| Surname | | Other Names | |
|---|---|---|---|
| Centre Number | | | Candidate Number | | | | |
| Candidate Signature | | | | | | | | | |

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General Certificate of Secondary Education
June 2005

ASSESSMENT and QUALIFICATIONS ALLIANCE

# DESIGN AND TECHNOLOGY
# SYSTEMS AND CONTROL TECHNOLOGY
## Foundation Tier

**3546/F**

**F**

Friday 24 June 2005 1.30 pm to 3.30 pm

**In addition to this paper you will require:**
a pen, pencil, ruler, eraser and pencil sharpener.

Time allowed: 2 hours

### Instructions

- Write your name and other details in the spaces provided above.
- Answer **either Section A** – Mechanisms Focus Technology;
  **or Section B** – Pneumatics Focus Technology.
  **not both**.
- Write your answers in this question paper/answer book.

### Information

- The maximum mark for this paper is 125.
- A list of formulae is given on page 2 which you may need to use when answering certain questions.
- Mark allocations are shown in brackets.
- Wherever calculations are needed you should show your working.
- All dimensions are given in millimetres unless otherwise stated.
- You are reminded of the need for good English and clear presentation.

| For Examiner's Use | |
|---|---|
| SECTION A<br>MECHANISMS FOCUS | |
| Number | Mark |
| A1 | |
| A2 | |
| A3 | |
| A4 | |
| A5 | |
| A6 | |
| A7 | |
| A8 | |
| A9 | |
| TOTAL | |
| SECTION B<br>PNEUMATICS FOCUS | |
| Number | Mark |
| B1 | |
| B2 | |
| B3 | |
| B4 | |
| B5 | |
| B6 | |
| B7 | |
| B8 | |
| B9 | |
| TOTAL | |
| Examiner's initials | |

**The following information may be of use to you when answering questions on this paper.**

Pneumatics

$$\text{Force} = \text{Pressure} \times \text{Area}$$

Ratio of Simple Gears

$$\text{Gear Ratio} = \frac{\text{Number of teeth on driven gear}}{\text{Number of teeth on driver gear}}$$

Velocity Ratio

$$\text{Velocity Ratio} = \frac{\text{Diameter of driven pulley}}{\text{Diameter of driver pulley}}$$

$$\text{Output speed} = \frac{\text{Input speed}}{\text{Gear/Velocity ratio}}$$

Forces

$$\text{Moments} = \text{Force} \times \text{Distance}$$

Sum of clockwise moments = sum of anti-clockwise moments

Series Resistance

$$R_T = R_1 + R_2 + R_3$$

Parallel Resistance

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{OR} \quad R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

Potential Difference

$$V = I \times R$$

Transistors

$$\text{Current Gain} = \frac{\text{Collector Current}}{\text{Base Current}}$$

Amplifier Gain

$$\text{Av} = \frac{\text{Change in output voltage}}{\text{Change in input voltage}}$$

Area of circle = $\pi r^2$

$\pi = 3.142$

Resistor Colour Code

| Colour | Number | Number of Zeros |
|---|---|---|
| Black | 0 | |
| Brown | 1 | 0 |
| Red | 2 | 00 |
| Orange | 3 | 000 |
| Yellow | 4 | 0,000 |
| Green | 5 | 00,000 |
| Blue | 6 | 000,000 |
| Violet | 7 | 0,000,000 |
| Grey | 8 | 00,000,000 |
| White | 9 | 000,000,000 |

E12 Resistor preferred values

10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades thereafter.

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR QUESTION A1 – MECHANISMS FOCUS**

**TURN TO PAGE 26 FOR QUESTION B1 – PNEUMATICS FOCUS**

LEAVE MARGIN BLANK

## SECTION A – MECHANISMS FOCUS

Answer **all** questions in this section.

Do **not** answer these questions if you have answered the questions in **Section B – Pneumatics Focus** (pp. 26–47).

**A1** (a) **Figure 1** shows a mountain bike.

**Figure 1**

**Figure 2** shows a simplified drawing of the chain drive mechanism.

(i) Which is the faster moving sprocket (gear) A or B?

Label the faster moving sprocket (gear). *(1 mark)*

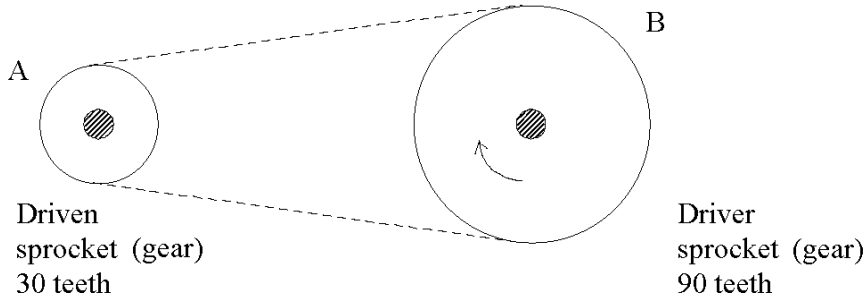



**Figure 2**

(ii) Calculate the gear ratio.

Formula .....

*(1 mark)*

Working .....

.....

.....

*(1 mark)*

Answer .....

*(1 mark)*

(b) **Figure 3** shows a quick release mechanism used on the front wheels of a mountain bike.

**Figure 3**

(i) Why is the lever long?

.....

.....

*(1 mark)*

(ii) What material do you think the lever would be made of?

.....

*(2 marks)*

(iii) Why do you think this material is suitable?

.....

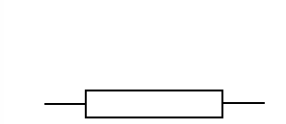
.....

*(1 mark)*

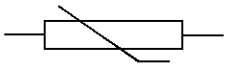
8

**TURN OVER FOR THE NEXT QUESTION**

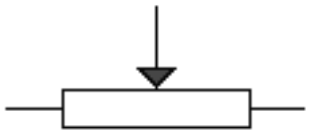
**A2** (a) Name the components represented by the electronic circuit symbols shown below.



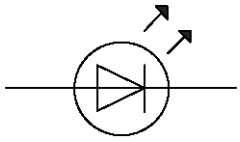
(i) .....



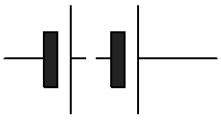
(ii) .....



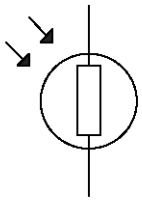
(iii) .....



(iv) .....



(v) .....



(vi) .....

*(6 marks)*

(b) **Table 1** shows a number of different components that can be used as sensors in circuits.

Complete the table.

*One example has been completed for you.*

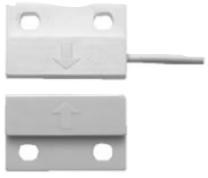
| *Name of component* | *What it senses* | *A typical use* |
|---|---|---|
| Reed switch  | *Removal or presence of a magnet* | *Used in burglar alarm systems to sense if a door is opened* |
| Light dependent resistor  | ..... ..... ..... ..... | ..... ..... ..... ..... |
| Mercury tilt switch   | ..... ..... ..... ..... | ..... ..... ..... ..... |
| Microswitch  | ..... ..... ..... ..... | ..... ..... ..... ..... |

**Table 1**

*(6 marks)*

**QUESTION A2 CONTINUES ON THE NEXT PAGE**

(c)

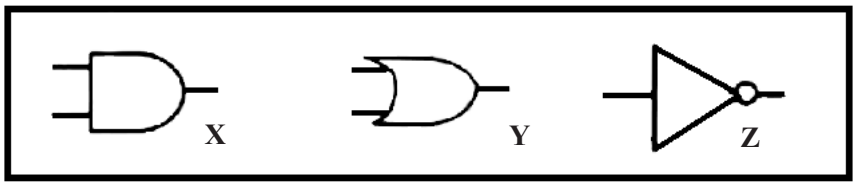



**Figure 4**

Study the symbols shown in **Figure 4** then fill in the missing words in the sentences below.

(i) The symbols in **Figure 4** are all examples of ..... gates.

*(1 mark)*

(ii) The gate labelled **X** is an ..... gate and the gate labelled **Y** is an ..... gate.

*(2 marks)*

(iii) Complete the truth table **Figure 5** for gate **X**.

| Input 1 | Input 2 | Output |
|---|---|---|
| 0 | 0 | |
| 0 | 1 | |
| 1 | 0 | |
| 1 | 1 | |

**Figure 5**

*(4 marks)*

19

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**A3** (a) Flow charts can be used when planning command sequences for control programs.

Complete **Table 2** by drawing the outline shape of the relevant box alongside the label.

*The START box has been shown as an example.*

| | |
|---|---|
| START | START |
| PROCESS | |
| INPUT/OUTPUT | |
| DECISION | |

**Table 2**

*(3 marks)*

(b) Flow charts can also be used for fault-finding operations. One of the common faults made by students making electronic circuit boards is to connect an LED with the legs the wrong way around.

The main stages are listed below – *they are shown in their correct sequence*.

- Start
- Check LED legs are correct way around
- If not desolder and reposition LED
- Check quality of soldering
- If soldering is not adequate resolder
- Stop

In the space below complete the fault-finding flow chart in **Figure 6** to show how an LED could be checked.

Add all **yes/no** labels and **direction arrows** to your diagram.

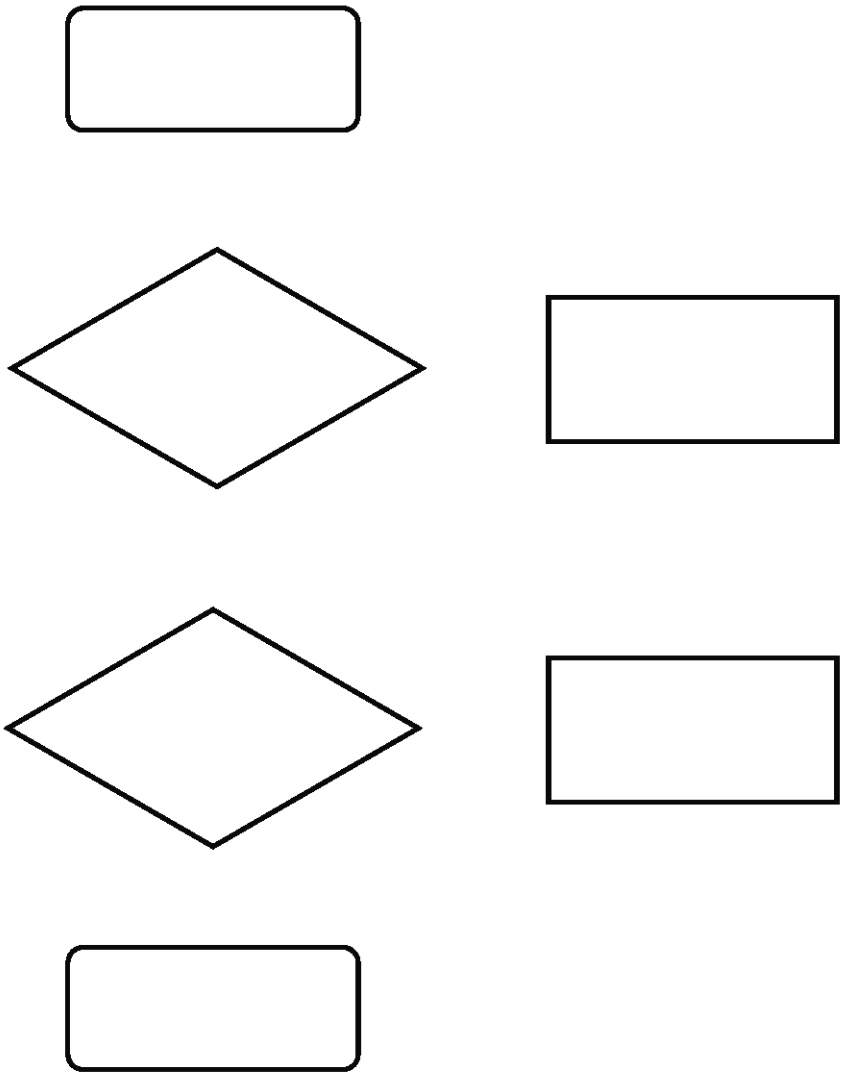


**Figure 6**

*(14 marks)*

17

**A4** (a) The block diagram, **Figure 7** shows how a fire prevention water sprinkler system works.

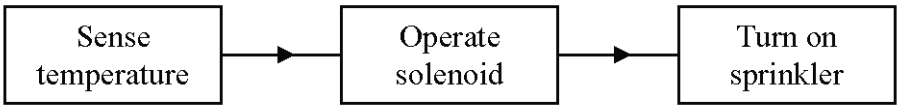



**Figure 7**

The sensing part of the circuit created to operate the sprinkler is shown in **Figure 8** below.

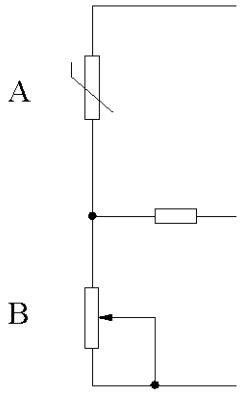



**Figure 8**

(i) Which component acts as a sensor in this circuit?

.....

*(1 mark)*

(ii) What does the component sense?

.....

*(1 mark)*

(b) Which component is used to adjust the sensitivity of the circuit?

.....

*(1 mark)*

(c) The circuit could also be modified to sense ice.

Complete **Figure 9** to show how you would re-arrange the components from **Figure 8** to detect ice.

The heater must turn on when ice is detected.

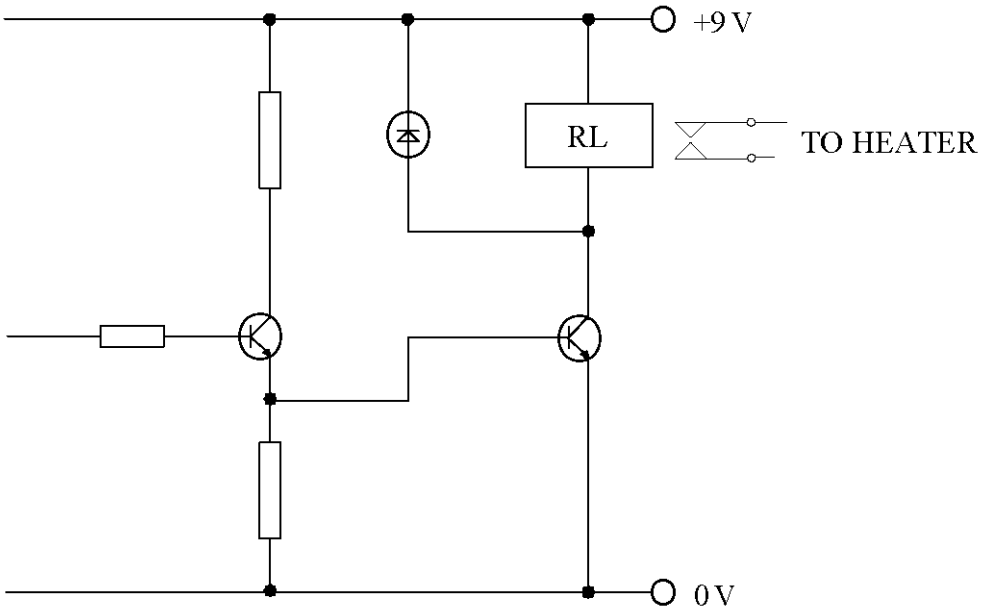



**Figure 9**

*(8 marks)*

**QUESTION A4 CONTINUES ON THE NEXT PAGE**

(d) (i) Many circuits use a safety procedure requiring two switches to be pressed before a mechanism operates.

In the space below draw a circuit requiring **two** push-to-make switches to be pressed before the motor will work.

*A range of components that can be used are shown in* **Figure 10**.

This question is worth 10 marks.

Marks will be awarded as follows:

| | |
|---|---|
| Quality of drawing; | *(2 marks)* |
| Correct arrangement of switches; | *(2 marks)* |
| Correct circuit symbols; | *(4 marks)* |
| Correct output. | *(2 marks)* |

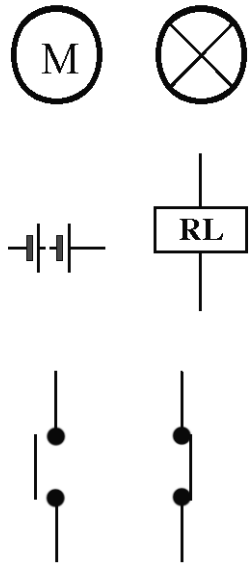



**Figure 10**

(ii) The system diagram, **Figure 11** shows a similar safety circuit to the one you have designed in part (i) of this question. It is used on a machine to ensure it will not start unless the guard is in position.

- Switch 1 is the ON button.
- Switch 2 checks the guard is in the correct position.

1 Name **one** suitable switch for Switch 2 and write your answer in the INPUT Switch 2 box of **Figure 11**.

2 State the output of the system and write your answer in the OUTPUT box of **Figure 11.**

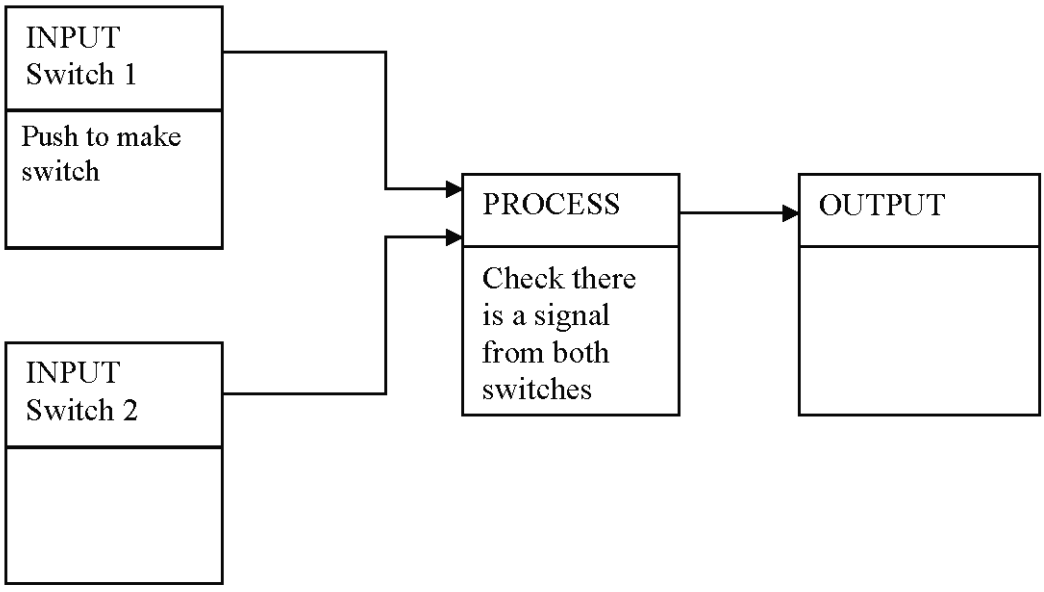



**Figure 11**

*(2 marks)*

23

**TURN OVER FOR THE NEXT QUESTION**

**A5** Safety is of great importance in the workshop.

Give **two** *different* safety precautions for each of the situations below.

(a) Soldering components to a PCB.

(i) .....

(ii) .....

*(2 marks)*

(b) Using a pillar drill – *(do not repeat any of your previous answers)*.

(i) .....

(ii) .....

*(2 marks)*

(c) Handling materials – *(do not repeat any of your previous answers)*.

(i) .....

(ii) .....

*(2 marks)*

6

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**A6** This question is about design specifications and safety.

The design specification below is for a small goods lift that is used in a restaurant.

**Figure 16** shows a sketch of the goods lift. Goods are placed through the opening into the goods box which moves up and down as shown.

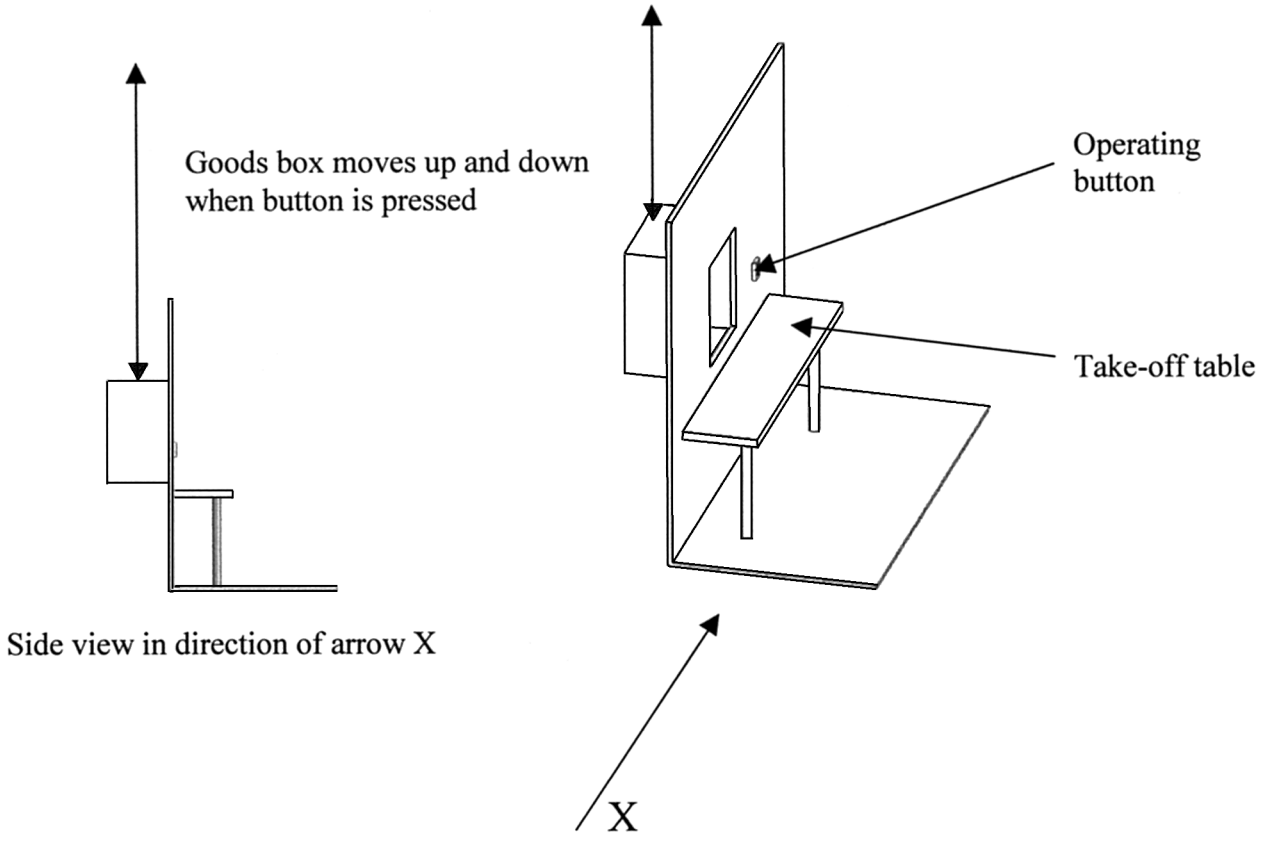



**Figure 12**

Part of the design specification for the goods lift.

- The Goods lift is to be electrically powered.
- The maximum height the box will travel through is 3 m.
- The Goods box unit is to be no larger than 800 × 400 × 600.
- There will be sliding doors to cover the opening on each floor.

(a) Add **two** safety requirements to the specification given above and suggest a method of satisfying each of them.

1 Safety requirement

.....

.....

*(2 marks)*

Method of satisfying the requirement

.....

.....

*(2 marks)*

2 Safety requirement

.....

.....

*(2 marks)*

Method of satisfying the requirement

.....

.....

*(2 marks)*

(b) The goods lift is controlled by an electronic control circuit.

Describe **two** ways of protecting electronic circuits from damage.

(i) .....

.....

*(2 marks)*

(ii) .....

.....

*(2 marks)*

12

**TURN OVER FOR THE NEXT QUESTION**

**A7** Manufacturers try to ensure high product quality in a number of different ways.

(a) Describe **two** ways in which CAD/CAM can improve product quality.

(i) .....

.....

*(2 marks)*

(ii) .....

.....

*(2 marks)*

(b) Computer software can be used to design and model circuits.

Use examples to show **two** *advantages* of using this type of computer software.

(i) .....

.....

*(2 marks)*

(ii) .....

.....

*(2 marks)*

(c) When a printed circuit board has been produced and assembled it needs to be checked.

(i) Describe **one** visual check you could perform on an assembled circuit board.

.....

.....

*(2 marks)*

(ii) Describe **one** electronic check you could perform on an assembled circuit board.

.....

.....

*(2 marks)*

12

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**A8** *Secure-it* make rising bollards for people to protect their drive-ways. The bollard is a post that rises out of the ground to prevent a car being removed from the driveway.


**Figure 13**

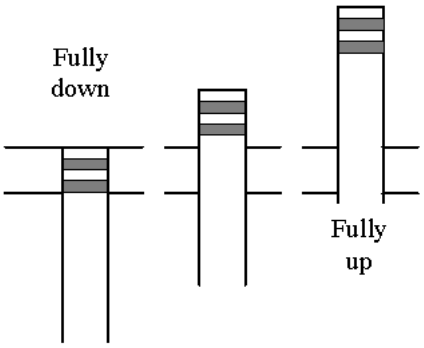



**Figure 14**

(a) *Secure-it* has asked you to design a working model that could be used in an exhibition. The model will be table mounted and the bollard and the table surface are shown in **Figure 14**.

Complete **Figure 15** to show a suitable mechanism to give a *continuous* slow up and down movement.

This question is worth 10 marks.

Marks will be awarded as follows:

| | |
|---|---|
| Suitability of mechanism; | *(4 marks)* |
| Notes on construction/materials/components/operation; | *(4 marks)* |
| Quality of drawing. | *(2 marks)* |

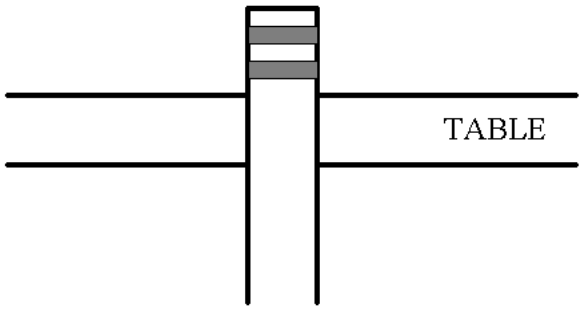



**Figure 15**

(b) Improve your system to include a *pause at the top and bottom* of the bollard's travel.

This question is worth 9 marks.

Marks will be awarded as follows:

| | |
|---|---|
| Facility to pause at top/bottom; | *(4 marks)* |
| Notes explaining how the system works; | *(3 marks)* |
| Quality of drawing. | *(2 marks)* |

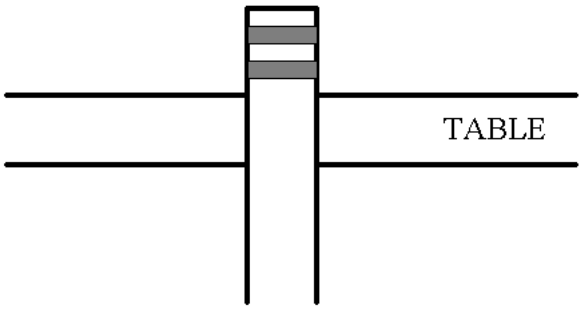
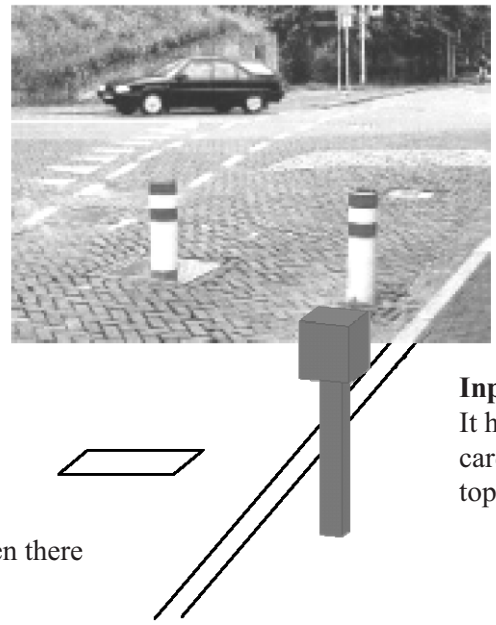



**Figure 16**

**A9** The rising bollards are to be controlled by a box, mounted on a pillar, and by sensors in the road that will allow the driver to pull alongside and insert a card into the box to make the bollards go down.

A basic design for the box has been added to **Figure 17**.



**Input A** – road sensor
It has a value of 1 when there is a car over it

**Input B** – card box reader
It has a value of 1 when the card is inserted into the box on top of the pillar

**Figure 17**

There are four outputs in the system:

- Output C = bollard moving down;
- Output D = Green light on to say safe to move forward;
- Output E = Red light on to say STOP bollard about to rise;
- Output F = bollard moving up.

The sequence control program is given below:

```
If Input A = 1 and Input B = 1 run BOLLARDS
        Turnon Output C until bollard down
        Turnon Output D
        When Input A = 0 wait 30 seconds
        Turnoff Output D
        Turnon Output E
        Turnon Output F until bollard up
        Set Input B to 0
End BOLLARDS
```

(a) How many inputs does the system need before it begins to operate?

.....

*(1 mark)*

(b) How many seconds is the green light on for?

.....

*(1 mark)*

(c) What value does the road sensor have when the car has moved forward off it?

.....

*(1 mark)*

(d) In operation the system was found to have a fault. If a car had to stop over the bollards there was no way of stopping the bollards from coming up after the time delay and damaging the car.

Complete **Figure 18** to show how a second road sensor could be used to solve this problem.

*(3 marks)*

*The first sensor and the bollards are already drawn for you.*

Add brief notes to explain how your system would work. *(3 marks)*

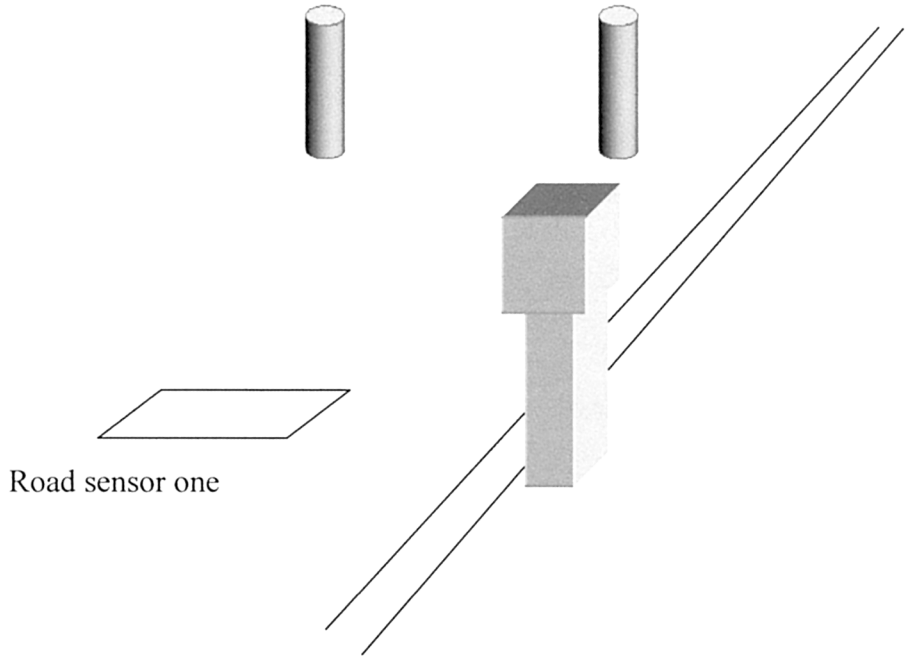



**Figure 18**

**TURN OVER FOR SECTION B – PNEUMATICS FOCUS TECHNOLOGY**

## SECTION B – PNEUMATICS FOCUS

Answer **all** questions in this section.

Do **not** answer these questions if you have answered the questions in **Section A – Mechanisms Focus** (pp. 4–25).

**B1** **Figure 1** shows a pneumatic system constructed from a kit.

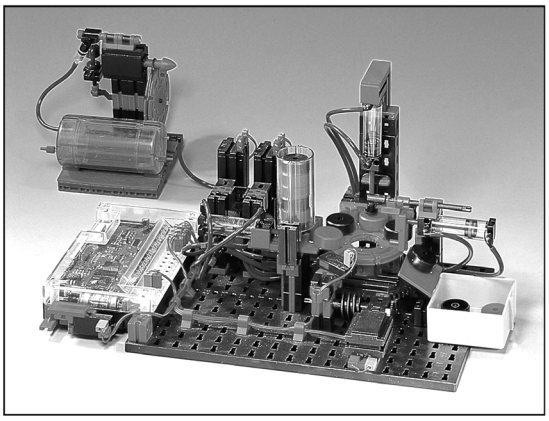


**Figure 1**

(a) One of the components is a cylinder, which is shown in simplified form in **Figure 2**.

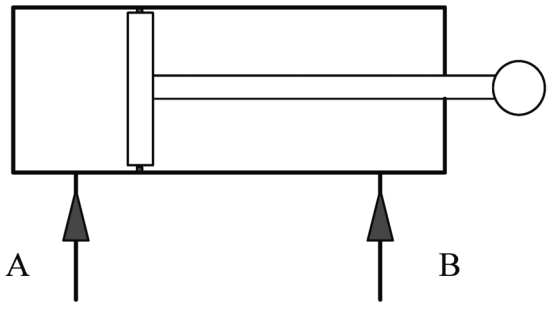



**Figure 2**

(i) Which input sends the cylinder positive?

.....

*(1 mark)*

(ii) If the area of the piston is 200 $mm^2$ and the air coming into the cylinder is at a pressure of 0.5 $Nmm^2$ what is the force of the piston as it goes positive?

Formula .....

*(1 mark)*

Working .....

.....

*(1 mark)*

Answer .....

*(1 mark)*

(b) **Figure 3** shows part of a pneumatic system.

**Cylinder A** operates as a press.

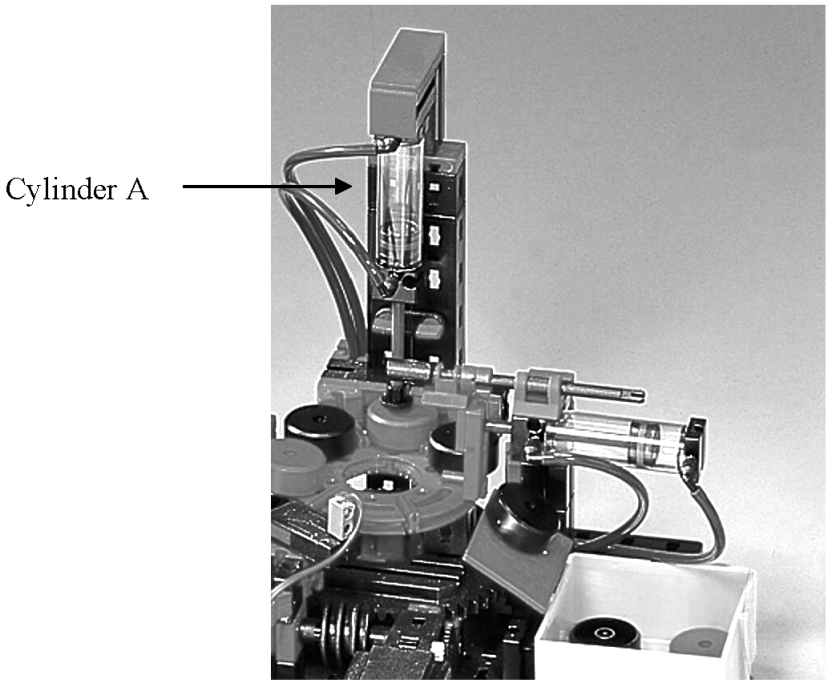



**Figure 3**

(i) **Cylinder A** is a double acting cylinder.

What is the benefit of this over a single acting cylinder?

.....

.....

*(1 mark)*

(ii) What material do you think the cylinder in the model would be made of?

.....

*(2 marks)*

(iii) Why do you think this material is suitable?

.....

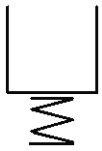
.....

*(1 mark)*

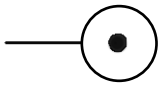
8

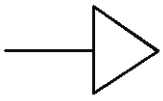
**B2** (a) Name the components or features represented by the pneumatic circuit symbols shown below.

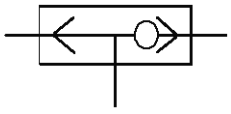




(i) ..... (ii) ..... (iii) .....







(iv) ..... (v) ..... (vi) .....

*(6 marks)*

(b) **Table 1** shows a number of different components that can be used as sensors in circuits.

Complete the table.

*One example has been completed for you.*

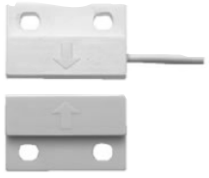
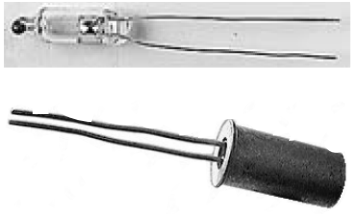
| *Name of component* | *What it senses* | *A typical use* |
|---|---|---|
| Reed switch  | *Removal or presence of a magnet* | *Used in burglar alarm systems to sense if a door is opened* |
| Light dependent resistor  | ..... ..... ..... ..... | ..... ..... ..... ..... |
| Mercury tilt switch  | ..... ..... ..... ..... | ..... ..... ..... ..... |
| Microswitch  | ..... ..... ..... ..... | ..... ..... ..... ..... |

**Table 1**

*(6 marks)*

**QUESTION B2 CONTINUES ON THE NEXT PAGE**

(c)

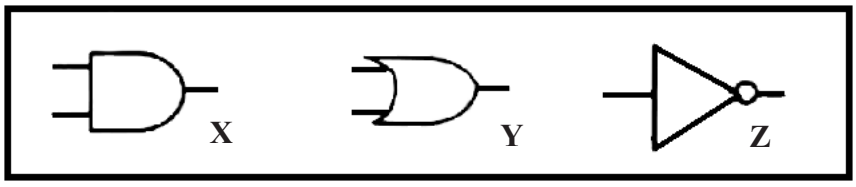



**Figure 4**

Study the symbols shown in **Figure 4** then fill in the missing words in the sentences below.

(i) The symbols in **Figure 4** are all examples of ..... gates.

*(1 mark)*

(ii) The gate labelled **X** is an ..... gate and the gate labelled **Y** is an ..... gate.

*(2 marks)*

(iii) Complete the truth table **Figure 5** for gate **X**.

| Input 1 | Input 2 | Output |
|---|---|---|
| 0 | 0 | |
| 0 | 1 | |
| 1 | 0 | |
| 1 | 1 | |

**Figure 5**

*(4 marks)*

19

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**B3** (a) Flow charts can be used when planning command sequences for control programs.

Complete **Table 2** by drawing the outline shape of the relevant box alongside the label.

*The START box has been shown as an example.*

| | |
|---|---|
| START | START |
| PROCESS | |
| INPUT/OUTPUT | |
| DECISION | |

**Table 2**

*(3 marks)*

(b) Flow charts can also be used for fault-finding operations. One of the common faults made by students making electronic circuit boards is to connect an LED with the legs the wrong way around.

The main stages are listed below – *they are shown in their correct sequence*.

- Start
- Check LED legs are correct way around
- If not desolder and reposition LED
- Check quality of soldering
- If soldering is not adequate resolder
- Stop

In the space below complete the fault-finding flow chart, **Figure 6** to show how an LED could be checked.

Add all **yes/no** labels and **direction** arrows to your diagram.

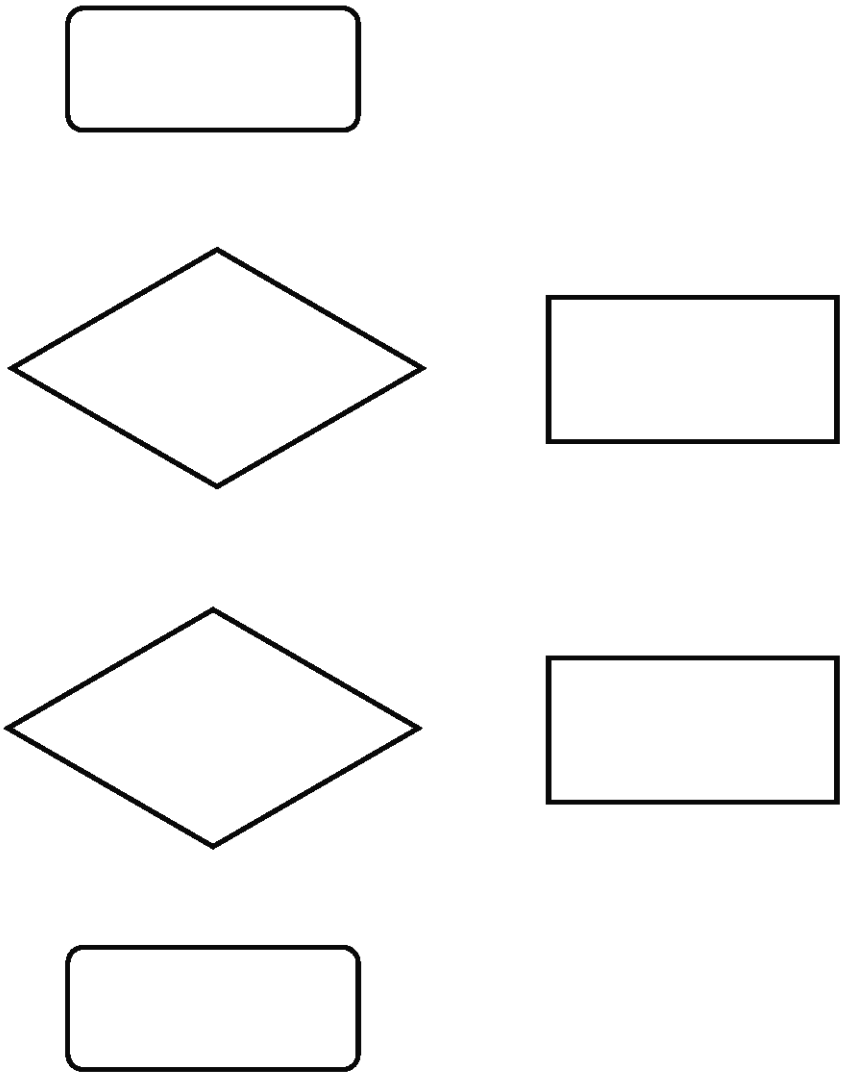


**Figure 6**

*(14 marks)*

17

**B4** (a) The block diagram, **Figure 7** shows how a fire prevention water sprinkler system works.

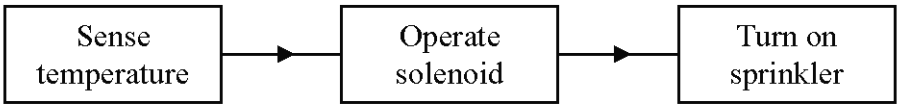



**Figure 7**

The sensing part of the circuit created to operate the sprinkler is shown in **Figure 8** below.

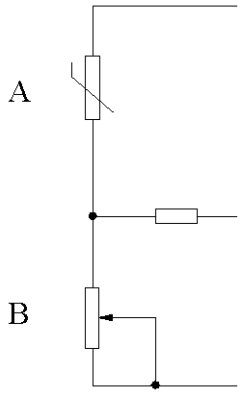



**Figure 8**

(i) Which component acts as a sensor in this circuit?

.....

*(1 mark)*

(ii) What does the component sense?

.....

*(1 mark)*

(b) Which component is used to adjust the sensitivity of the circuit?

.....

*(1 mark)*

(c) The circuit could also be modified to sense ice.

Complete **Figure 9** to show how you would re-arrange the components from **Figure 8** to detect ice.

The heater must turn on when ice is detected.

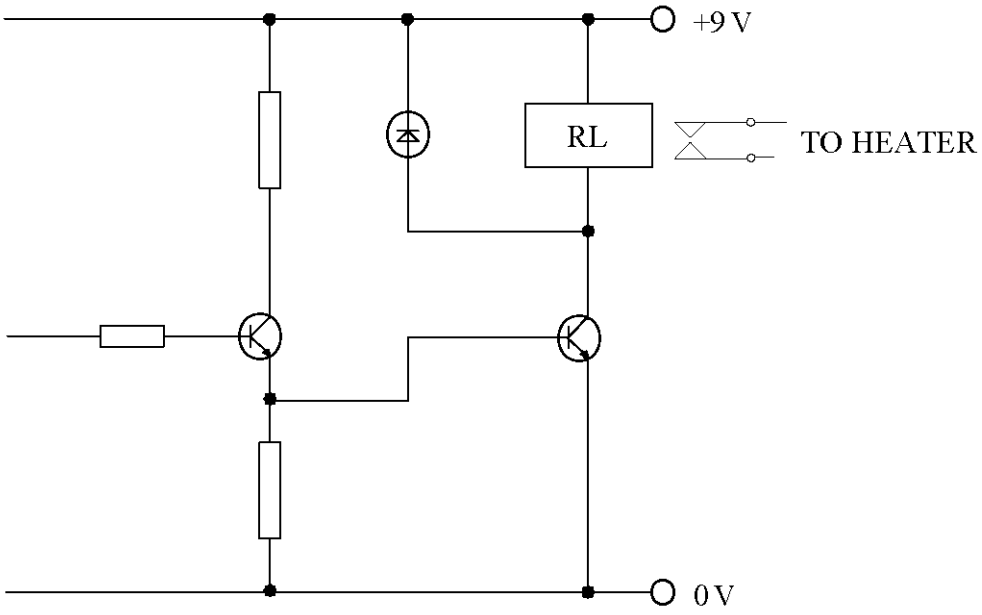



**Figure 9**

*(8 marks)*

**QUESTION B4 CONTINUES ON THE NEXT PAGE**

(d) (i) Many circuits use a safety procedure requiring two switches to be pressed before a mechanism operates.

In the space below draw a circuit requiring **two** push-to-make switches to be pressed before the motor will work.

*A range of components that can be used are shown in* **Figure 10**.

This question is worth 10 marks.

Marks will be awarded as follows:

| | |
|---|---|
| Quality of drawing; | *(2 marks)* |
| Correct arrangement of switches; | *(2 marks)* |
| Correct circuit symbols; | *(4 marks)* |
| Correct output. | *(2 marks)* |

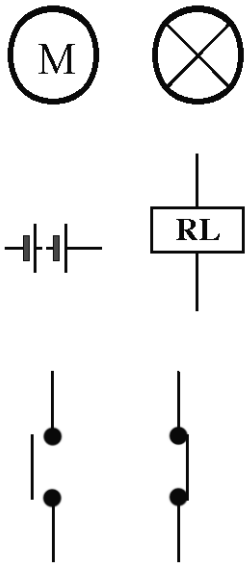



**Figure 10**

(ii) The system diagram, **Figure 11** shows a similar safety circuit to the one you have designed in part (i) of this question. It is used on a machine to ensure it will not start unless the guard is in position.

- Switch 1 is the ON button.
- Switch 2 checks the guard is in the correct position.

1 Name **one** suitable switch for Switch 2 and write your answer in the INPUT Switch 2 box of **Figure 11**.

2 State the output of the system and write your answer in the OUTPUT box of **Figure 11.**

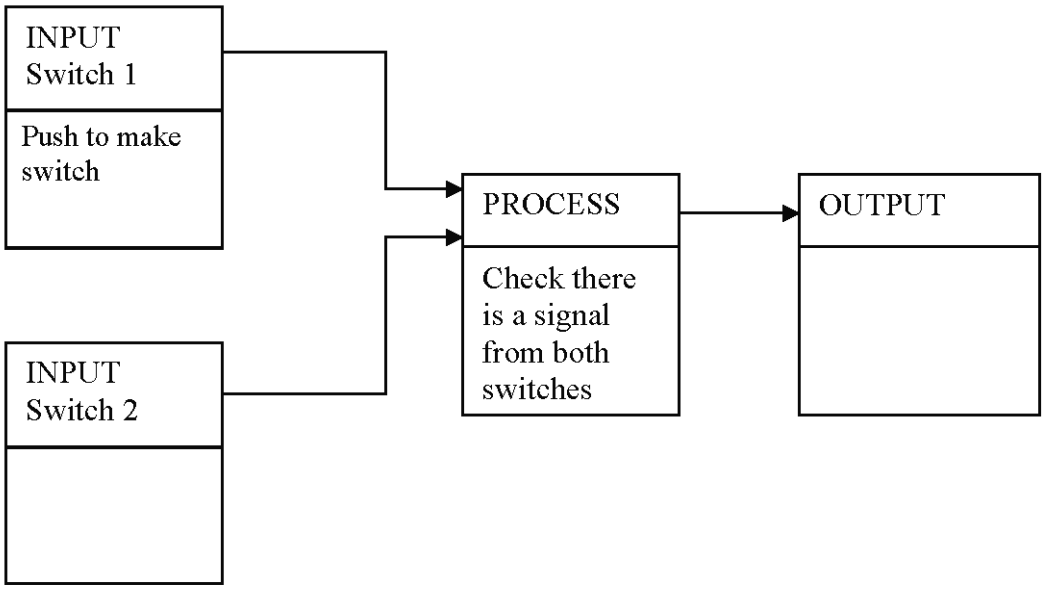



**Figure 11**

*(2 marks)*

23

**TURN OVER FOR THE NEXT QUESTION**

**B5** Safety is of great importance in the workshop.

Give **two** *different* safety precautions for each of the situations below.

(a) Soldering components to a PCB.

(i) .....

(ii) .....

*(2 marks)*

(b) Using a pillar drill – *(do not repeat any of your previous answers)*.

(i) .....

(ii) .....

*(2 marks)*

(c) Handling materials – *(do not repeat any of your previous answers)*.

(i) .....

(ii) .....

*(2 marks)*

6

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**B6** This question is about design specifications and safety.

The design specification below is for a small goods lift that is used in a restaurant.

**Figure 16** shows a sketch of the goods lift. Goods are placed through the opening into the goods box which moves up and down as shown.

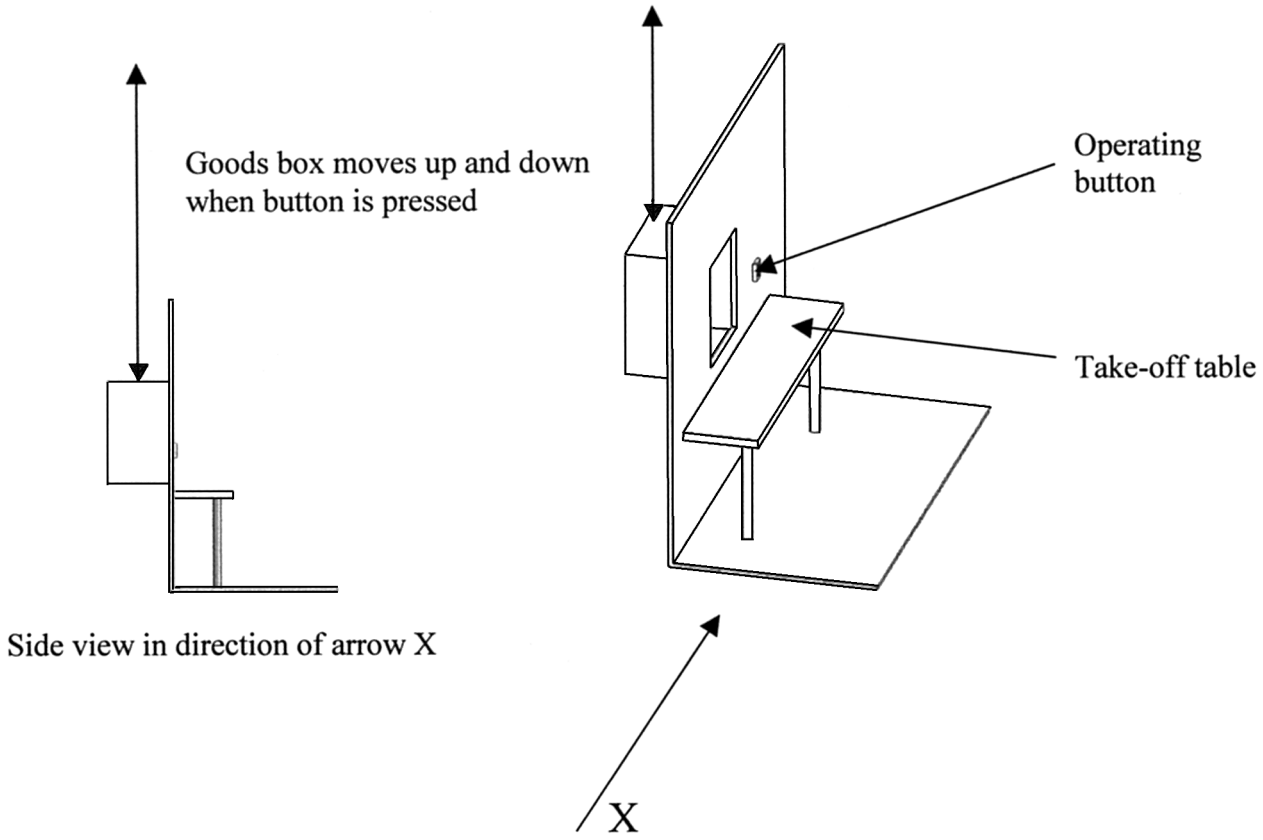



**Figure 12**

Part of the design specification for the goods lift.

- The Goods lift is to be pneumatically powered.
- The maximum height the box will travel through is 3 m.
- The Goods box unit is to be no larger than 800 × 400 × 600.
- There will be sliding doors to cover the opening on each floor.

(a) Add **two** safety requirements to the specification given above and suggest a method of satisfying each of them.

1 Safety requirement

.....

.....

*(2 marks)*

Method of satisfying the requirement

.....

.....

*(2 marks)*

2 Safety requirement

.....

.....

*(2 marks)*

Method of satisfying the requirement

.....

.....

*(2 marks)*

(b) The goods lift is controlled by an electronic control circuit.

Describe **two** ways of protecting electronic circuits from damage.

(i) .....

.....

*(2 marks)*

(ii) .....

.....

*(2 marks)*

12

**TURN OVER FOR THE NEXT QUESTION**

**B7** Manufacturers try to ensure high product quality in a number of different ways.

(a) Describe **two** ways in which CAD/CAM can improve product quality.

(i) .....

.....

*(2 marks)*

(ii) .....

.....

*(2 marks)*

(b) Computer software can be used to design and model circuits.

Use examples to show **two** *advantages* of using this type of computer software.

(i) .....

.....

*(2 marks)*

(ii) .....

.....

*(2 marks)*

(c) When a printed circuit board has been produced and assembled it needs to be checked.

(i) Describe **one** visual check you could perform on an assembled circuit board.

.....

.....

*(2 marks)*

(ii) Describe **one** electronic check you could perform on an assembled circuit board.

.....

.....

*(2 marks)*

12

**NO QUESTIONS APPEAR ON THIS PAGE**

**TURN OVER FOR THE NEXT QUESTION**

**B8** *Secure-it* make rising bollards for people to protect their drive-ways. The bollard is a post that rises out of the ground to prevent a car being removed from the driveway.


**Figure 13**

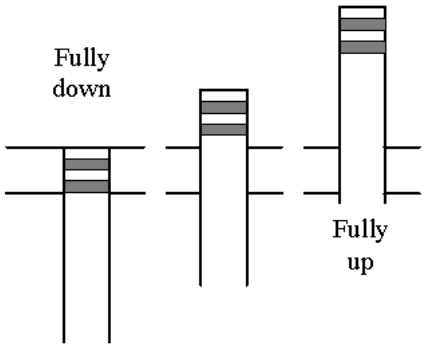



**Figure 14**

(a) *Secure-it* has asked you to design a working model that could be used in an exhibition. The model will be table mounted and the bollard and the table surface are shown in **Figure 14**.

Complete **Figure 15** to show a suitable pneumatic system to give a *continuous* slow up and down movement.

This question is worth 10 marks.

Marks will be awarded as follows:

| | |
|---|---|
| Suitability of pneumatic system; | *(4 marks)* |
| Notes on construction/materials/components/operation; | *(4 marks)* |
| Quality of drawing. | *(2 marks)* |

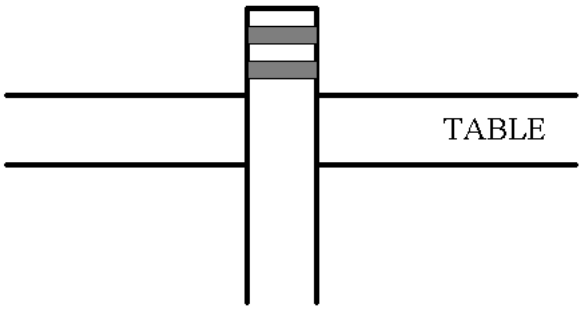



**Figure 15**

(b) Improve your system to include a *pause at the top and bottom* of the bollard's travel.

This question is worth 9 marks.

Marks will be awarded as follows:

| | |
|---|---|
| Facility to pause at top/bottom; | *(4 marks)* |
| Notes explaining how the system works; | *(3 marks)* |
| Quality of drawing. | *(2 marks)* |

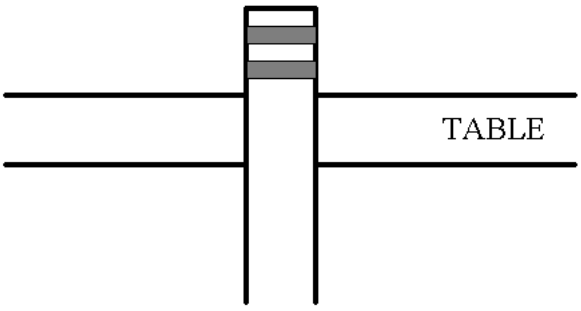
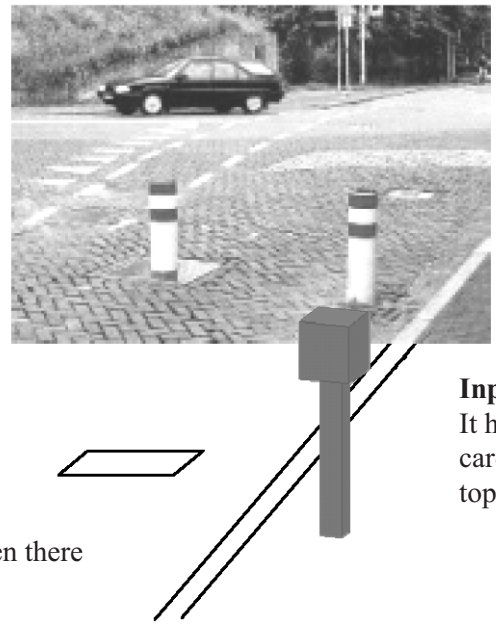



**Figure 16**

**B9** The rising bollards are to be controlled by a box, mounted on a pillar, and by sensors in the road that will allow the driver to pull alongside and insert a card into the box to make the bollards go down.

A basic design for the box has been added to **Figure 17**.



**Input A** – road sensor
It has a value of 1 when there is a car over it

**Input B** – card box reader.
It has a value of 1 when the card is inserted into the box on top of the pillar

**Figure 17**

There are four outputs in the system:

- Output C = bollard moving down;
- Output D = Green light on to say safe to move forward;
- Output E = Red light on to say STOP bollard about to rise;
- Output F = bollard moving up.

The sequence control program is given below:

```
If Input A = 1 and Input B = 1 run BOLLARDS
      Turnon Output C until bollard down
      Turnon Output D
      When Input A = 0 wait 30 seconds
      Turnoff Output D
      Turnon Output E
      Turnon Output F until bollard up
      Set Input B to 0
End BOLLARDS
```

(a) How many inputs does the system need before it begins to operate?

.....

*(1 mark)*

(b) How many seconds is the green light on for?

.....

*(1 mark)*

(c) What value does the road sensor have when the car has moved forward off it?

.....

*(1 mark)*

(d) In operation the system was found to have fault. If a car had to stop over the bollards there was no way of stopping the bollards from coming up after the time delay and damaging the car.

Complete **Figure 18** to show how a second road sensor could be used to solve this problem.

*(3 marks)*

*The first sensor and the bollards are already drawn for you.*

Add brief notes to explain how your system would work. *(3 marks)*

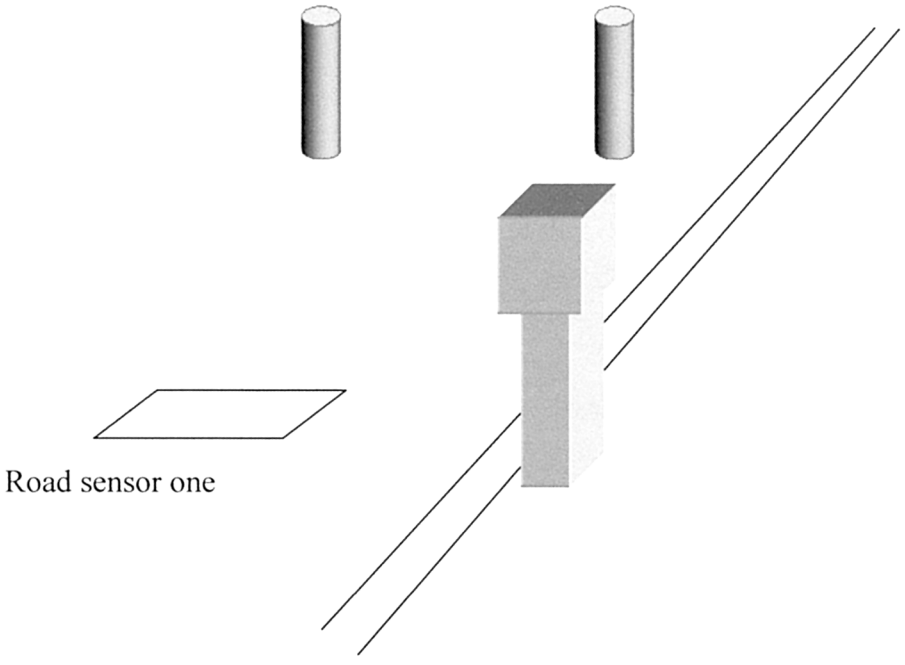



**Figure 18**

**END OF QUESTIONS**

**THERE ARE NO QUESTIONS PRINTED ON THIS PAGE**