark

- (b) The target in a toy is shown in **Fig. 5**. As the handle is rotated through one turn, the target is required to rise, then fall, and then remain at rest or dwell.



**Fig. 5**

- (i) Select the correct cam from **Fig. 4** to produce this motion.

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

- (ii) Explain how the rest or dwell is produced by the cam shape.

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

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

**10 (a)** Write down the name of each electrical unit used to measure current, voltage and resistance.

Current \_\_\_\_\_  
 Voltage \_\_\_\_\_  
 Resistance \_\_\_\_\_ [3]

**(b)** Resistors are used with LEDs in electronic circuits.



Source: *Electronic Products, Collins, ISBN 0-0032001204, page 84*

**(i)** What does the term LED mean?

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

**(ii)** Suggest a suitable reason for using a LED in an electronic circuit.

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

**(iii)** State the reason for using a resistor with an LED in an electronic circuit.

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

**(c)** State the purpose of a conductor and an insulator in an electronic circuit and give an example of each.

**(i)** Purpose: Conductor \_\_\_\_\_  
 \_\_\_\_\_ [1]

**(ii)** Purpose: Insulator \_\_\_\_\_  
 \_\_\_\_\_ [1]

**(iii)** Example: Conductor \_\_\_\_\_  
 \_\_\_\_\_ [1]

**(iv)** Example: Insulator \_\_\_\_\_  
 \_\_\_\_\_ [1]

11 Fig. 6 shows two methods, A and B, for transmitting power from a motor to an output shaft.

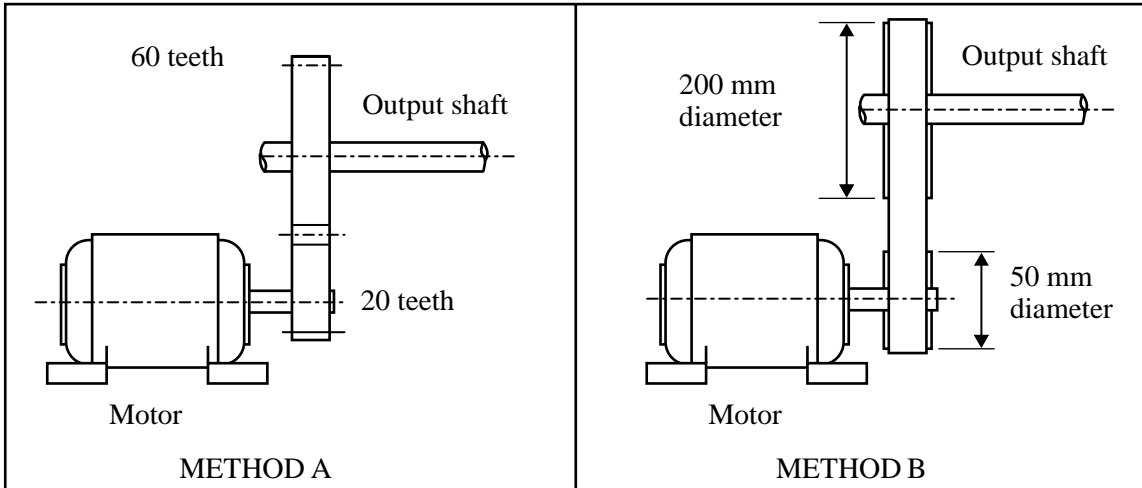


Fig. 6

(a) Complete the following:

(i) Which transmission requires lubrication?

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

(ii) Which transmission can slip if the output shaft jams?

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

(iii) Which transmission would be used if the distance between the motor and the output shaft is large?

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

(iv) Which transmission would be used if an exact speed ratio is required?

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

Examiner Only	
Marks	Remark





12 Computer control processes are widely used in industry for automatic processes. Fig. 7 shows a bottle to be filled with lemonade by such a process.

To fill the bottle it must be positioned under a valve which controls the flow of lemonade. A screw top is then attached to the bottle.

(a) Complete the flow chart for this operation by inserting the listed operations in the correct order. [5]

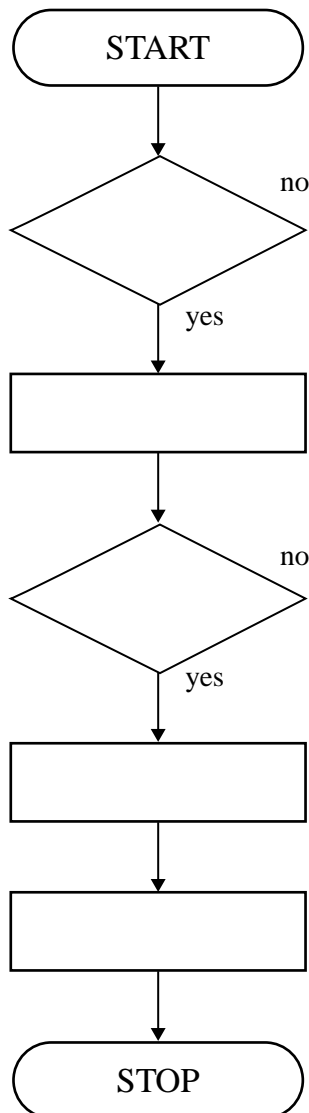
(b) Complete the two decision loops. [4]

Operations

- Close valve
- Fix screw top
- Is the bottle full?
- Open valve to let lemonade flow
- Is the bottle present?



Fig. 7



Examiner Only	
Marks	Remark

13 A pneumatic cylinder is used in a guillotine to cut strips of plastic as shown in Fig. 8.

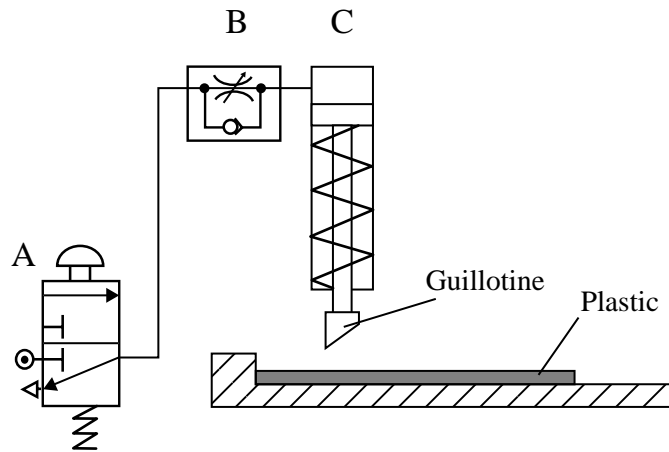


Fig. 8

(a) (i) Name the type of cylinder shown.

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

(ii) Which stroke of the piston (outstroke or instroke) is speed controlled?

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

(iii) Give a reason for your answer.

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

(iv) Explain how this speed can be changed.

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

Examiner Only	
Marks	Remark

(b) The circuit in Fig. 8 is modified to improve safety. This new modified circuit is shown in Fig. 9.

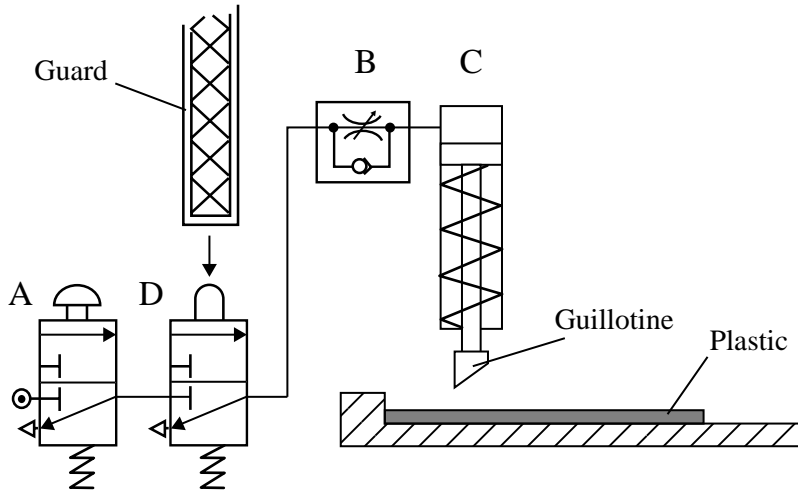


Fig. 9

(i) Which **one** of the following is used to actuate valve D?

**Roller    Lever    Plunger    Pilot air**

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

(ii) Explain how the guillotine can be operated as shown in Fig. 9.

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

Examiner Only	
Marks	Remark



15 Fig. 11 shows a pictorial sketch of an aluminum block required for a pupil's project. The block requires four M6 threaded holes which are 30 mm deep.

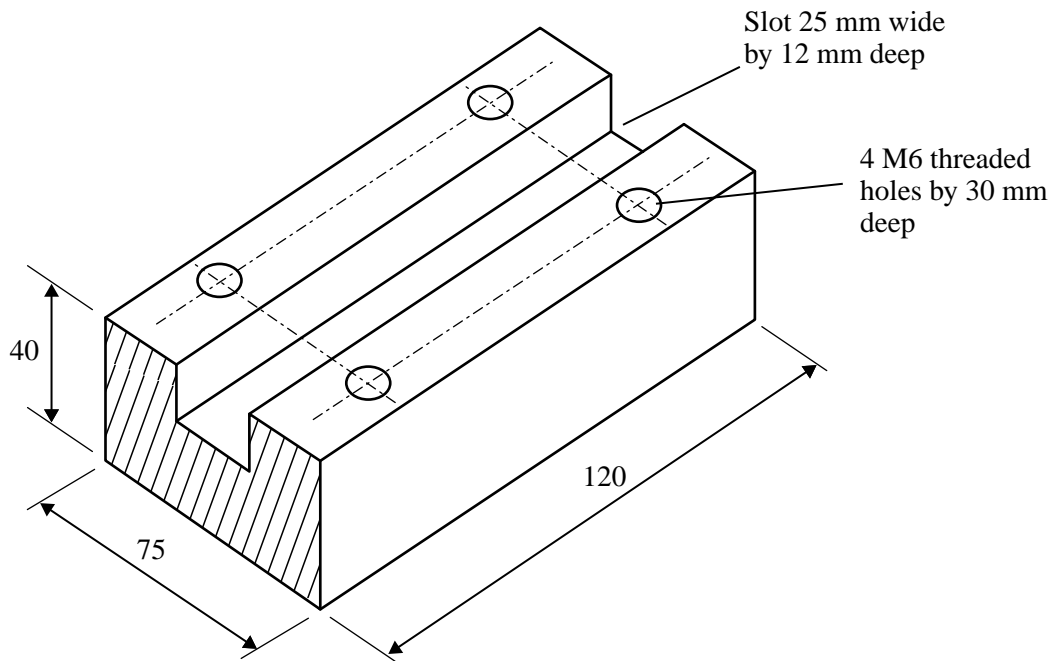


Fig. 11

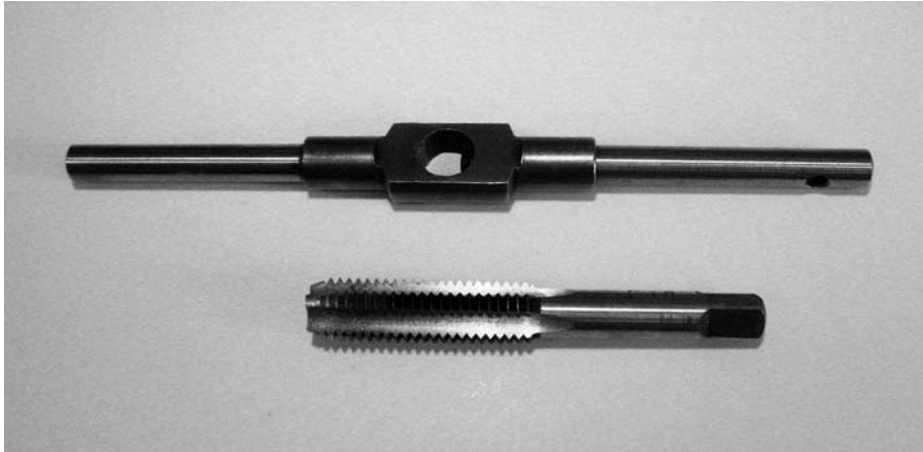
(a) Using the list below, select the workshop machine that could be used to cut the slot in the aluminium.

- Bandsaw**
- Lathe**
- Milling machine**
- Drilling machine**

Machine: \_\_\_\_\_ [2]

Examiner Only	
Marks	Remark

(b) The picture below shows the hand tool used to thread the holes. Name the tool.



Tool: \_\_\_\_\_ [2]

(c) The picture below shows the hand tool used to thread a round bar. Name the tool.



Tool: \_\_\_\_\_ [2]

(d) List the **three** main stages in producing a threaded hole.

Stage 1: \_\_\_\_\_

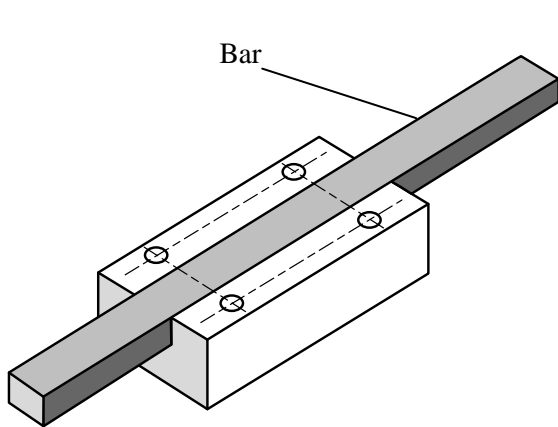
Stage 2: \_\_\_\_\_

Stage 3: \_\_\_\_\_ [3]

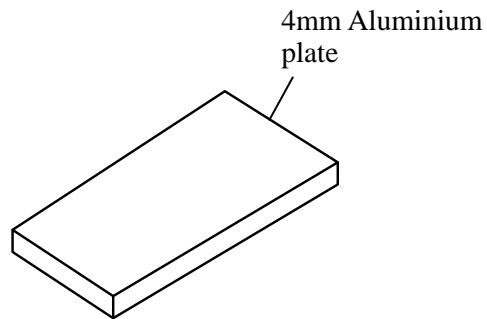
Examiner Only	
Marks	Remark

- (e) A rectangular bar is inserted into the block as shown in **Fig. 12**. The aluminium plate shown in **Fig. 13** is to be attached and easily removed from the top of the block.

Show by means of sketches and notes how the 4 mm thick plate could be attached to the block and easily removed if required. [6]



**Fig. 12**



**Fig. 13**

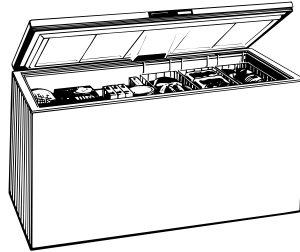
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## Part 2

### Option 1

#### COMPUTER SYSTEMS AND CONTROL

- 16** A shop uses a chest freezer to store its frozen food. Sometimes the staff leave the lid open which may affect the frozen food. The owner of the shop decides to fit an alarm system to the freezer to warn if the lid is left open or if the freezer is getting too hot.



- (a) (i)** Name a suitable sensor which operates when the lid is opened.

Sensor: \_\_\_\_\_ [1]

- (ii)** Is your named sensor a digital or analogue sensor?

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

- (iii)** Outline the essential differences between digital and analogue sensors.

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

- (b)** It is decided to use a microprocessor control system. The alarm should operate when the lid is left open and/or the temperature of the freezer rises.

- (i)** Name a suitable temperature sensor for the freezer.

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

Examiner Only	
Marks	Remark

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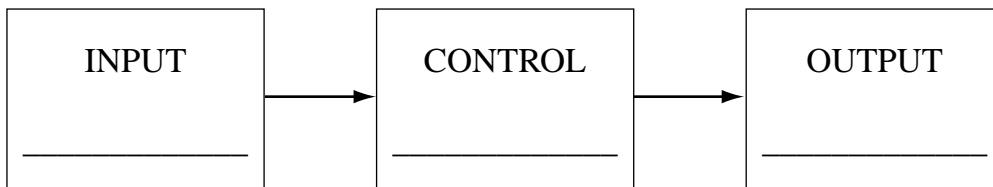


(ii) Name the type of memory used to store the main program for this system.

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

(c) A keypad with a small display unit is used to input data into the processor for the alarm system to allow the staff to read data.

Complete the block diagram by identifying the parts for this system as outlined: [3]

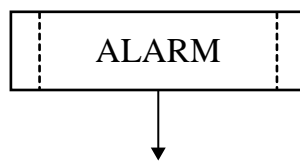


(d) Design a flow chart for the overall system that includes a macro called "ALARM" for the sound.

(i) The alarm macro consists of four sounds, numbers 42; 48; 57; 59 which each come on for 0.5 seconds. To produce, for example, "SOUND 30" for 1 second the command would be written as

SOUND 30, 1 sec

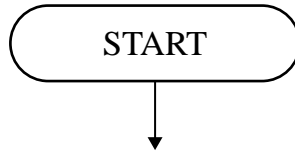
Complete the macro below for the alarm: [2]



Examiner Only	
Marks	Remark

(ii) If the lid of the freezer is opened or the freezer temperature is too high, then the system should wait for 30 seconds before the alarm sounds.

Complete the overall flowchart below to include two sensors, one for the lid and the other for the temperature. Include the macro "ALARM" in the flowchart. The alarm should continue to play until reset. [9]



Examiner Only	
Marks	Remark

17 A PIC micro-controller is used by many students in their electronic projects in school.

(a) State the **two** main functions of a PIC.

(i) \_\_\_\_\_

(ii) \_\_\_\_\_ [2]

(b) A student wishes to design a child's toy to flash a number of lights for 8 seconds and then play a tune for 6 seconds.

Suggest **two** reasons (other than cost) why LEDs should be used as the lights in the toy.

\_\_\_\_\_

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

(c) (i) Draw, below, a macro titled "**FLASH**" to turn on the lights for 0.5 second and then turn them off. [3]

Examiner Only	
Marks	Remark

- (ii) Draw a second macro below titled “**TUNE**” to play a tune with the following numbers to the set times:  
To produce, for example, “SOUND 30” for 1 second the command would be written as

SOUND 30, 1 sec

- Sound 29 for 0.5 seconds
- Sound 26 for 0.5 seconds
- Sound 25 for 0.5 seconds
- Sound 22 for 1 second

[2]

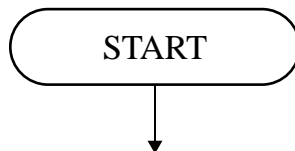
- (iii) Draw, below, an additional macro titled “**STAGE 1**” to include the “FLASH” macro followed by a time delay of 8 seconds. [3]

Examiner Only	
Marks	Remark

- (iv) Draw another macro titled “**STAGE 2**” to include the “TUNE” macro followed by a time delay of 6 seconds. [3]

Examiner Only	
Marks	Remark

- (d) Finally, complete the overall flowchart for the toy to include “STAGE 1” and “STAGE 2” macros. A push button switch must be pressed to operate the toy. A 4 second delay must be included between “STAGE 1” and “STAGE 2”. The systems will then stop. [5]



Option 2

ELECTRONIC SYSTEMS AND CONTROL

18 Two circuits (a) and (b) are shown in Fig. 14. Both circuits use identical components.

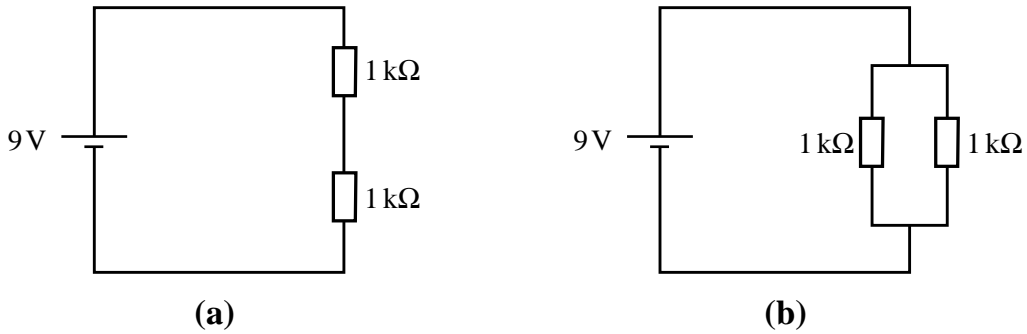


Fig. 14

(a) Complete the sentences below.

The resistors shown in circuit (a) are connected in:

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

The resistors shown in circuit (b) are connected in:

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

(b) (i) In the space below state or explain Ohm's law to show the relationship between current, voltage and resistance.

[2]

Examiner Only	
Marks	Remark

- (ii) Use Ohm's law to **calculate** the current, across both resistors, in each circuit in **Fig. 14**.

Current **Fig. 14(a)** \_\_\_\_\_

Current **Fig. 14(b)** \_\_\_\_\_ [6]

- (iii) Redraw circuit (a) in the space below and show a voltmeter correctly connected to the circuit.

[2]

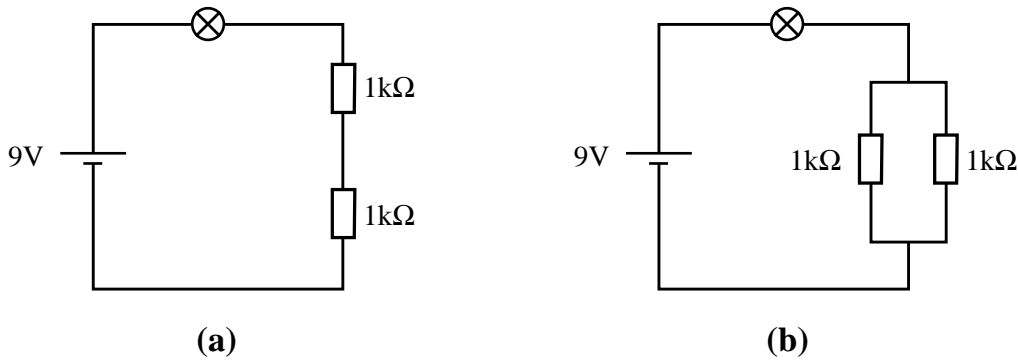
- (iv) Redraw circuit (a) in the space below, but this time show an ammeter correctly connected to the circuit.

[2]

Examiner Only	
Marks	Remark

[Turn over

(c) A bulb has been added to each circuit as shown in **Fig. 15**.



**Fig. 15**

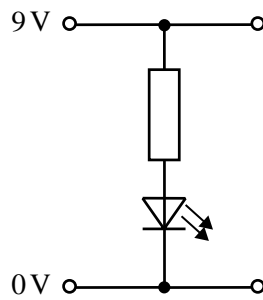
State in which circuit the bulb will be brightest and give a reason for your answer.

Circuit bulb in **Fig. 14(a)** or **Fig. 14(b)** \_\_\_\_\_

Reason

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

(d) A student is building a circuit which requires a LED to be connected across a 9V supply to act as a 'light on indicator'. This is shown in **Fig. 16**. If the LED is rated at 2V, 20mA calculate the minimum value that should be used for the resistor in this circuit.



**Fig. 16**

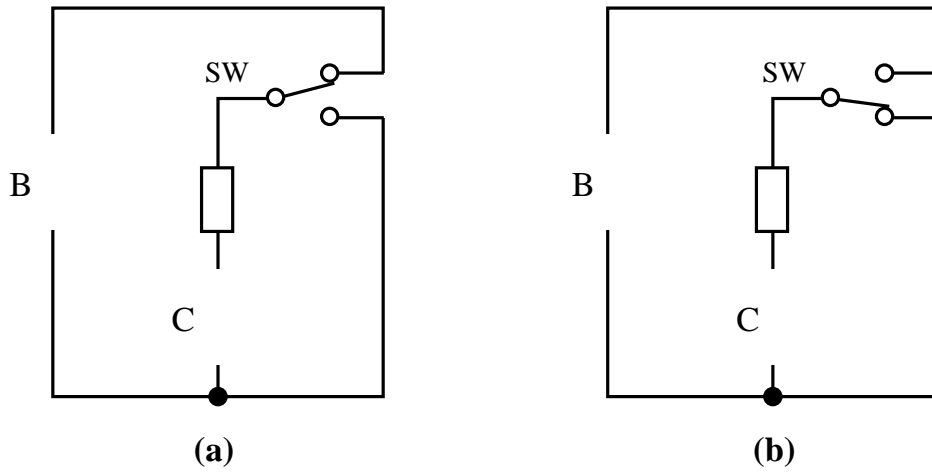
[4]

Examiner Only	
Marks	Remark





- (b) (i) A capacitor and a multi-cell battery symbol are to be inserted into each circuit in **Fig. 18** at points C and B respectively. Complete the circuits by inserting the capacitor and multi-cell battery symbols in the correct locations.



**Fig. 18**

[2]

- (ii) Explain how the circuit operates when the switch is connected as shown in **Fig. 18**.

**Fig. 18(a)** \_\_\_\_\_  
 \_\_\_\_\_

**Fig. 18(b)** \_\_\_\_\_  
 \_\_\_\_\_ [4]

- (c) (i) State a purpose of using a capacitor in an electronic circuit.

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

- (ii) The value of capacitors are often expressed in  $\mu\text{F}$  and  $\text{nF}$ .  
 What do  $\mu\text{F}$  and  $\text{nF}$  stand for?

$\mu\text{F}$  \_\_\_\_\_

$\text{nF}$  \_\_\_\_\_ [3]

Examiner Only	
Marks	Remark

(iii) Explain the operation of the circuit shown in Fig. 19. Refer to the function of the components used in the circuit when giving your answer.

Please insert a capacitor symbol at C to complete the circuit.

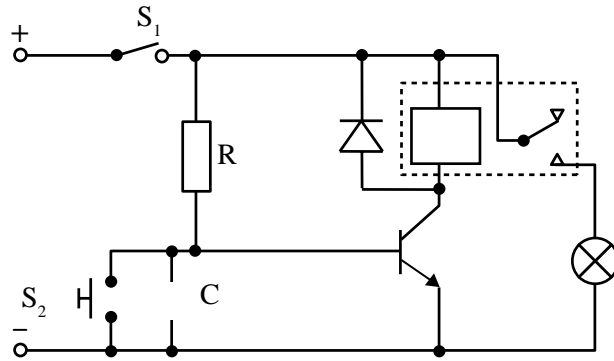


Fig. 19

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[6]

Examiner Only	
Marks	Remark

### Option 3

#### MECHANICAL SYSTEMS AND CONTROL

Examiner Only	
Marks	Remark

**20** Pulleys and belts are used in many transmission systems. **Table 7** gives four examples where belts are used in transmission systems.

(a) Complete **Table 7** by identifying the most appropriate belt from the given list: [4]

- |   |  |
|---|--|
| <p><b>Flat belt</b><br/><b>V belt</b></p> | <p><b>Toothed belt</b><br/><b>Round belt</b></p> |
|---|--|

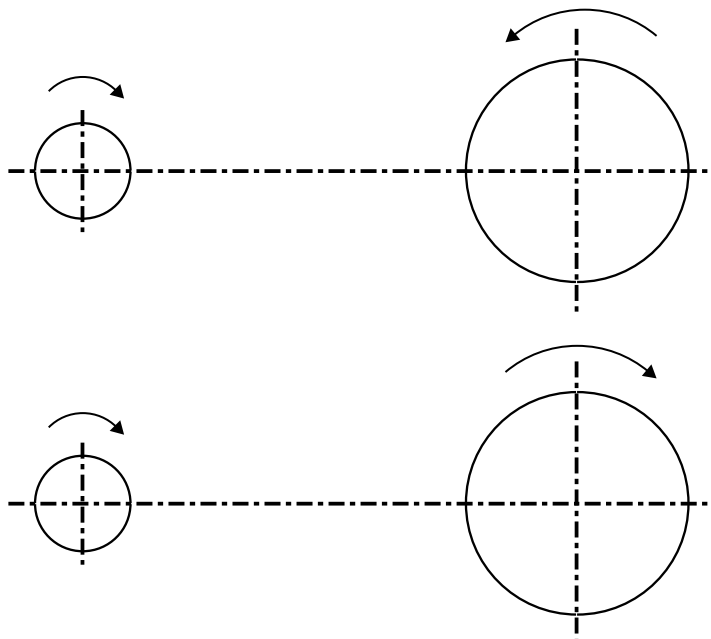
**Table 7**

Example	Type of belt
Timing for a car	
Vacuum cleaner	
Drilling machine	
Conveyor system	

(b) Name another machine that uses a pulley and belt system.

Machine: \_\_\_\_\_ [2]

(c) (i) Complete the sketches in **Fig. 20** by drawing the appropriate pulley belt to transmit the required motion as shown by the arrows. [4]



**Fig. 20**

(ii) Suggest **two** reasons (other than cost) why a belt system is suitable for the pillar drill.

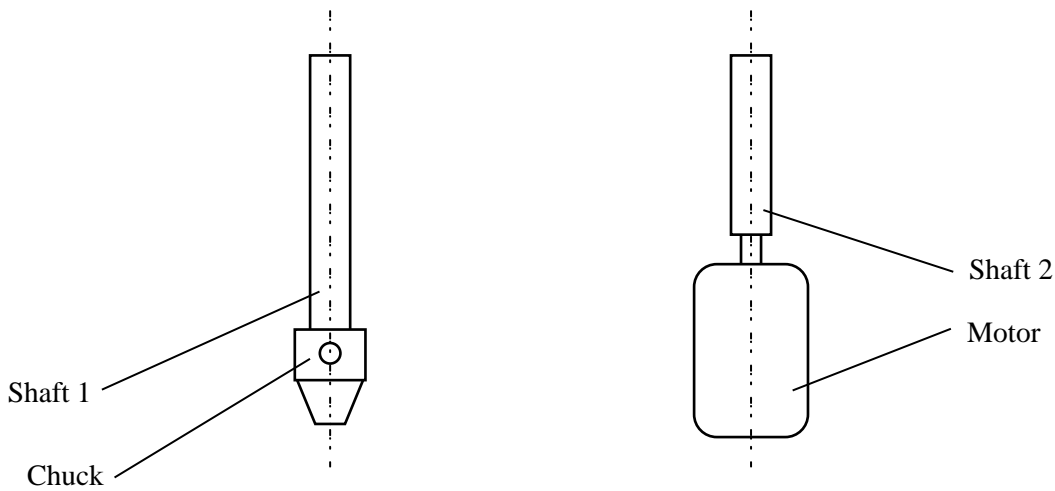
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[2]

(d) **Fig. 21** shows a line diagram of the shafts, chuck and motor for a pillar drilling machine. Complete the diagram by showing clearly how three different speeds are obtained. Include the belt in your answer. [4]



**Fig. 21**

(e) Most belt systems need to be tensioned correctly. Name **two** methods that can be used to tension pulley belts.

Method 1: \_\_\_\_\_

Method 2: \_\_\_\_\_ [4]

Examiner Only	
Marks	Remark



(b) Fig. 23 shows three linkages.

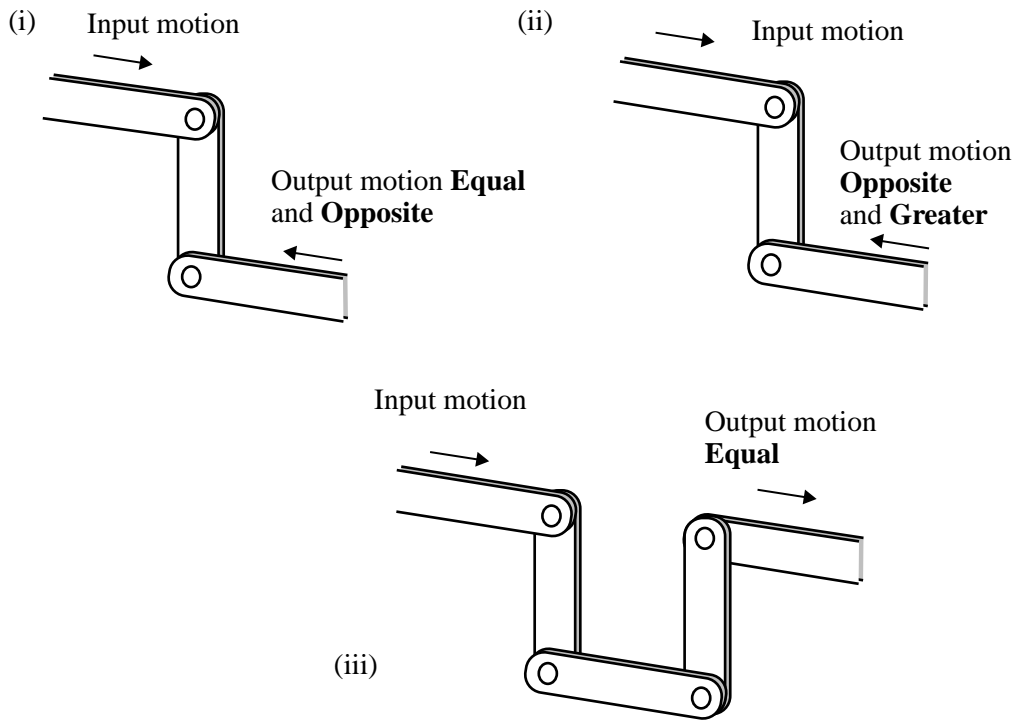


Fig. 23

Mark on each linkage in **Fig. 23** the position of the pivot or pivots to produce the output shown. [3]

Examiner Only	
Marks	Remark

(c) Fig. 24 shows the mechanisms which are used in the operation of a sliding security barrier.

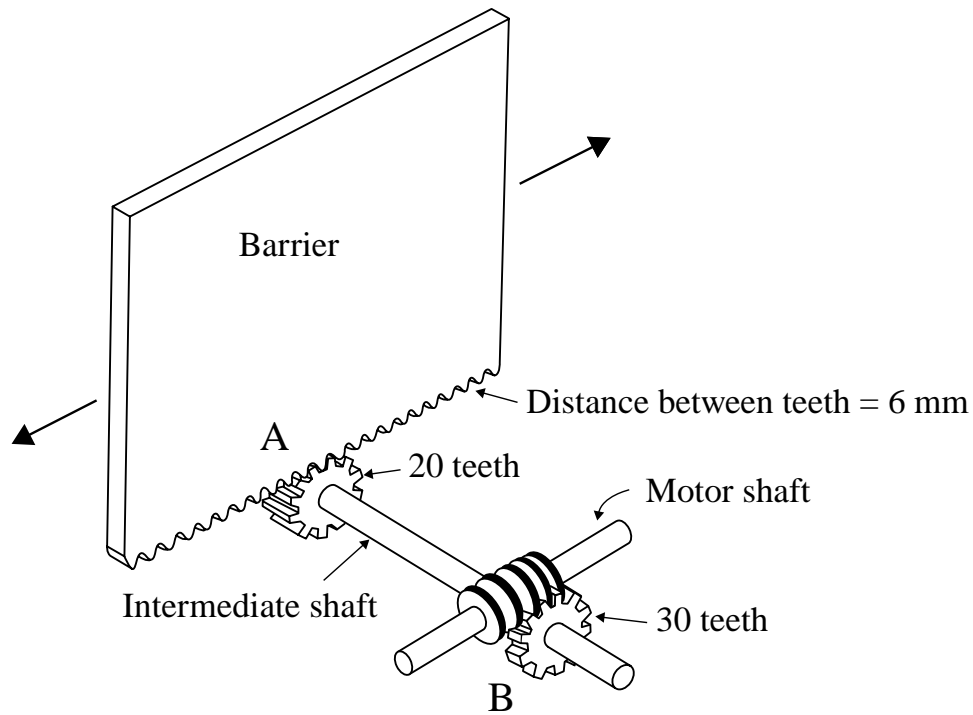


Fig. 24

(i) Name the mechanisms A and B in Fig. 24.

A \_\_\_\_\_

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

(ii) Suggest an alternative mechanism to B which would also give a large speed reduction.

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

Examiner Only	
Marks	Remark



**(iii)** If the motor runs at 1440 rev/min calculate:

- The speed of the intermediate shaft.

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

- The speed of the barrier in m/min.

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

**(iv)** Suggest how the system could be modified to give a greater barrier speed for the same motor speed.

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

Examiner Only	
Marks	Remark

### Option 4

#### PNEUMATIC SYSTEMS AND CONTROL

22 (a) Fig. 25 shows a pneumatic circuit which is used in a packaging process.

The circuit can be stopped for maintenance, in different positions, by pressing buttons A or B or C.

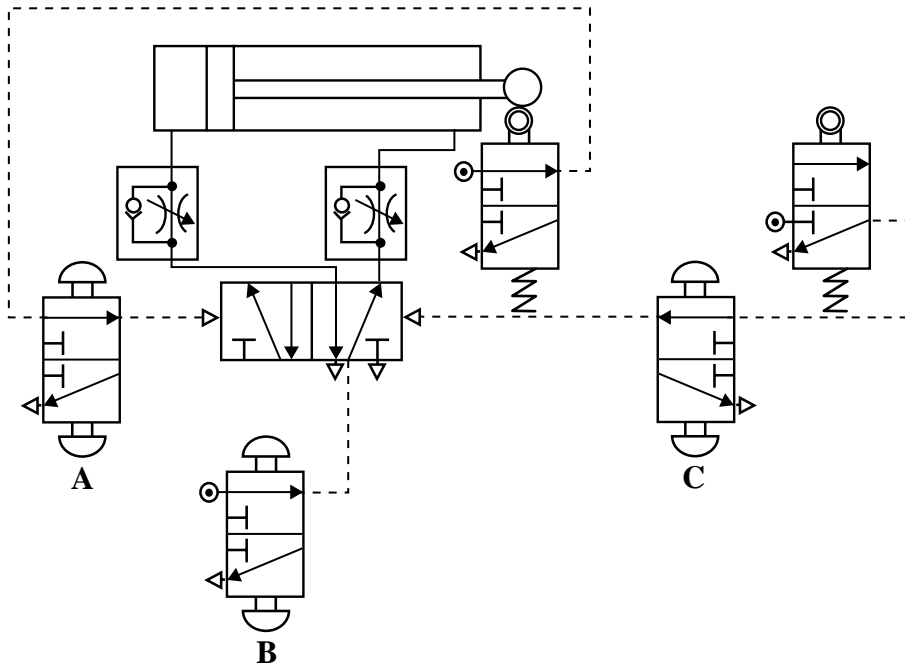


Fig. 25

(i) Describe briefly the operation of the circuit when the air supply is switched on.

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

(ii) Explain how the stroke of the cylinder can be adjusted.

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

Examiner Only	
Marks	Remark

(b) (i) State the position in which the piston stops (i.e. outstroked or instroked or any position) when each of the following buttons is pressed:

- Button A \_\_\_\_\_
- Button B \_\_\_\_\_
- Button C \_\_\_\_\_ [3]

(ii) Which **one** of the buttons should be used as an emergency stop?

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

(iii) Give a reason for your answer.

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

Examiner Only	
Marks	Remark

(c) Fig. 26 shows part of a pneumatic circuit where signals can be given from several places A, B, C and D.

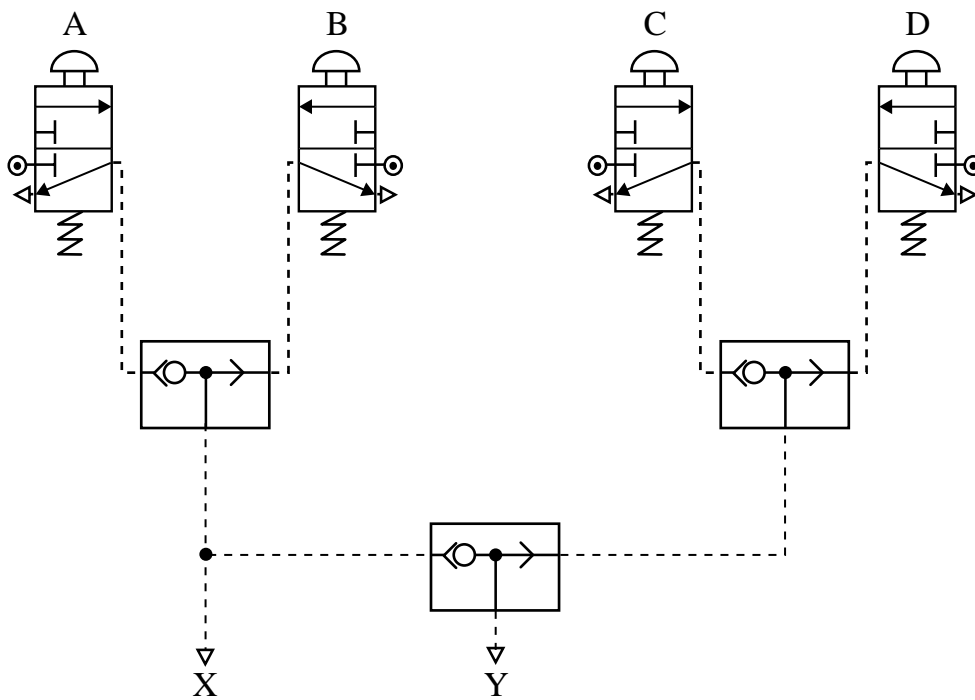


Fig. 26

State whether a signal appears at X or Y, when each of the buttons A, B, C or D is pressed by completing Table 8.

Table 8

Button Pressed				Output	
A	B	C	D	X	Y
0	0	0	0	0	0
1	0	0	0		
0	1	0	0		
0	0	1	0		
0	0	0	1		

[4]

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Marks	Remark

(d) Fig. 27 shows part of a pneumatic circuit.

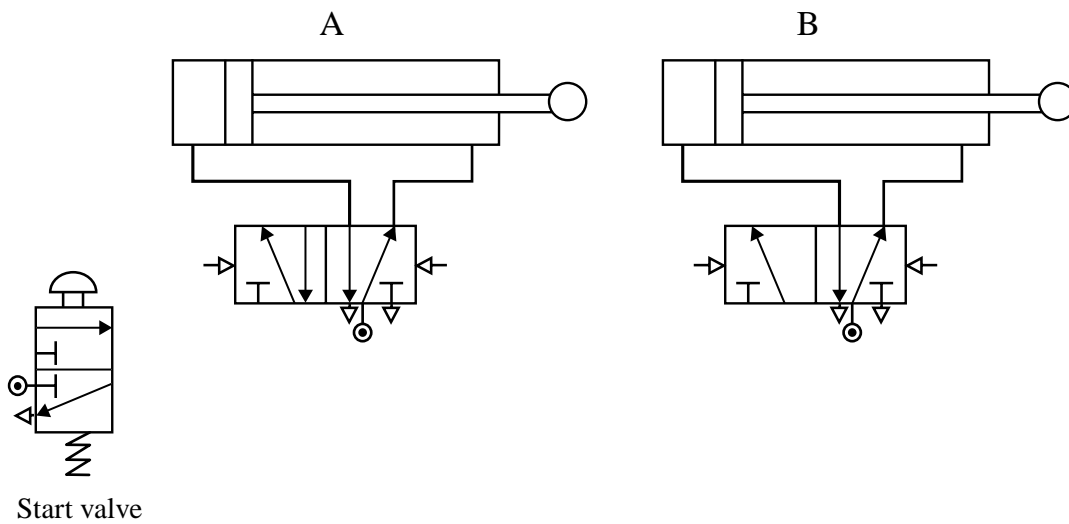


Fig. 27

When a start signal is given for an instant, the cylinders are to operate in the following sequence:

- A and B outstroke simultaneously.
- When the outstroke of cylinder A and the outstroke of cylinder B are confirmed, cylinder B may return.
- When the instroke of cylinder B is confirmed, cylinder A may return.

Design a circuit to give the required sequence for one cycle. [9]

Examiner Only	
Marks	Remark

23 A furnace door is operated by pneumatic cylinders as shown in Fig. 28.

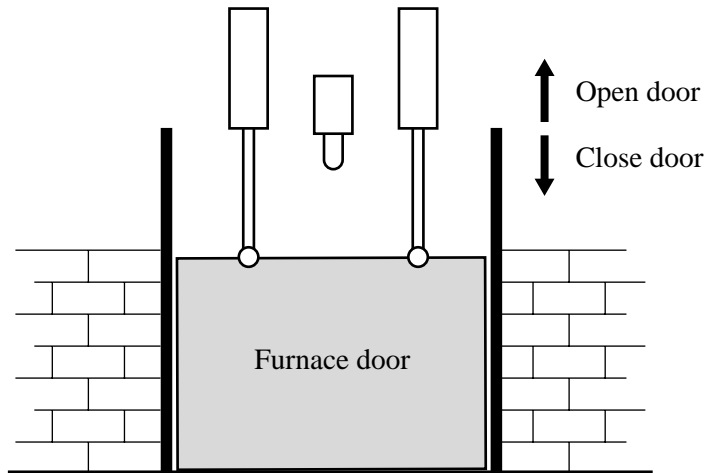


Fig. 28

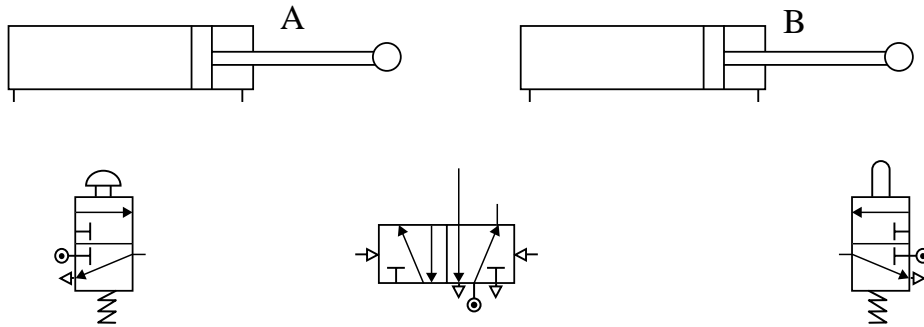
(a) In selecting the cylinders, state **two** factors which should be considered when determining their diameters.

Factor 1 \_\_\_\_\_

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

Examiner Only	
Marks	Remark

- (b) The door is to open when a button is pressed.  
 Fully open is confirmed when the door operates a plunger.  
 The door is to remain open for a set time before closing automatically.  
 Part of the pneumatic circuit to control the door is shown in **Fig. 29**.



**Fig. 29**

Complete **Fig. 29**, showing all the connecting pipelines and the components needed to give the time delay. [5]

- (c) The closing speed of the door is to be controlled.

Insert a flow regulator in **Fig. 29** which could control the closing speed. [2]

- (d) Name the electrical switches A and B shown in **Fig. 30**.



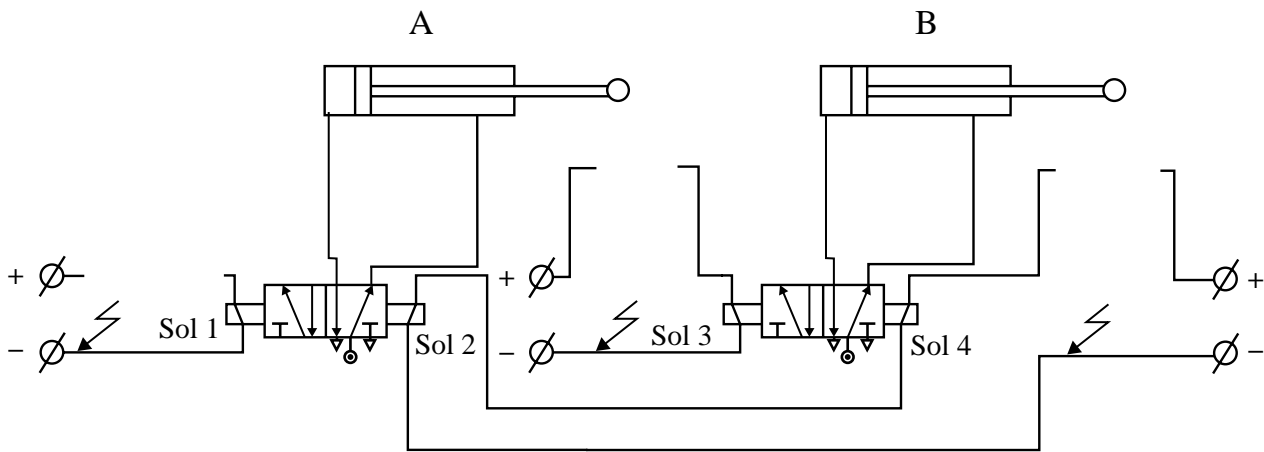
**Fig. 30**

A \_\_\_\_\_

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

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Marks	Remark

(e) **Fig. 31** shows an electropneumatic circuit used in a packaging machine.



**Fig. 31**

An outline of the ladder diagram for the electric circuits is shown in **Fig. 32**.



**Fig. 32**

The circuit is to operate as follows:

- When push button S1 or S2 is pressed for an instant, cylinder A outstrokes.
- When A is fully extended, it contacts a roller operated switch S3. This causes cylinder B to outstroke.
- When B is fully extended, it contacts a roller operated switch S4. This causes A and B to instroke.

Complete the circuit diagram **Fig. 31** and the ladder diagram **Fig. 32** and label each component. [9]

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Marks	Remark
Quality of written communication	



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