



General Certificate of Secondary Education
2010

Technology and Design

Higher Tier

[G9502]

WEDNESDAY 26 MAY, AFTERNOON



71

Candidate Number

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
QWC	

Total Marks	
--------------------	--

TIME

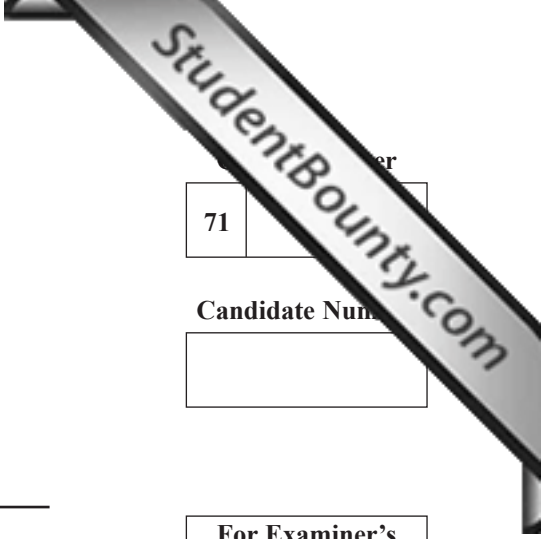
2 hours 30 minutes.

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**.



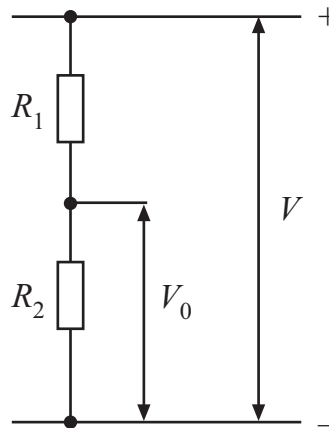
Formulae for GCSE Technology and Design

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



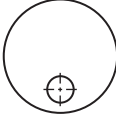



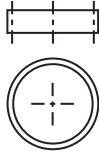
8 Pneumatics Force = Pressure \times Area ($F = P \times A$)

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	Variable Resistor
	Mechanical Control	
	Safe Condition Sign	
		LDR
	Computer/Microprocessor Control	
		

[10]

3 (a) Fig. 3 shows a block diagram of a control system which contains input, process and output.

Name this type of system.



Fig. 3

Name of system: _____ [1]

(b) Fig. 4 shows a block diagram of a control system which contains input, process, output and feedback.

Name this type of system.

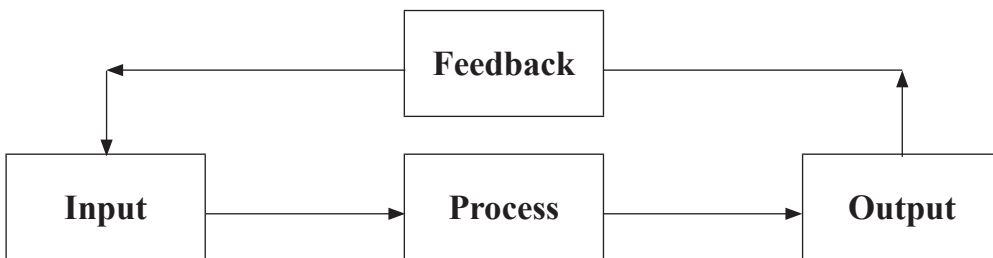


Fig. 4

Name of system: _____ [1]

(c) Explain the function of feedback in Fig. 4.

 _____ [2]

(d) Suggest a reason for using block diagrams for designing systems.

Reason:

 _____ [2]

Examiner Only	
Marks	Remark

- 5 (a) Plastics are commonly used in everyday life. Using the list below, complete **Table 2** by selecting the most appropriate **use** and **characteristic** for each plastic. [4]

List:
Toys
Scratch resistant
Kitchen work surfaces
Lightweight

Table 2

Plastic	Use	Characteristic
Melamine		
Rigid polystyrene		

- (b) Which of the two plastics listed in **Table 2** would be suitable for vacuum forming? Give a reason for your answer.

Name of plastic:

_____ [1]

Reason:

_____ [2]

Examiner Only	
Marks	Remark

- 6 **Fig. 5** shows a mechanism for winding a cable on to a drum. The drum is turned by a system of gears using the handle as shown.

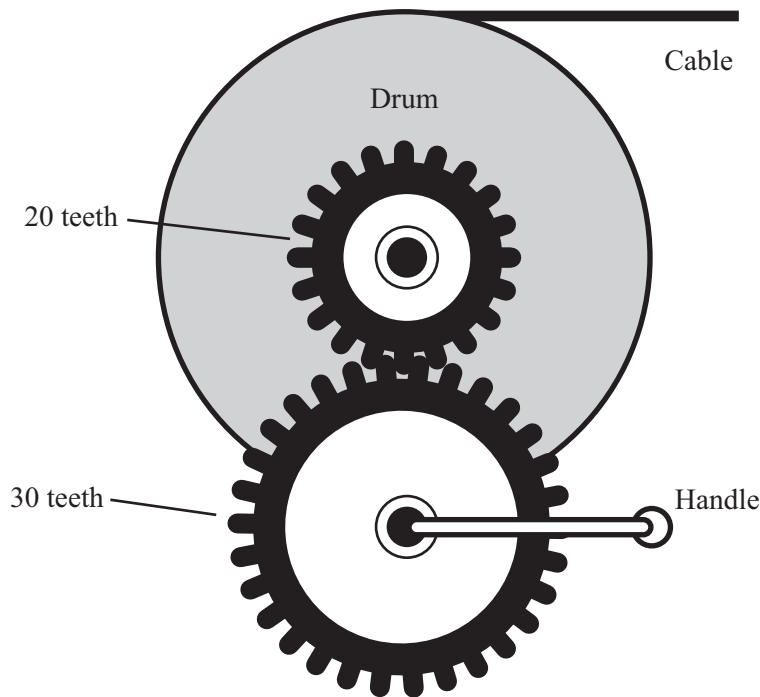


Fig. 5

- (a) (i) Mark on **Fig. 5** the direction in which the handle should be rotated in order to wind the cable on to the drum. [1]
- (ii) If the handle is rotated at 80 rev/min, calculate the speed of the drum.

[2]

Examiner Only	
Marks	Remark

(b) The mechanism is modified as shown in Fig. 6.

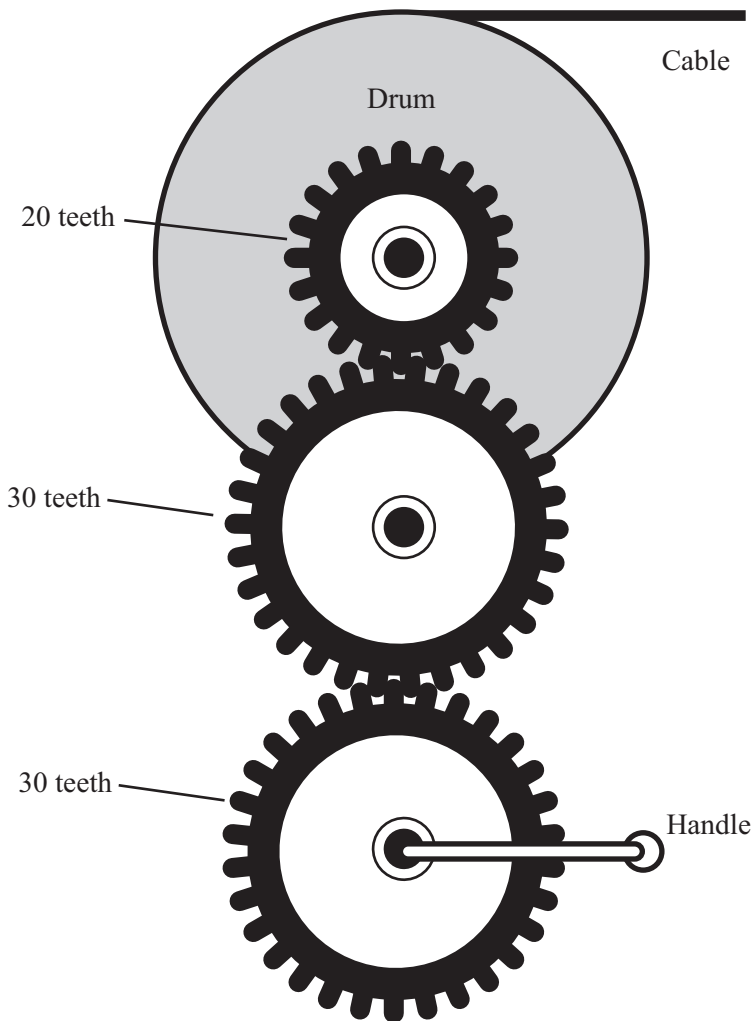


Fig. 6

(i) What name is given to the middle gear?

_____ [1]

(ii) What effect will the middle gear have on:

The direction of rotation of the drum?

_____ [1]

The speed of the drum?

_____ [1]

(iii) Name another mechanism which could be used to connect two rotating shafts.

_____ [1]

Examiner Only	
Marks	Remark

7 The circuit diagram shown in **Fig. 7** is incomplete and requires the inclusion of a resistor and a LDR to enable it to function as follows:

When the switch, labelled A, is closed, component D should operate in dark conditions.

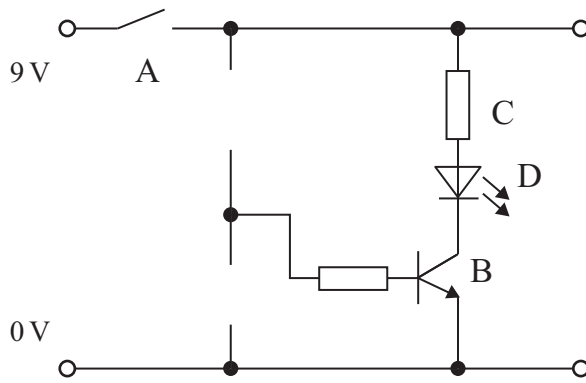


Fig. 7

(a) Complete the circuit diagram, **Fig. 7**, by inserting the symbols for the resistor and LDR in the correct positions. [4]

(b) Name the component symbols labelled B and D.

Component symbol B _____

Component symbol D _____ [2]

(c) Explain how the circuit operates.

 _____ [5]

Examiner Only	
Marks	Remark

(d) State a suitable use for this circuit.

Use: _____
_____ [1]

(e) What is the purpose of component C in this circuit?

Purpose: _____
_____ [1]

Examiner Only	
Marks	Remark

BLANK PAGE

(Questions continue overleaf)

10 At the end of year 10, pupils normally select their study options for GCSE. Completed study option forms can be checked automatically by computer. Design a flowchart to show how the form can be checked automatically by computer. The flowchart should operate as follows:

- The form is checked electronically and if it is completed correctly, it will be accepted with the word 'CORRECT' appearing on a screen;
- If the form is not completed correctly, it will not be accepted and pupils will be directed to complete the form again by the words 'INCORRECT, RE-SUBMIT' appearing on screen. This process will continue until the form is completed correctly;
- The process ends when the form has been accepted.

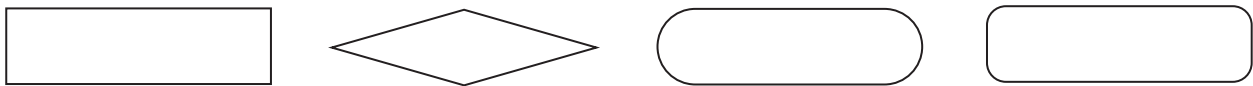
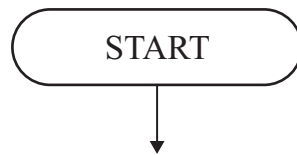


Fig. 9

Select and use the correct computer/microprocessor control symbols from Fig. 9 to complete the flowchart for this process.



Examiner Only	
Marks	Remark

[9]

12 A toy boat, used in a wall-mounted display, is fixed to an arm which is moved by a mechanism as shown in **Fig. 11**.

The driving mechanism moves the arm about the fixed point A.

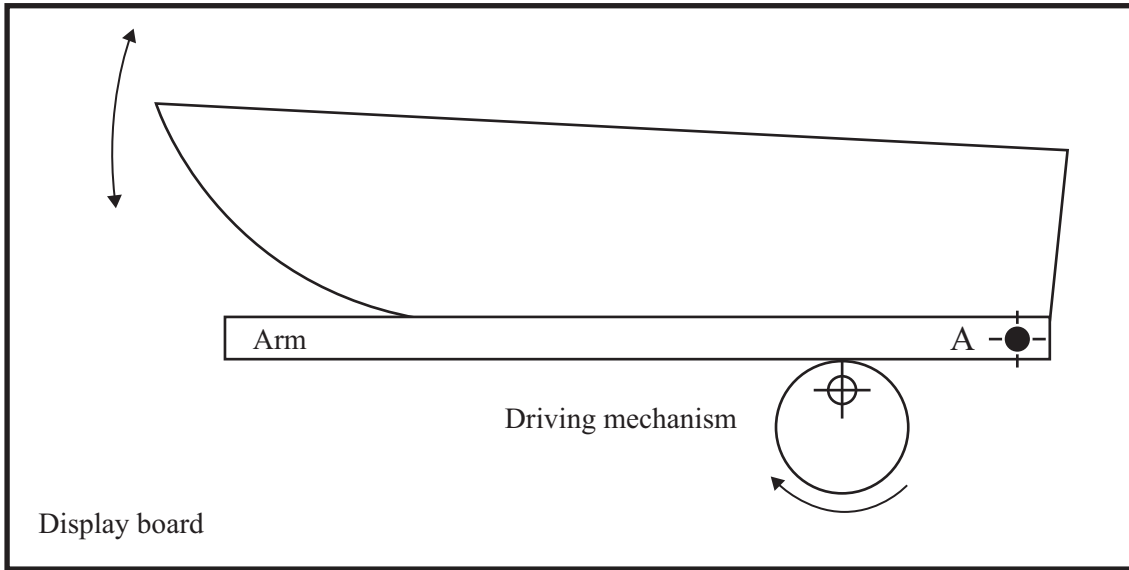


Fig. 11

(i) Label the following in **Fig. 11**:

- The lever
 - Its fulcrum
- [2]

(ii) Label and name the type of cam shown.

_____ [2]

(iii) Explain what keeps the arm in contact with the driving mechanism.

_____ [1]

(iv) Name a method which could be used to ensure that the arm is always in contact with the driving mechanism.

_____ [1]

(v) Suggest **one** change which could be made to **Fig. 11** to **increase** the movement of the boat.

Change: _____ [1]

Examiner Only	
Marks	Remark

- 13 (a) Materials can be joined together by either **permanent** or **semi-permanent** means. Complete **Table 5** below by identifying whether the joining method is permanent or semi-permanent. [4]

Table 5

Joining method	Permanent/semi-permanent
Adhesives	
Panel pins	
Nuts and bolts	
Brazing	

- (b) A pencil holder made from acrylic is to be attached to a mahogany base as shown in **Fig. 12**. Suggest a suitable method of attaching the two pieces together that is different to any in the above Table.

Suitable method:

[2]

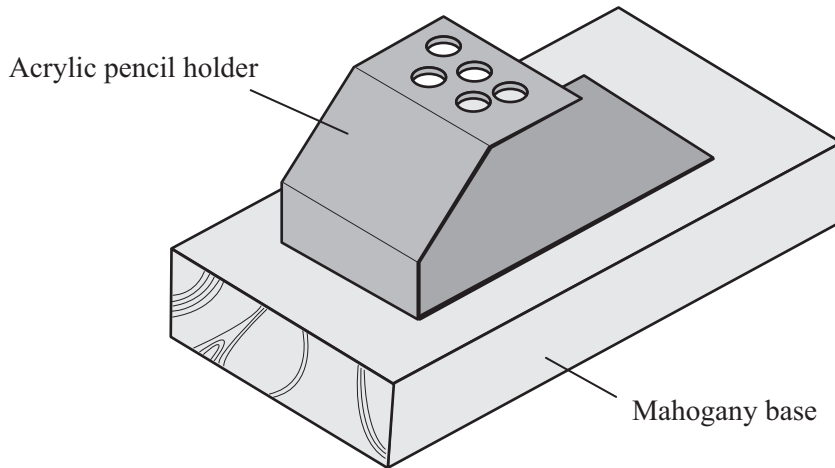


Fig. 12

- (c) How is the acrylic shaped as shown in **Fig. 12**?

[2]

Examiner Only	
Marks	Remark

14 (a) Fig. 13 shows different methods of operating pneumatic valves.

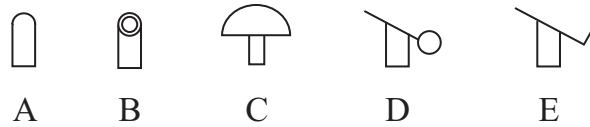


Fig. 13

(i) Complete Table 6 by inserting the correct letter to represent each of the methods listed.

Table 6

Method of operation	Letter
Roller trip	
Push button	
Lever	
Plunger	

[4]

(ii) Which method would be used in a valve to confirm the outstroke position of a piston rod?

Method _____ [1]

Examiner Only	
Marks	Remark

(b) Fig. 14 shows a pneumatic circuit used in a parcel sorting process.

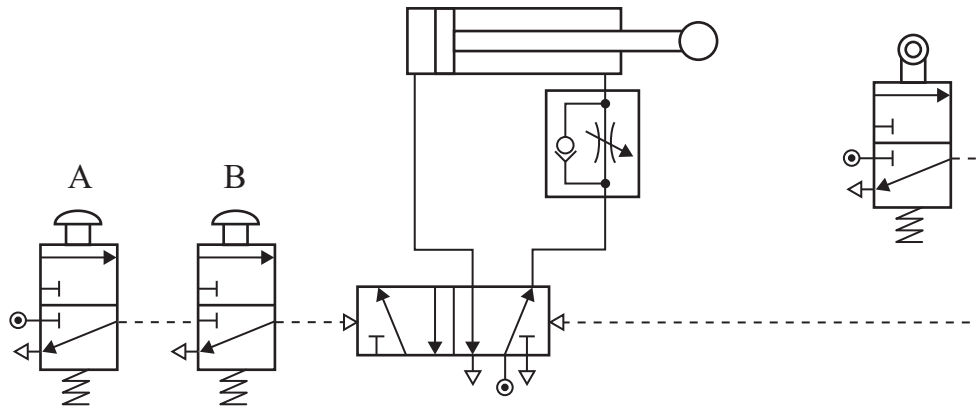


Fig. 14

(i) State the type of logic connection used for valves A and B.

_____ [1]

(ii) Suggest a reason for using this type of connection.

_____ [1]

Examiner Only	
Marks	Remark

(c) Fig. 15 shows a similar circuit used in baggage handling.

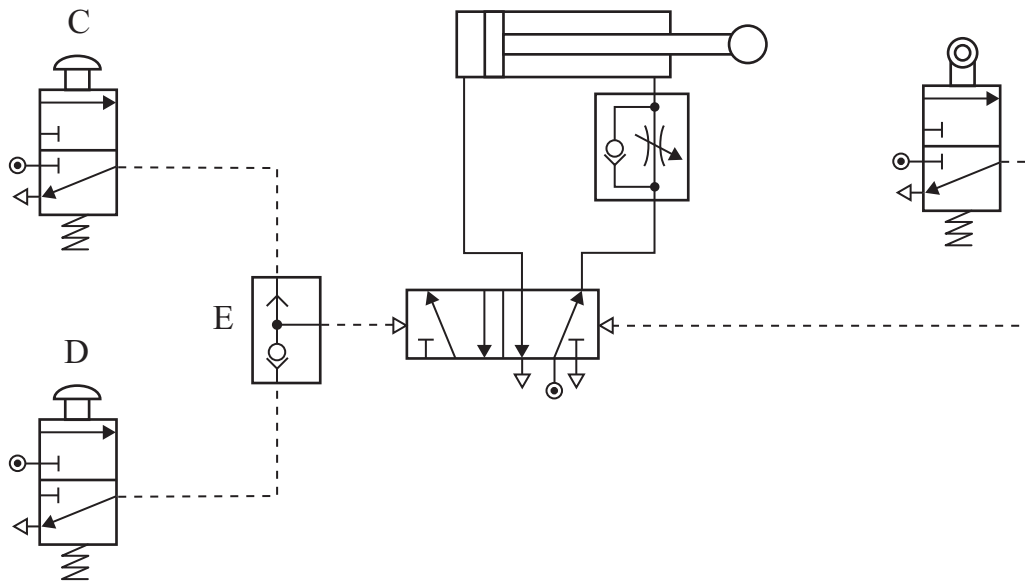


Fig. 15

(i) State the type of logic connection used for valves C and D.

_____ [1]

(ii) Suggest a reason for using this type of connection.

_____ [1]

(iii) Name valve E.

_____ [1]

(iv) Explain why valve E is necessary in the circuit.

 _____ [2]

Examiner Only	
Marks	Remark

BLANK PAGE

(Questions continue overleaf)

15 Fig. 16(a) shows a child's toy which is to be made from MDF. When the strings are pulled the legs and arms move as shown.

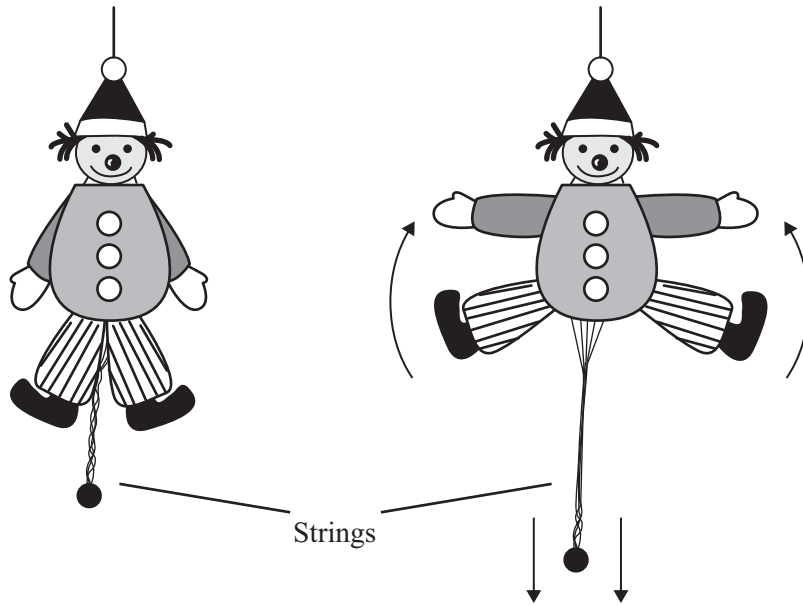


Fig. 16(a)

Fig. 16(b)

(a) On Fig. 16(b), label the **input** motion and the **output** motion. [2]

(b) (i) Is MDF a natural or manufactured material?

_____ [1]

(ii) Give **two** reasons, other than cost, why MDF is used as the main material for the toy.

Reason 1: _____ [1]

Reason 2: _____ [1]

Examiner Only	
Marks	Remark

Part 2

Answer any **two** questions.

Option 1

COMPUTER SYSTEMS AND CONTROL

16 Microprocessor/computer control systems use two types of signals.

(a) Identify each signal from the following information:

(i) binary notation is used to show if the signal is either high or low.

_____ [1]

(ii) the signal may have a range of values.

_____ [1]

(b) Complete the graphs in **Fig. 18** and **Fig. 19** to illustrate the two types of signals identified in **(a)(i)** and **(ii)**.

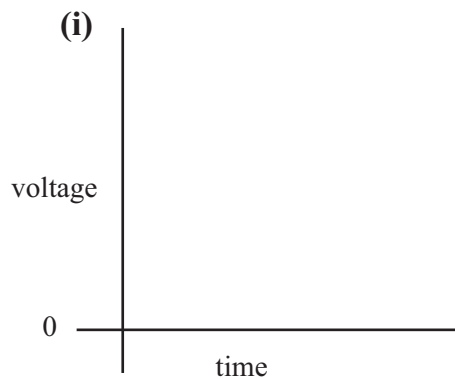


Fig. 18

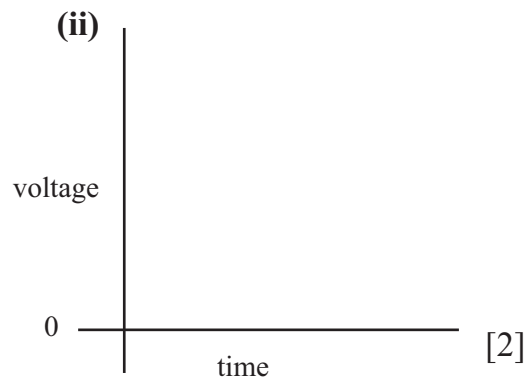


Fig. 19 [2]

Examiner Only	
Marks	Remark

- (c) A student has decided to design, program and make a rotating disco unit which has a set of LEDs on each of its four faces. The disco unit is shown in **Fig. 20**.

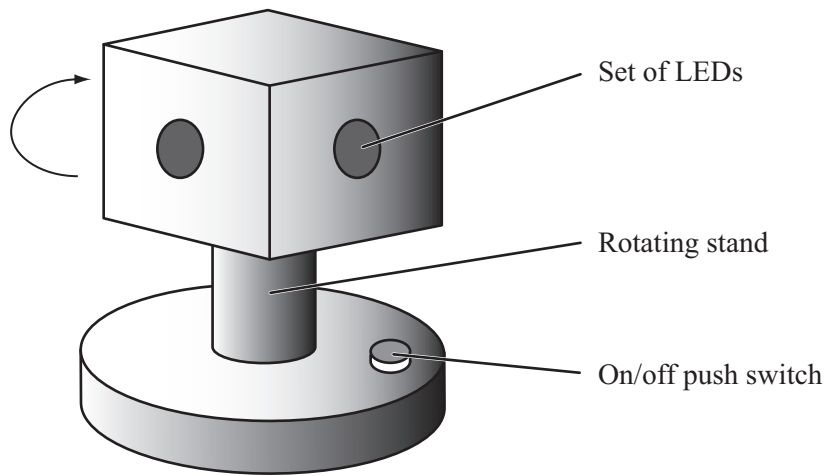


Fig. 20

To enable the program to operate, the student decides to design a sub-routine or macro called “LIGHTS” for the operating sequence of LEDs.

The LEDs are to turn on one set at a time with a 2-second delay after each set is switched on. When this process has been completed, a 5-second delay must be included before all the LEDs are turned off. Complete the “LIGHTS” macro flow chart in **Fig. 21**. [4]



Fig. 21

Examiner Only	
Marks	Remark

- (d) (i) The disco unit is activated when the on/off switch is pressed. This turns on a motor which rotates the disco unit after a delay of three seconds. The 'LIGHTS' macro is then activated and should be performed 50 times. The motor will then switch off and the program will end. Complete the flowchart, **Fig. 22**, to illustrate this program. [10]

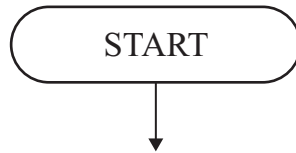


Fig. 22

- (ii) Modify the program in **Fig. 22** to enable it to run continuously. [2]

Examiner Only	
Marks	Remark

BLANK PAGE

(Questions continue overleaf)

17 Computer control systems use a variety of hardware equipment.

Examiner Only	
Marks	Remark

(a) (i) Outline two reasons which show the need for an interfacing device to be used in a computer control system.

Reason 1 _____

 Reason 2 _____
 _____ [2]

(ii) Complete Table 7 by identifying the input and output components.

Table 7

Components	Input/Output
LED	
Reed switch	
Buzzer	
Motor	
Position sensor	

[5]

(b) A sketch of a target for basketball or netball training exercises is shown in Fig. 23. The ball is to pass through the ring three times.

A PIC circuit is used to count the number of times the player puts the ball through the ring. The circuit will have a trip switch attached to the ring to activate and continue the count. The count will be shown on a seven segment display.

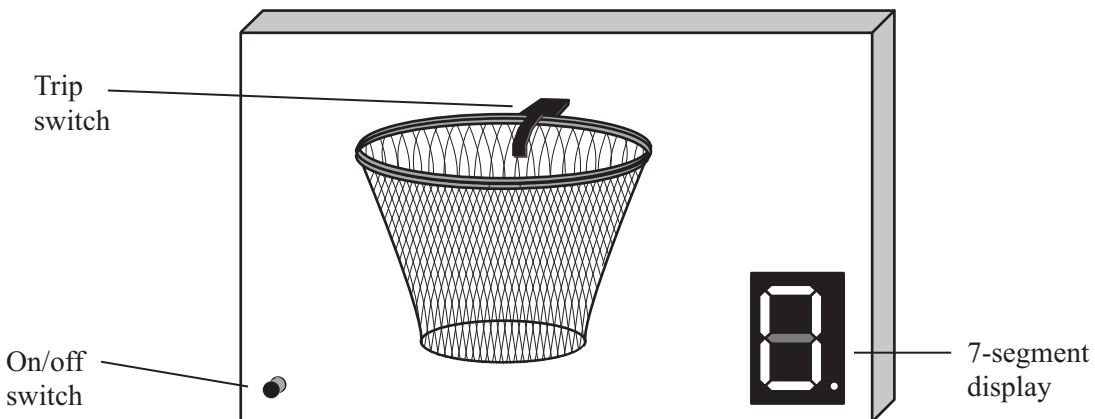


Fig. 23

Complete the flowchart in **Fig. 24** to illustrate the program for the PIC. A push button will be used to turn on the circuit. Once the counter reaches **3**, it should display **0** again.

The program sequence for this counter is as follows:

The ON switch is pressed. When the trip switch is activated by the ball passing through the ring the display shows the number 1. This then repeats for the second and third time the player puts the ball through the ring, displaying the numbers 2 and 3 respectively. A delay of 10 seconds is needed before the display shows 0 again. The sequence should repeat unless the off switch is pressed. [11]

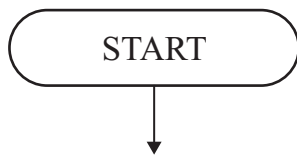


Fig. 24

Examiner Only	
Marks	Remark

(c) Seven segment displays are used in a number of products in the home.
Name **two** products.

Product 1: _____

Product 2: _____ [2]

Examiner Only	
Marks	Remark

- (b) A simplified diagram of the CMOS4017 decade counter illustrating the output pins and the clock pulse CLK input pin is shown in Fig. 26.

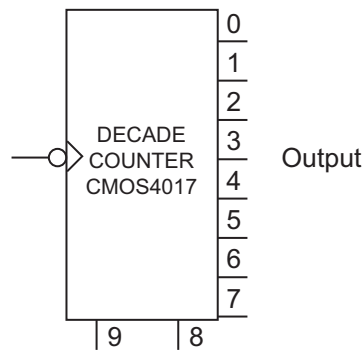


Fig. 26

© Higher Technology and Design by Raymond Caldwell. Published by Hodder & Stoughton Ltd, 2003, ISBN 0340850066. Reproduced by permission of Hodder & Stoughton Ltd

- (i) Use Fig. 26 to sketch an input pulse signal going to the CLK input pin. [2]

- (ii) With the aid of binary notation, explain this input pulse signal.

- (c) (i) Outline how a series of input pulses will influence the outputs if each pulse is designed to arrive every five minutes at the CLK input.

- (ii) If a 555 timer is used as the input to the decade counter, which pin should the CLK input be connected to?

Examiner Only	
Marks	Remark

- (iii) The 555 timer can be connected to the decade counter as part of an astable or monostable circuit. Outline the difference between a 555 astable circuit and a 555 monostable circuit.

555 astable _____

555 monostable _____

_____ [4]

- (iv) Which circuit would be best to deliver the inputs to the decade counter?

_____ [1]

- (v) Give a reason for your answer.

_____ [2]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

19 Fig. 27 shows a part completed electronic circuit that a student is building to control the operation of a heater system. The output of component A should become high when the surrounding temperature falls. Both R_1 and R_2 are rated at 10 K.

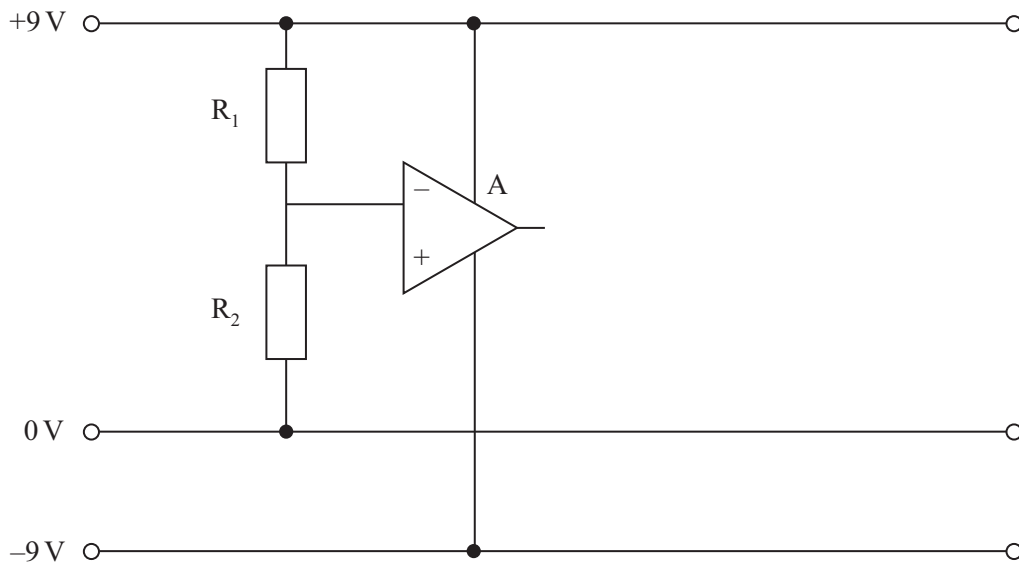


Fig. 27

(a) (i) Name the component symbol labelled A in Fig. 27.

Component A _____ [1]

(ii) How are the components labelled R_1 and R_2 connected in this circuit?

_____ [1]

(b) A variable resistor and a thermistor are to be added between the +9V and the 0V rails to enable component A to operate as described above. Develop Fig. 27 to allow the circuit to function as described. [6]

(c) (i) Label where the reference voltage is on Fig. 27. [1]

(ii) State the value of the reference voltage and give a reason for your answer.

Value _____ [1]

Reason _____

_____ [2]

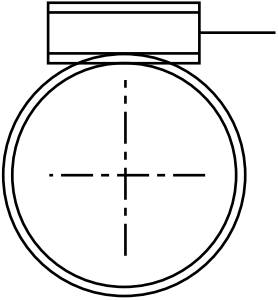
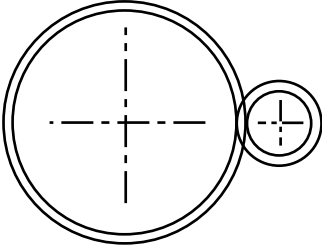
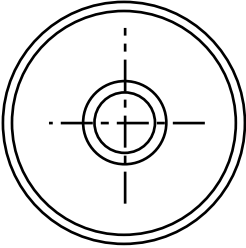
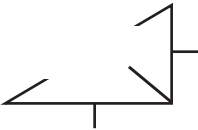
Option 3

MECHANICAL SYSTEMS AND CONTROL

20 A slow rotating trophy display is to be designed for a school foyer. A student is to prototype and design a suitable system for the display.

(a) Complete **Table 8** by identifying the mechanical symbols. [4]

Table 8

Symbol	Name of symbol
	
	
	
	

Examiner Only	
Marks	Remark

(c) The student decides to design a second gear system. The view of the gear system is shown in Fig. 29.

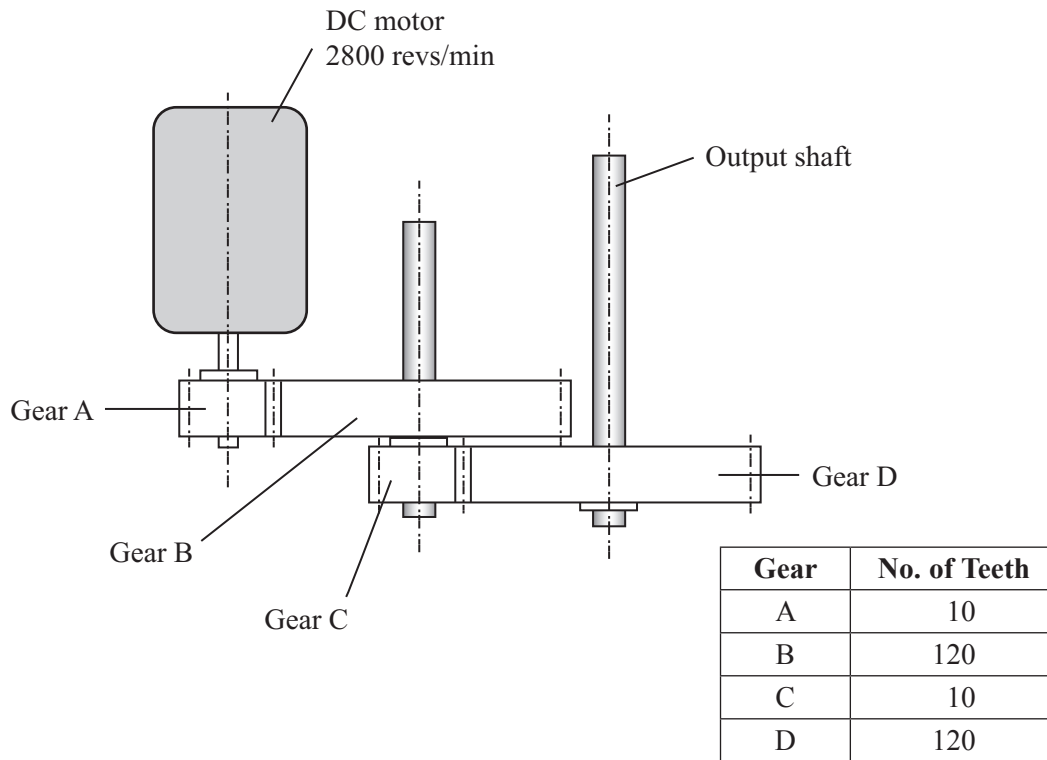


Fig. 29

(i) Calculate the gear ratio for this system.

[4]

Examiner Only	
Marks	Remark

(ii) Calculate the speed for the driven gear.

[5]

(iii) Which of the two gear systems shown in **Fig. 28** and **Fig. 29** should be used for the rotating display? Give a reason for your answer.

[3]

Examiner Only	
Marks	Remark

- 21 (a) For each movement identified in **Table 9**, insert a word which describes the type of motion.

Table 9

Movement	Type of motion
Pendulum of a grandfather clock	
Blades of an electric hedge cutter	
Drum of a cement mixer	

[3]

- (b) **Fig. 30** shows a foot brake system.

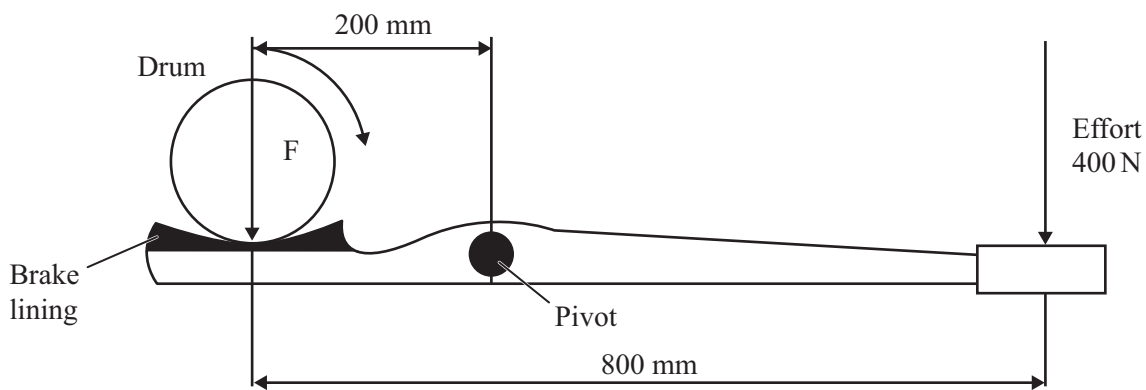


Fig. 30

- (i) State **one** requirement of the material to be used in the brake lining.

_____ [1]

- (ii) Calculate the force F applied at the drum when an effort of 400 N is exerted as shown.

 _____ [3]

Examiner Only	
Marks	Remark

(c) Fig. 31 shows a mechanism which is used to raise a platform on a machine. The effort applied at the handle turns the crank.

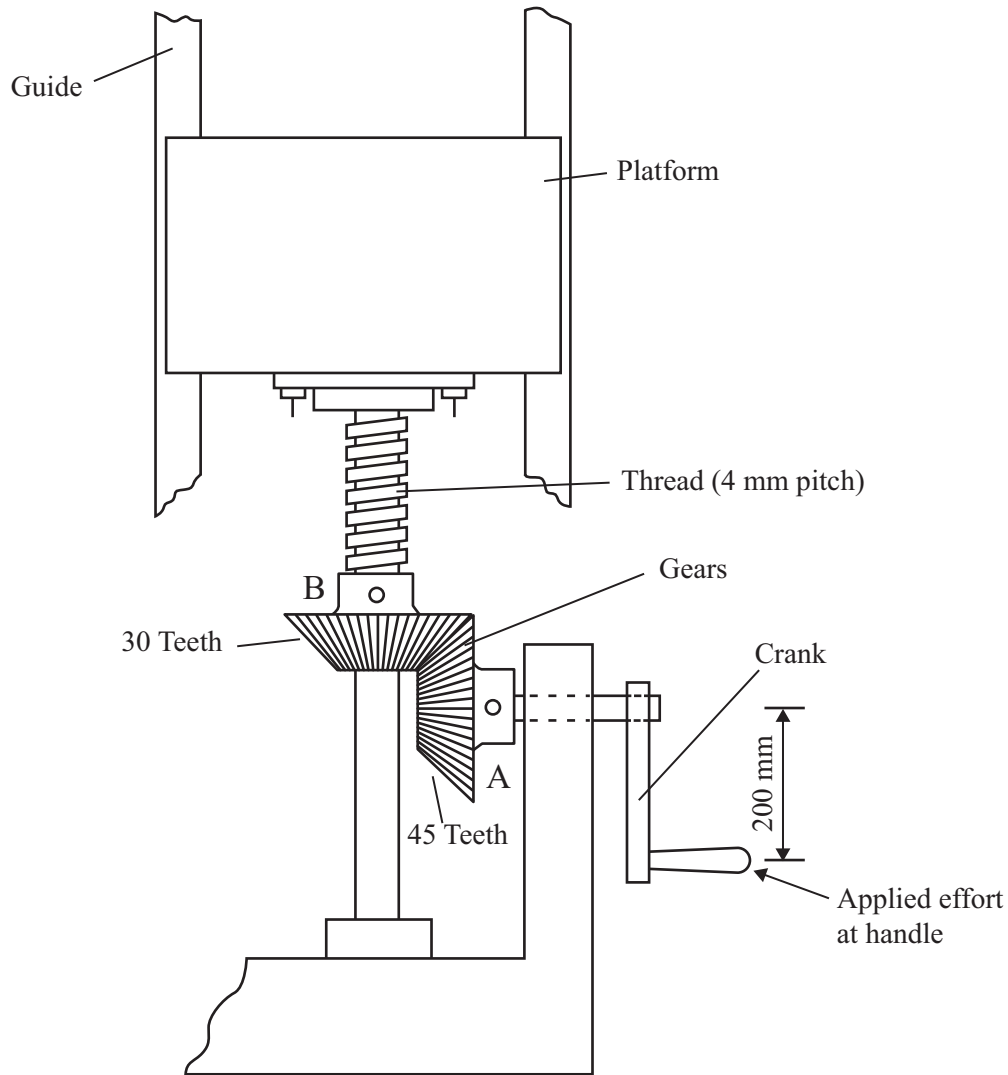


Fig. 31

(i) State the type of gears shown at A and B.

_____ [1]

(ii) Name **one** other mechanism which can transmit rotary motion through 90 degrees.

_____ [1]

Examiner Only	
Marks	Remark

BLANK PAGE

(Questions continue overleaf)

Option 4

PNEUMATIC SYSTEMS AND CONTROL

Examiner Only	
Marks	Remark

22 (a) (i) Name the component represented by the symbol shown in Fig. 32.

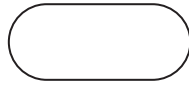


Fig. 32

_____ [1]

(ii) What valve can be used along with this component to produce a time delay?

_____ [1]

(b) A pneumatic cylinder is used to press shapes in plastic sheets. This pneumatic circuit is shown in Fig. 33.

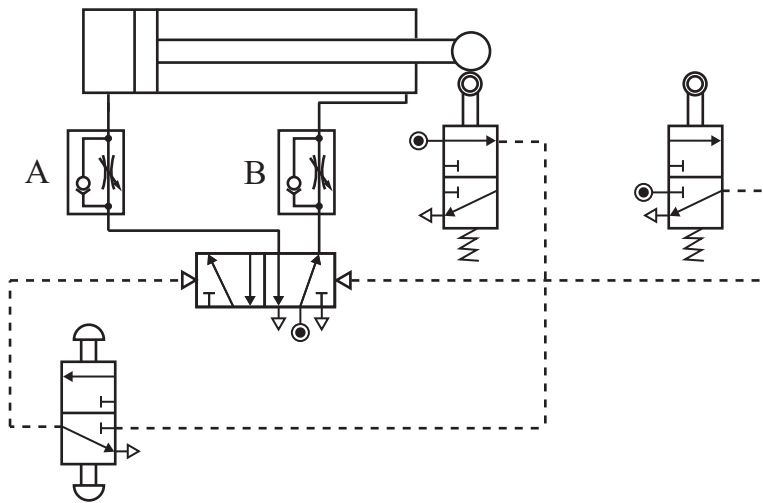


Fig. 33

(i) The cylinder must apply a force of 300 N.
Calculate the cross sectional area of the piston required.
Air supply pressure 0.6 N/mm².

_____ [3]

(ii) Name the type of motion produced by the piston when the start valve is operated.

_____ [1]

(iii) Explain how the **outstroke** speed of the piston can be changed.

_____ [2]

(iv) The circuit in **Fig. 33** is to be modified so that when the piston instrokes, there is a short delay before it outstrokes again. Draw on **Fig. 33** the additional components required for the time delay. [3]

(c) **Fig. 34** shows a pneumatic circuit used in a packaging process.

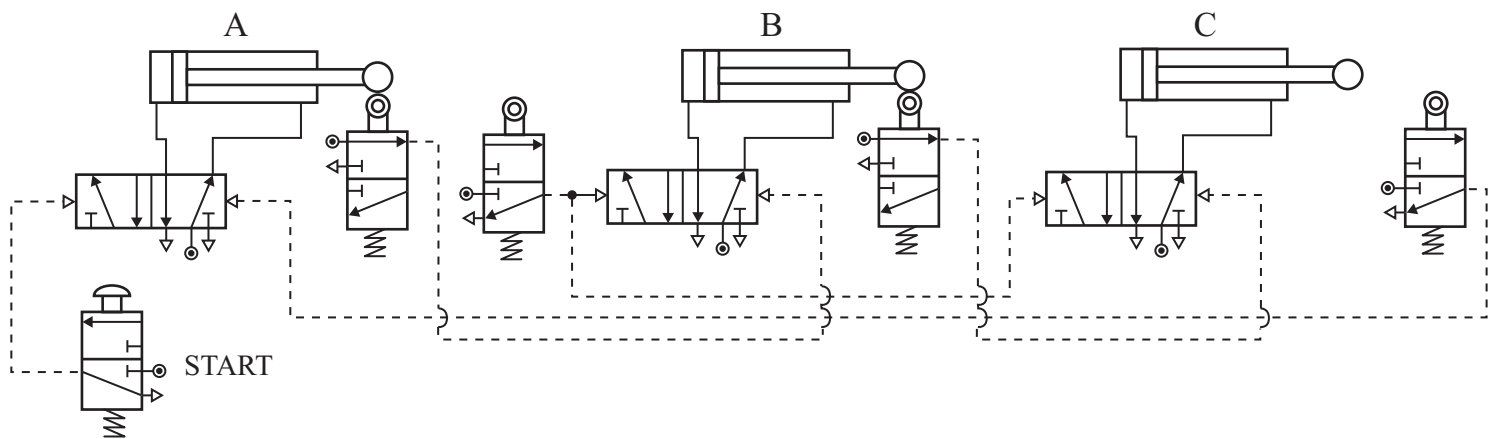


Fig. 34

(i) Write down the sequence of operation of the cylinders in **Fig. 34** when the start button is pressed.

 _____ [6]

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(ii) Explain how the circuit should be modified so that the sequence runs continuously when a start button is pressed for an instant.

[3]

Examiner Only	
Marks	Remark

23 Fig. 35 shows a valve symbol.

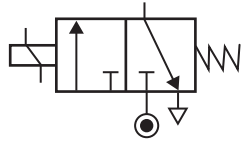


Fig. 35

(a) Use this valve symbol to complete Table 10.

Table 10

How many ports has the valve?	
How many switching positions has the valve?	
State the method used to operate the valve.	

[3]

(b) Fig. 36 illustrates a parcel on a conveyor belt. When the parcel reaches the stop it is sensed by an air bleed. The parcel is then pushed off the belt by the pneumatic cylinder.

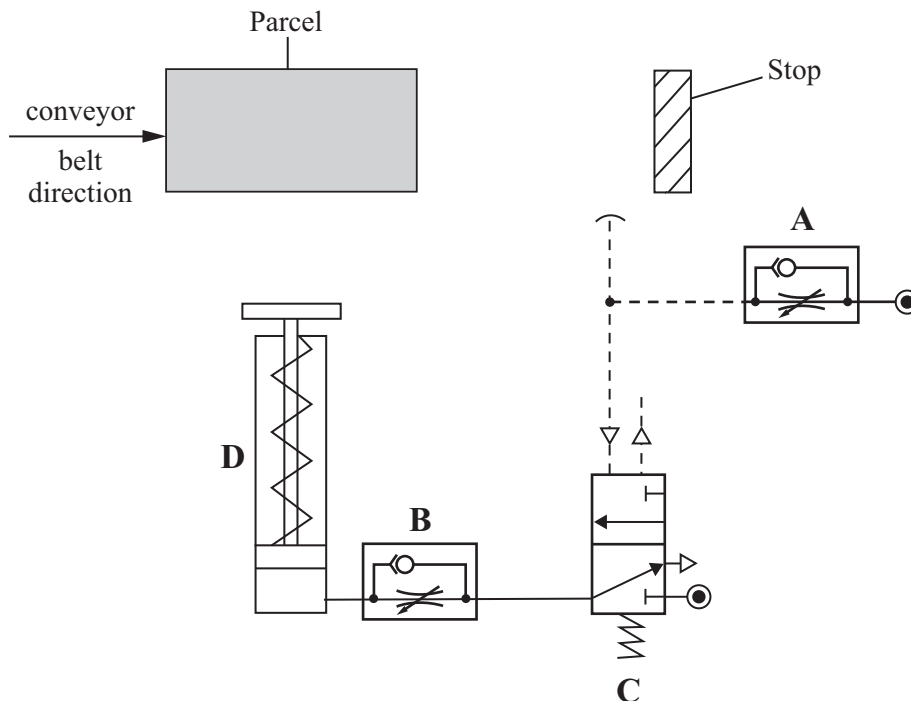


Fig. 36

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(i) Explain the function of:

Valve A _____ [1]

Valve B _____ [1]

(ii) Explain how the circuit operates to push a parcel off the conveyor belt.

_____ [3]

(c) Fig. 37 shows part of a pneumatic circuit which is to be used for moving components.

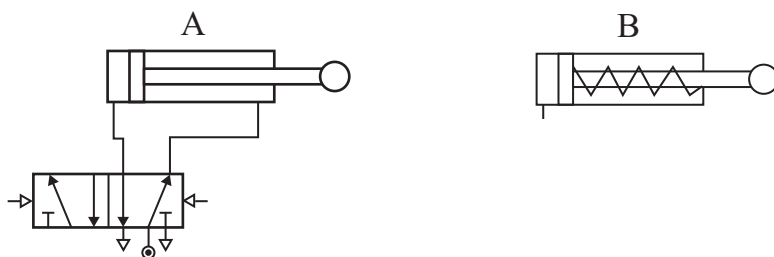


Fig. 37

Cylinder A is to outstroke when a start valve is operated for an instant. When the outstroke of cylinder A is confirmed, cylinder B also outstrokes. Both cylinders instroke when a reset valve is operated for an instant.

Complete Fig. 37 so that the pneumatic circuit operates in the required sequence. [5]

(d) An alternative method to control the cylinders uses electrical switches and electrically operated valves.

Fig. 38 shows part of this electro pneumatic circuit.

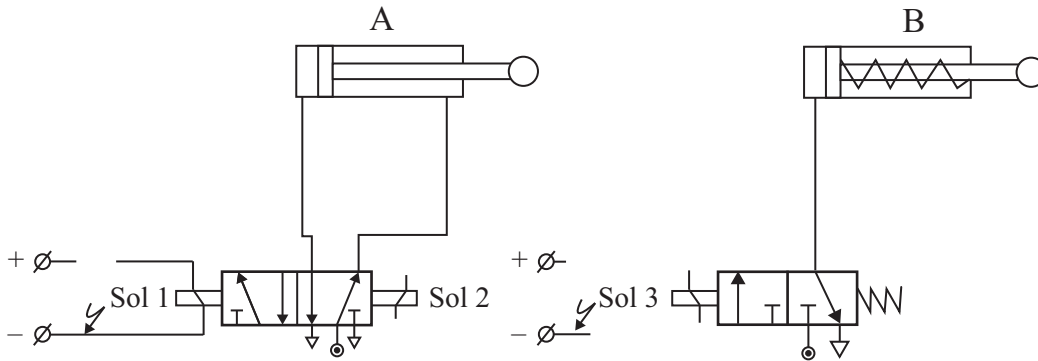


Fig. 38

An outline of the ladder diagram is shown in Fig. 39.

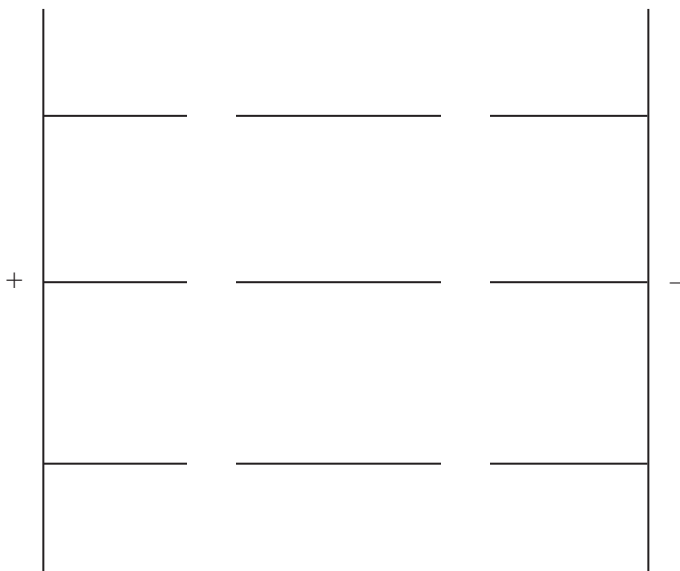


Fig. 39

Complete the circuit diagram in Fig. 38 and the ladder diagram in Fig. 39 by selecting appropriate electrical switches from Fig. 40. Label each component in the ladder diagram. [7]

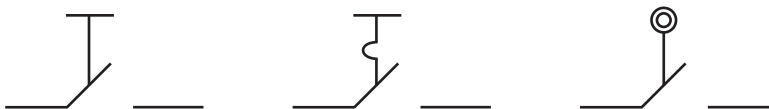


Fig. 40

Examiner Only	
Marks	Remark
Quality of written communication	

THIS IS THE END OF THE QUESTION PAPER

