

Surname						Other Names					
Centre Number						Candidate Number					
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General Certificate of Secondary Education  
June 2004



**DESIGN AND TECHNOLOGY  
SYSTEMS AND CONTROL TECHNOLOGY  
Higher Tier**

3546/H

**H**

Friday 28 May 2004 Afternoon Session

<p><b>In addition to this paper you will require:</b></p> <ul style="list-style-type: none"> <li>• a pen, pencil, ruler, eraser and pencil sharpener;</li> <li>• a calculator.</li> </ul>
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Time allowed: 2 hours

**Instructions**

- Use blue or black ink or ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
- Answer **either Section A** – Mechanisms Focus Technology;  
**or Section B** – Pneumatics Focus Technology.  
**not both.**
- Answer the questions in the spaces provided.

**Information**

- The maximum mark for this paper is 125.
- Mark allocations are shown in brackets.
- A list of formulae is given on page 2 which you may need to use when answering certain questions.
- Wherever calculations are needed you should show all 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 MECHANISMS FOCUS	
Number	Mark
A1	
A2	
A3	
A4	
A5	
A6	
A7	
TOTAL	
SECTION B PNEUMATICS FOCUS	
Number	Mark
B1	
B2	
B3	
B4	
B5	
B6	
B7	
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

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

Area of circle =  $\pi r^2$

$$\pi = 3.142$$

Resistor Colour Code

E12 Resistor preferred values

Colour	Number	Number of Zeros	
Black	0		10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 and decades thereafter.
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	

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

**TURN TO PAGE 24 FOR QUESTION B1 – PNEUMATICS FOCUS**

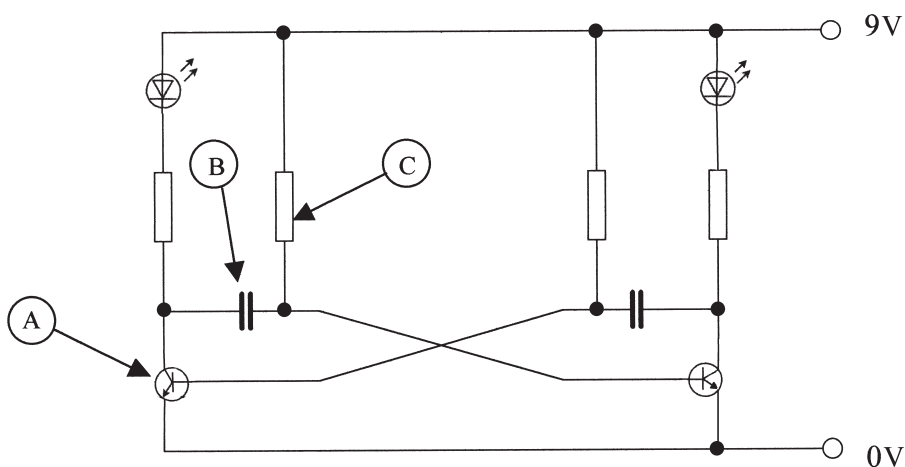
**SECTION A – MECHANISMS FOCUS**

Answer **all** questions in this section.

Do **not** answer these questions if you have answered the questions in **Section B – Pneumatics Focus** (pp. 24–43).

**A1** A school student has decided to design a dummy car burglar alarm. It will use two LEDs (light emitting diodes) that flash alternately to suggest an alarm is activated. The circuit, the power source and LEDs will be housed in a moulded case that will be visible on a car’s rear parcel shelf.

**Figure 1** is the first astable circuit that was considered by the student.



**Figure 1**

(a) Identify the components indicated and describe their function in the circuit.

(i) Component A ..... (1 mark)

Function in circuit .....  
..... (1 mark)

(ii) Component B ..... (1 mark)

Function in circuit .....  
..... (1 mark)

(iii) Component C ..... (1 mark)

Function in circuit .....  
..... (1 mark)

(iv) Name **two** components which function together to determine the flash intervals of the LEDs.  
 ..... (2 marks)

(b) After further research the student found that the astable multivibrator circuit could be replaced by a circuit using a 555 timer integrated circuit. The circuit is shown in **Figure 2** and it uses a 555 timer integrated circuit together with two different coloured LEDs that flash alternately.

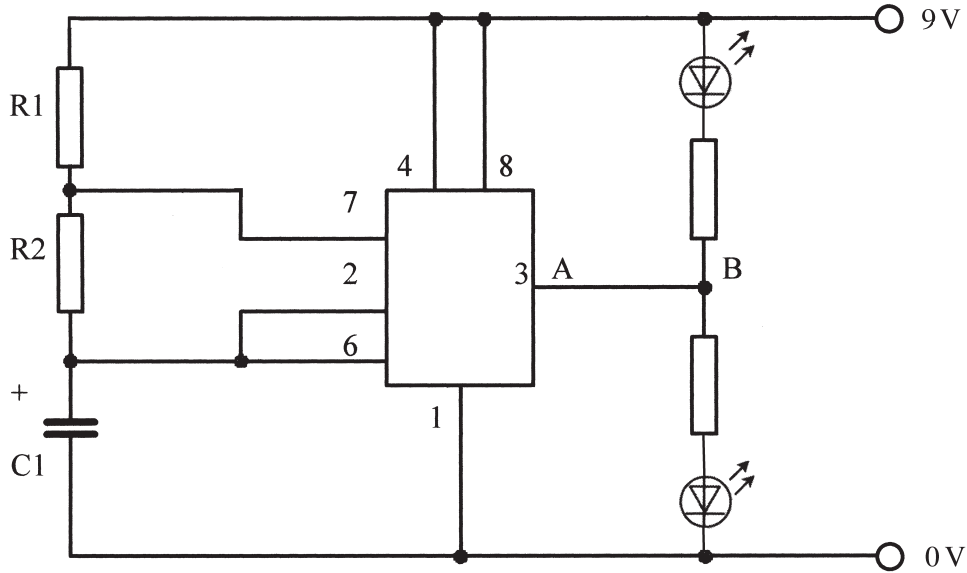
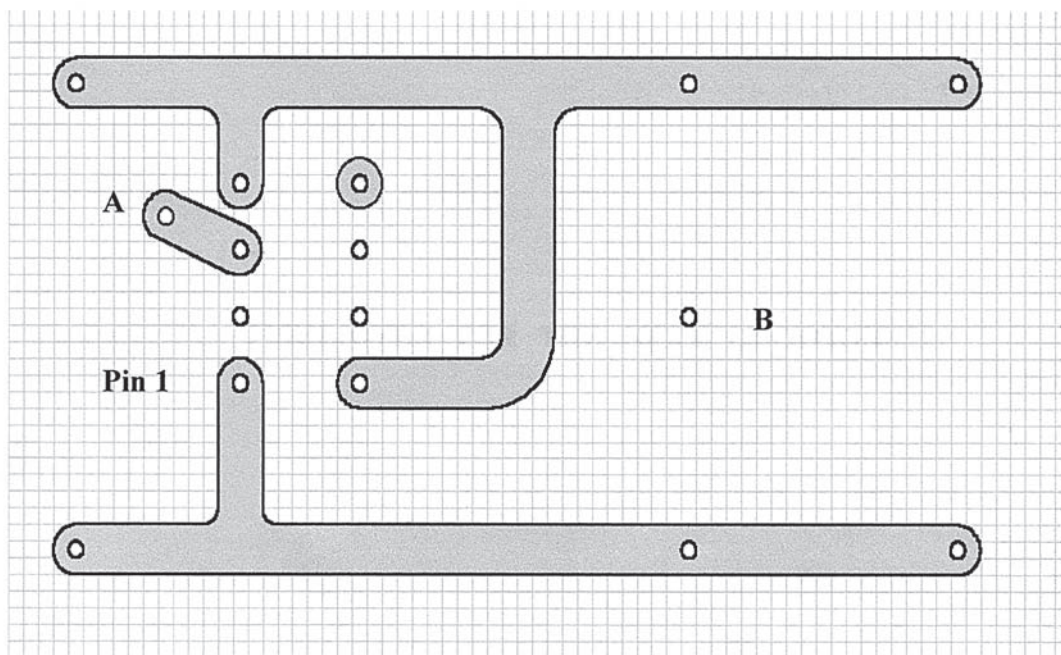


Figure 2

Complete the PCB layout in **Figure 3** using the circuit diagram given in **Figure 2**. Pin number 1 of the 555 integrated circuit is labelled for you. Ensure that tracks and pads are of a reasonable size.

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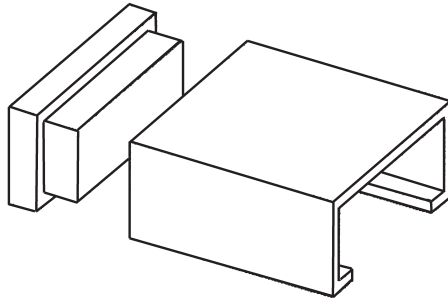


A and B are to be linked by a separate wire.

Figure 3

(6 marks)

**A2** The student decides to enclose the alarm circuit and battery holder in an aluminium case with plastic end plates. See **Figure 4**.



This drawing shows *one* of the plastic end plates and the aluminium case.

**PARTS LIST**

- Two end plates – injection moulded.
- One body case from an aluminium section.

**Figure 4**

(a) What is injection moulding?

.....

.....

.....

(2 marks)

(b) Why is aluminium a suitable metal for the case?

.....

.....

(1 mark)

(c) Sketch an idea that will show how the student could modify the simple case idea in **Figure 4** to meet the following specification:

The modified case design must include:

- **one** battery holder;
- **two** LEDs to be used as flashing indicators;
- the assembled PCB;
- **one** method of attaching the case to the rear parcel shelf of a car (the shelf is 3 mm thick and can be easily drilled);
- methods of mounting the circuit board, battery and LEDs (they must be insulated from the aluminum case).

Assume that two leads leave the case to connect to a hidden switch. You do not need to include the switch in your solution.

Add notes to your answer to show how you have satisfied the specification. You may include any other parts or items you feel are appropriate to help complete the case design.

This question is worth 10 marks.

Marks will be awarded as follows:

Quality of communication	(2 marks)
Quality of notes	(2 marks)
Method of locating the components	(5 marks)
Method of fixing the unit to the parcel shelf	(1 mark)

**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

**A3** *Prirton Garage Doors* requires an animated shop display to demonstrate their product. Their doors slide horizontally on tracks.

Two different mechanisms that could be used to convert rotational movement, (a motor), into linear movement along a straight path are a crank and slider and a cam and follower.

In the spaces below draw a simple labelled diagram to show how each of the named mechanisms turn rotary motion into linear motion.

(a) Crank and slider

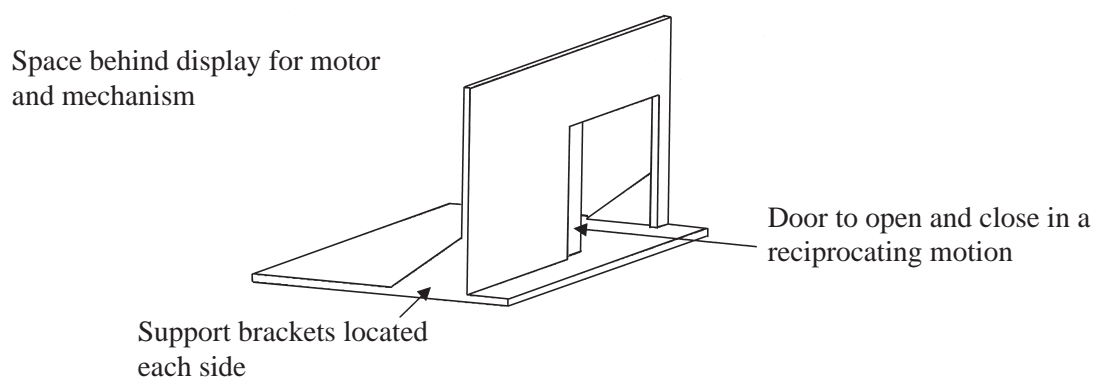
(3 marks)

(b) Cam and follower

(3 marks)

The manager of *Prirton Garage Doors* has decided that he wants the shop display model to take the basic form shown below.

The mechanism to be used to operate the door is a crank and slider mechanism.



**Figure 5**



- (c) In the space below using a system based on the crank and slider mechanism produce a design for the model that shows:
- how the mechanism will be attached to the door;
  - how the door can be fastened to the wall to allow for easy movement;
  - how the motor is attached to the mechanism.

Assume that the motor being used contains a gear box that allows the output shaft to turn at a slow speed.

This question is worth 9 marks.

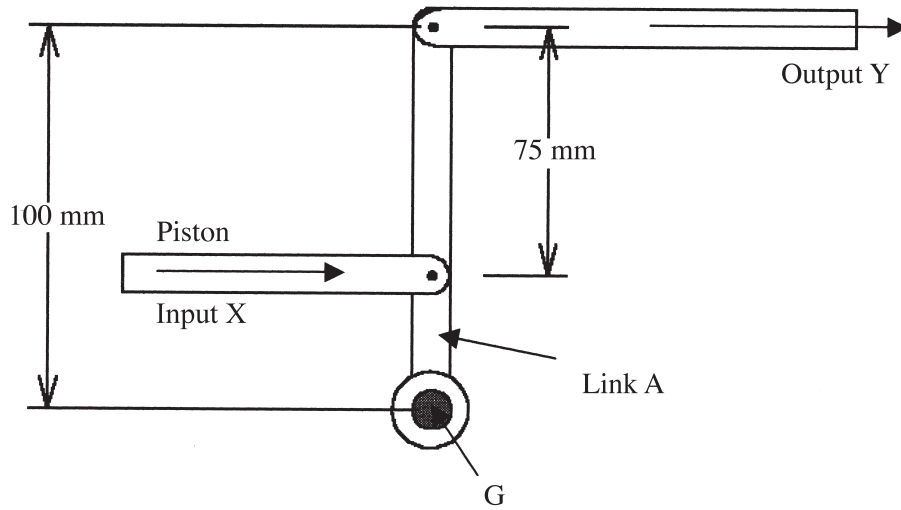
Marks will be awarded as follows:

Locating mechanism on door	(3 marks)
Free movement of door	(3 marks)
Attaching motor to the mechanism.	(3 marks)

**QUESTION A3 CONTINUES ON THE NEXT PAGE**

(d) The mechanism in **Figure 6** is part of a linkage that could have been used to move the door.

Calculate the force needed to be applied at input **X** if link A pivots at **G** to obtain an output force of 50 N at **Y**.



**Figure 6**

Formula and working.

.....

.....

.....

.....

(2 marks)

Answer

.....

(1 mark)

**A4** *Prirton Garage Doors* wish to develop an electromechanical locking system for the garage doors. A low voltage electronic control box operates a high voltage solenoid moving a locking bolt for the garage door. This operates when the correct key pad sequence is entered at the control box.

The system is normally locked. The application of power to the solenoid releases the bolt and enables the door to be opened.

(a) Complete the system diagram in **Figure 7** using the **three** correct terms from the list below:

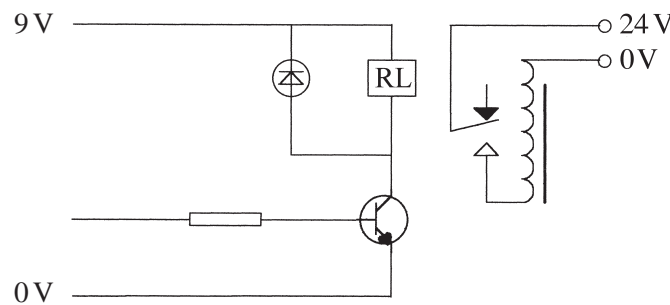
- Feedback
- Keypad
- Logic check
- Solenoid.



**Figure 7**

(3 marks)

(b) The section of the circuit diagram in **Figure 8** shows the solenoid and the relay.



**Figure 8**

Explain the purpose and operation of the diode in the circuit in **Figure 8**.

.....

.....

.....

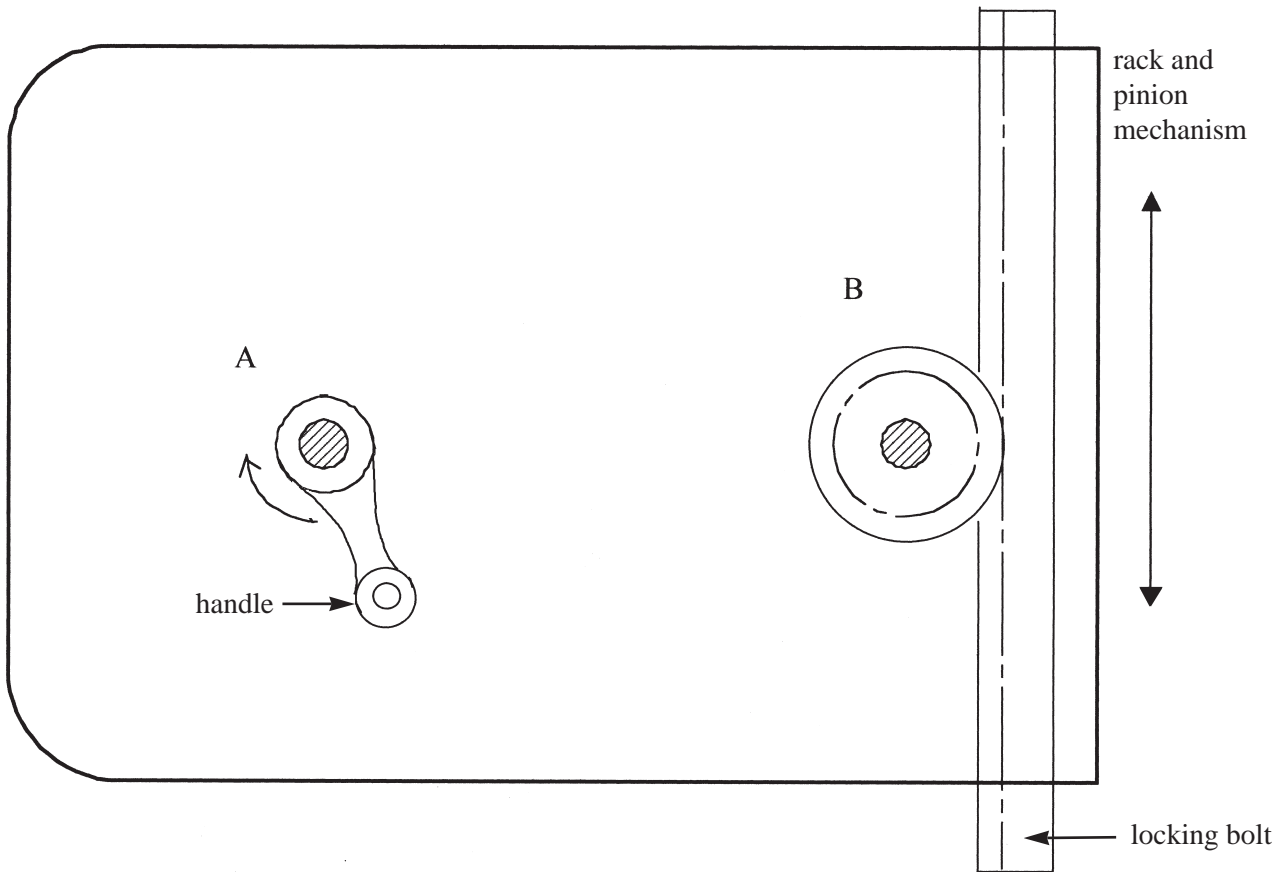
(4 marks)

**QUESTION A4 CONTINUES ON THE NEXT PAGE**

**Turn over ►**

- (c) The system is to have a manual over-ride. The over-ride will be in the form of a geared release mechanism. The force required to overcome the locking spring is quite large so a gear mechanism has to be used to amplify the force at the locking bar. The manual handle attaches to shaft A.

By adding gears to the diagram in **Figure 9** show **one** method of ensuring that a small force at **A** will be converted into a large force at **B** to allow the easy opening of the locking bolt in the direction shown.



**Figure 9**

(7 marks)

- (d) (i) An alternative method of moving the locking bolt is to use a pulley system with a toothed belt.

If pulleys of 150 mm diameter and 30 mm diameter are used what would be the velocity ratio of the pulley system.

.....  
.....  
.....

(4 marks)

- (ii) Give **one** advantage of using gears rather than pulleys.

.....  
.....  
.....

(2 marks)

20

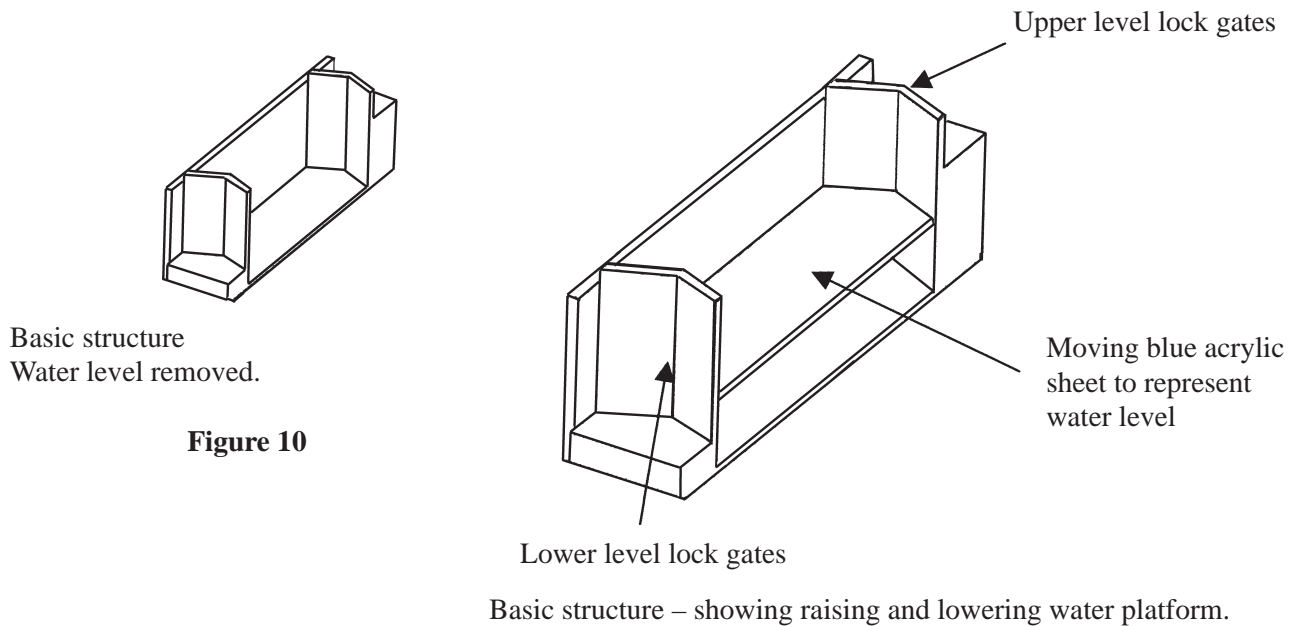
**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

**A5** A local primary school has approached you to make a working model to show children how a canal lock works.

- It will not use any water in the construction of the model.
- The water level is represented by a piece of blue acrylic sheet.
- The sheet is free moving and can be seen in the mid position in **Figure 11**.
- The model is electrically powered.

The basic design of the model is shown in **Figure 10** and **Figure 11** below.



**Figure 10**

**Figure 11**

**In both of these views one side has been removed to allow you to see inside.**

- (a) A rack and pinion mechanism has been chosen as the mechanism to raise and lower the acrylic sheet representing the water level.

In the space below draw and label this mechanism

(4 marks)

- (b) It is important that the electrically powered mechanism stops when the acrylic sheet reaches the upper and lower “water levels”.

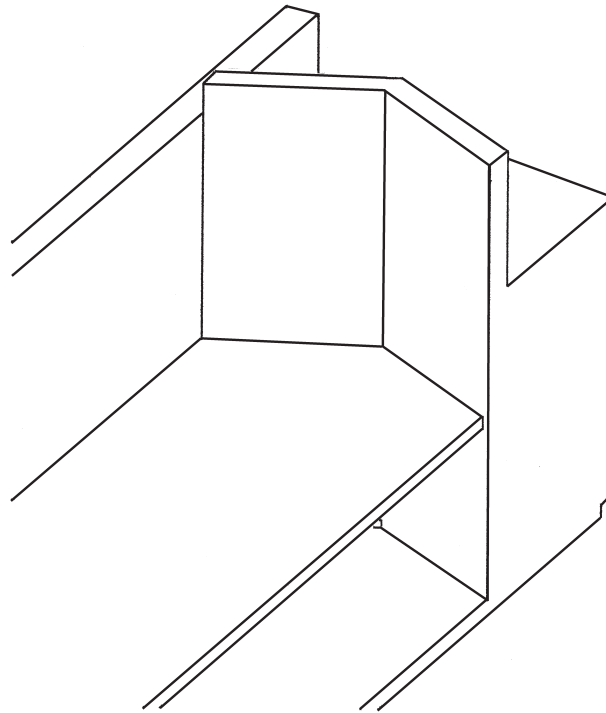
Name **one** electrical component that would be suitable to detect the lower “water level” when it is reached.

.....  
(1 mark)

- (c) Name **one** electronic component which would be suitable for varying the speed of the motor driving the system?

.....  
(1 mark)

- (d) Using the diagram in **Figure 12** and any additional diagrams necessary show how you would locate the device you named in part (b) to ensure that the “water level” stops at the correct lower level when the model is operating.



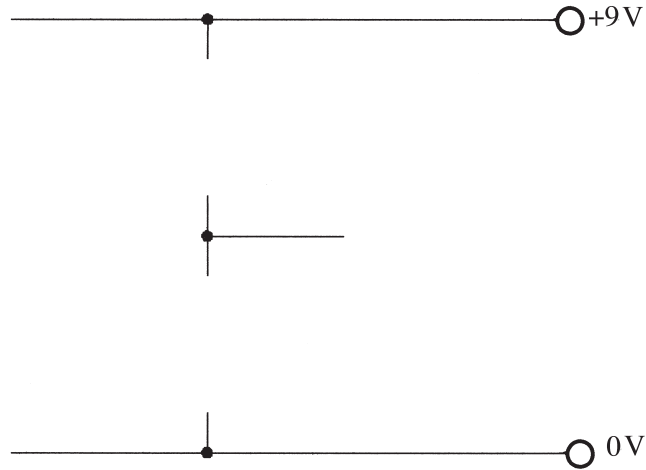
**Figure 12**

(5 marks)

**QUESTION A5 CONTINUES ON THE NEXT PAGE**

- (e) The maker of the model has decided to use an LDR (light dependent resistor) to detect the upper level. When the acrylic sheet platform reaches the correct height the LDR will be in darkness.

Complete the circuit diagram in **Figure 13** below to show the components required to detect the upper level.



**Figure 13**

(4 marks)



**A6** The student making the electronic control box for the lock gate model decided to develop the circuit using a computer software package. The software was also used to produce the PCB mask that would later be used in the printed circuit board etching process.

(a) Give **two** features of computer based programs to design an electronic circuit. For each of the features explain its advantage to the designer.

(i) Feature 1

.....  
.....

Advantage to the designer

.....  
.....

(2 marks)

(ii) Feature 2

.....  
.....

Advantage to the designer

.....  
.....

(2 marks)

**QUESTION A6 CONTINUES ON THE NEXT PAGE**

**Turn over ►**

- (b) Having produced a design for the circuit the student makes the circuit on copper clad board.

Describe, using notes and diagrams where appropriate, a process for producing a PCB on copper clad board.

.....

.....

.....

.....

.....

.....

(6 marks)

- (c) CAM can be used to produce circuit boards using a milling process.

Give **two** reasons why this may be a better way of producing printed circuit boards than etching.

- (i) Reason 1

.....

.....

(1 mark)

- (ii) Reason 2

.....

.....

(1 mark)

- (d) When assembling the circuit the student found that the school were short of some of the resistor values that were required. Rather than delay production it was decided to combine resistors to make the required resistance.

The only resistors available were 1K5, 1K8 and 2K2. There were plenty of each of these values so any combinations and quantities could be used.

- (i) Calculate how the student could have used the available resistors to produce a resistance of 3K3.

*Space for working*

.....

.....

.....

The resistors used are ..... and ..... (3 marks)

- (ii) This will require the resistors to be joined in ..... (1 mark)

- (iii) Calculate how the student could have used the available resistors to produce a resistance of 750R.

*Space for working*

.....

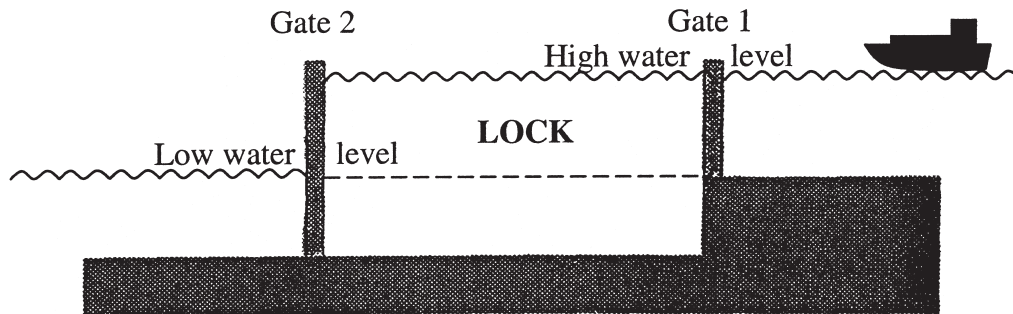
.....

.....

The resistors used are ..... and ..... (3 marks)

- (iv) This will require the resistors to be joined in ..... (1 mark)

**A7** A lock gate system uses a PIC to control the opening and closing of the gates.



Part of the lock system works in the following way:

- A sensor detects the boat as it approaches Gate 1.
- Gate 1 opens and the boat enters the lock.
- A sensor detects the boat is in the lock and closes Gate 1.
- A sensor detects Gate 1 is closed and a valve opens to allow the water to flow out of the lock at the low water end.
- A sensor detects when the water level reaches the low water level and Gate 2 opens. The boat exits the lock.
- A sensor detects the boat is outside Gate 2 and Gate 2 closes.

On page 21, produce a flow chart that could be used to help write the PIC control program.

This question is worth 15 marks.

Marks will be awarded as follows:

Starting the lock operation	(2 marks)
Opening entrance gates	(3 marks)
Changing water level and exit sequence	(6 marks)
Presentation of flow chart	(4 marks)

**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

15

**A8** When batch producing electronic products it is necessary to use a quality control and quality assurance system. Quality control is concerned with inspecting the product throughout the entire manufacturing process from order to dispatch. Quality assurance is establishing working practices to ensure that the product is manufactured in a consistent and controlled way.

(a) Give **two** quality control checks that can be applied to components that have been soldered onto a circuit board.

(i) Quality control check 1

.....

What is being checked?

.....

*(2 marks)*

(ii) Quality control check 2

.....

What is being checked?

.....

*(2 marks)*

(b) When purchasing resistors for use as components in accurate electronic measuring equipment what quality assurance step could be taken to ensure a high degree of accuracy to purchase specification?

.....

.....

*(1 mark)*

(c) (i) Testing an electronic circuit over a long period of time is commonly used.

Why is this form of testing used?

.....

*(1 mark)*

(ii) Give **one** example of where it would be appropriate.

.....

*(1 mark)*

(d) A multimeter is often used to check circuits.

Name **two** checks that can be made using this device.

1 .....

2 .....

(2 marks)

(e) Many electronic devices use a modular construction using several small circuit boards.

Give **one** advantage of having several small boards rather than one large one.

.....

.....

(1 mark)

10

**END OF SECTION A**

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

**Turn over ►**

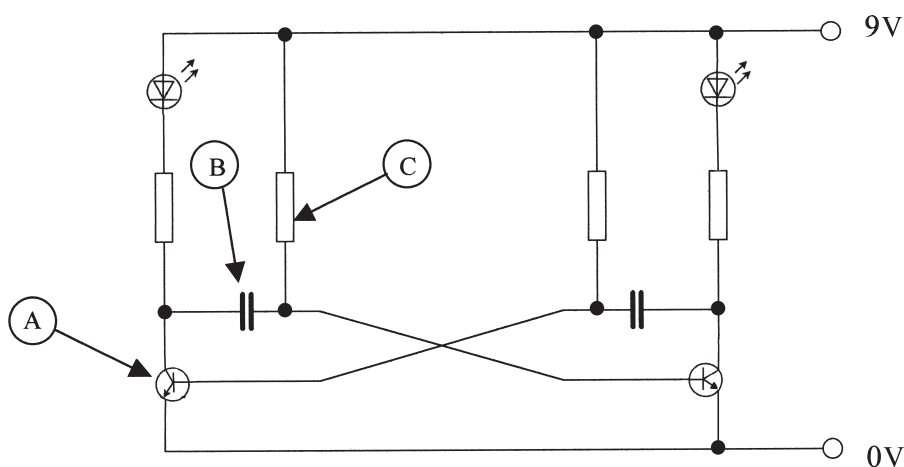
**SECTION B – PNEUMATICS FOCUS**

Answer **all** questions in this section.

Do **not** answer these questions if you have answered the questions in **Section A – Mechanisms Focus** (pp. 4–23).

**B1** A school student has decided to design a dummy car burglar alarm. It will use two LEDs that flash alternately to suggest an alarm is activated. The circuit, the power source and LEDs will be housed in a moulded case that will be visible on a car’s rear parcel shelf.

**Figure 1** is the first astable circuit that was considered by the student.



**Figure 1**

(a) Identify the components indicated and describe other functions what they do.

(i) Component A ..... (1 mark)

Function in circuit .....  
..... (1 mark)

(ii) Component B ..... (1 mark)

Function in circuit .....  
..... (1 mark)

(iii) Component C ..... (1 mark)

Function in circuit .....  
..... (1 mark)



(iv) Which **two** components function together to determine the flash intervals of the LEDs?

..... (2 marks)

(b) After further research the student found that the astable multivibrator circuit could be replaced by a circuit using a 555 timer integrated circuit. The circuit is shown in **Figure 2** and it utilises a 555 timer integrated circuit together with two different coloured LEDs that flash alternately.

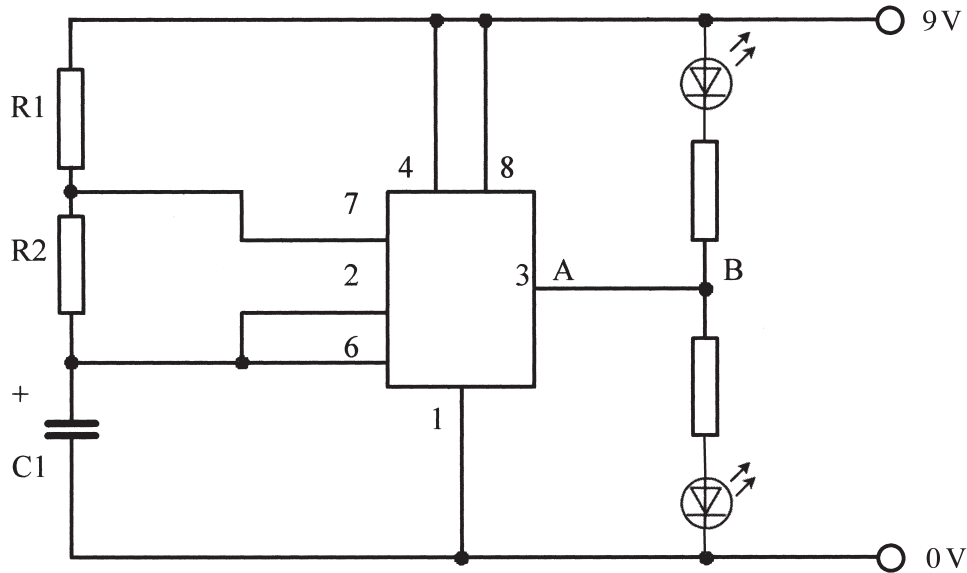
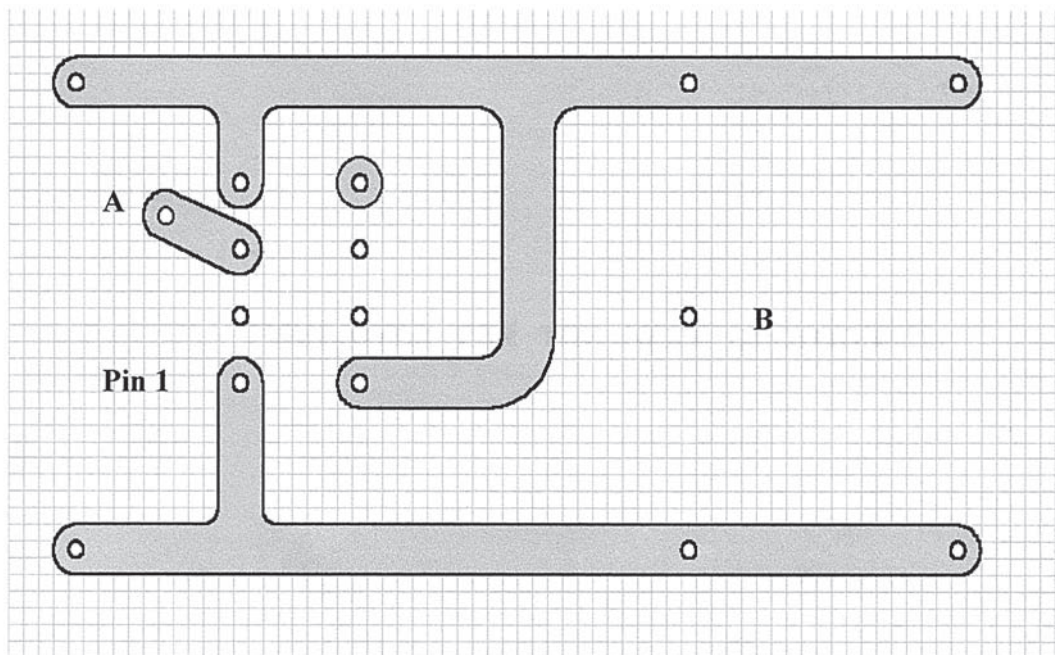


Figure 2

Complete the PCB layout in **Figure 3** using the circuit diagram given in **Figure 2**. Pin number 1 of the 555 integrated circuit is labelled for you. Ensure that tracks and pads are of a reasonable size.

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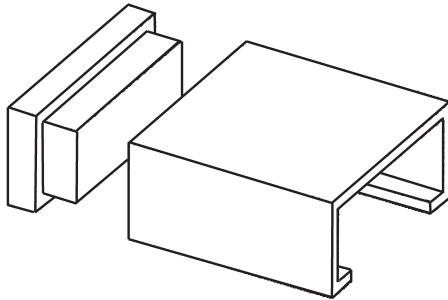
A and B are to be linked by a separate wire.

Figure 3

(6 marks)

Turn over ►

- B2** The student decides to enclose the alarm circuit and battery holder in an aluminium case with plastic end plates. See **Figure 4**.



This drawing shows *one* of the plastic end plates and the aluminium case.

#### PARTS LIST

- Two end plates – injection moulded.
- One body case from an aluminium section.

**Figure 4**

- (a) What is injection moulding?

.....

.....

.....

(2 marks)

- (b) Why is aluminium a suitable metal for the case?

.....

.....

(1 mark)

- (c) Sketch an idea that will show how the student could modify the simple case idea in **Figure 4** to meet the following specification:

The modified case design must include:

- **one** battery holder;
- **two** LEDs to be used as flashing indicators;
- the assembled PCB;
- **one** method of attaching the case to the rear parcel shelf of a car (the shelf is 3 mm thick and can be easily drilled);
- methods of mounting the circuit board, battery and LEDs (they must be insulated from the aluminium case).

Assume that two leads leave the case to connect to a hidden switch. You do not need to include the switch in your solution.

Add notes to your answer to show how you have satisfied the specification. You may include any other parts or items you feel are appropriate to help complete the case design.

This question is worth 10 marks.

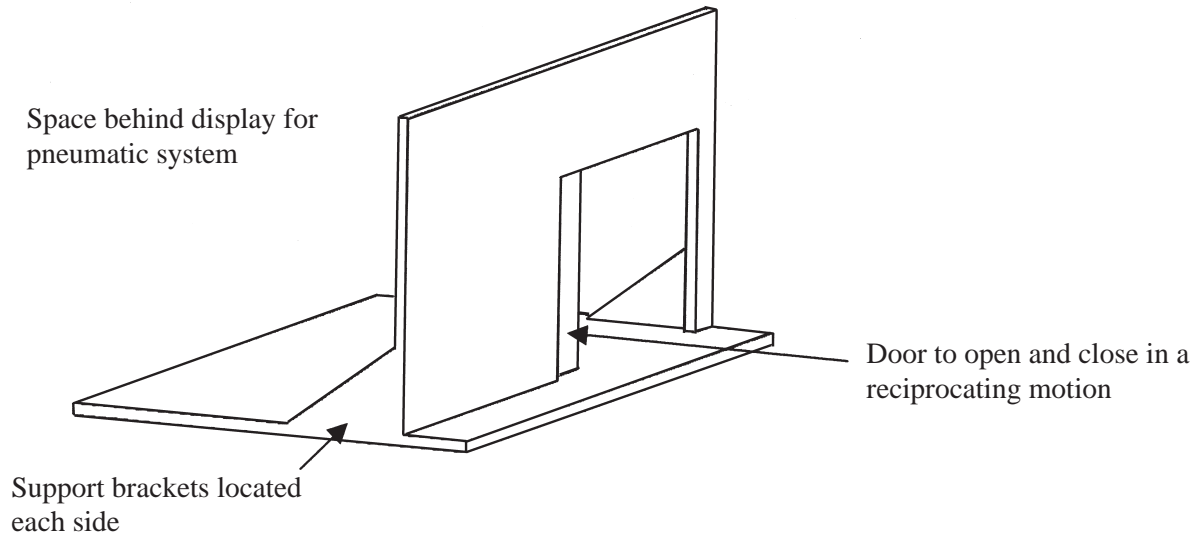
Marks will be awarded as follows:

Quality of communication	(2 marks)
Quality of notes	(2 marks)
Method of locating the components	(5 marks)
Method of fixing the unit to the parcel shelf.	(1 mark)

Turn over ►

**B3** *Prirton Garage Doors* require an animated shop display to demonstrate their product. Their doors slide horizontally on tracks.

The manager of *Prirton Garage Doors* has decided that he wants the shop display model to take the basic form shown in **Figure 5**.



**Figure 5**

(a) A double acting cylinder will be used to move the door through the short distance required on the model. The door is to open or close when an electrical control box button is pressed.

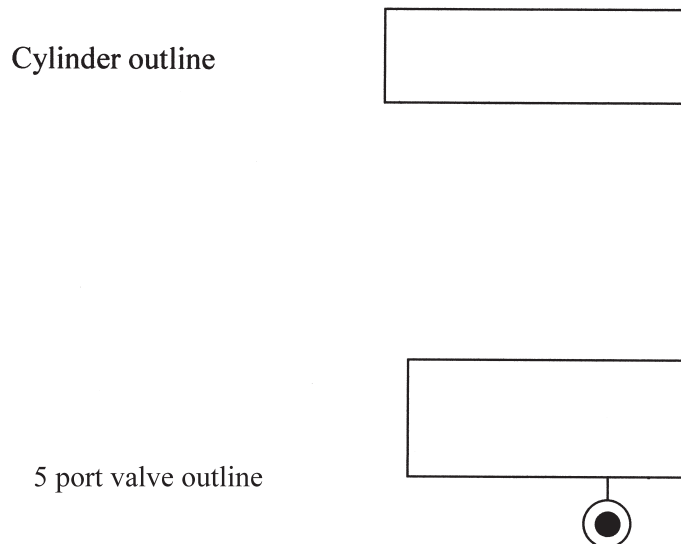
Using only a solenoid operated five-port valve and a double acting cylinder draw a simple pneumatic circuit that would allow the door to be opened or closed at the touch of a button.

The outlines of the components are shown in **Figure 6** below.

This question is worth 6 marks.

Marks will be awarded as follows:

- Correct identification of components (2 marks)
- Correct connections (2 marks)
- Quality of drawings (2 marks)



**Figure 6**

(6 marks)

- (b) Having seen the prototype model the manager of *Prirton Garage Doors* has asked for the system to run continuously.

Using **two** additional roller operated 3 port valves and **two** flow control restrictors modify your original circuit to produce a fully pneumatic circuit where the piston is moved automatically backward and forward.

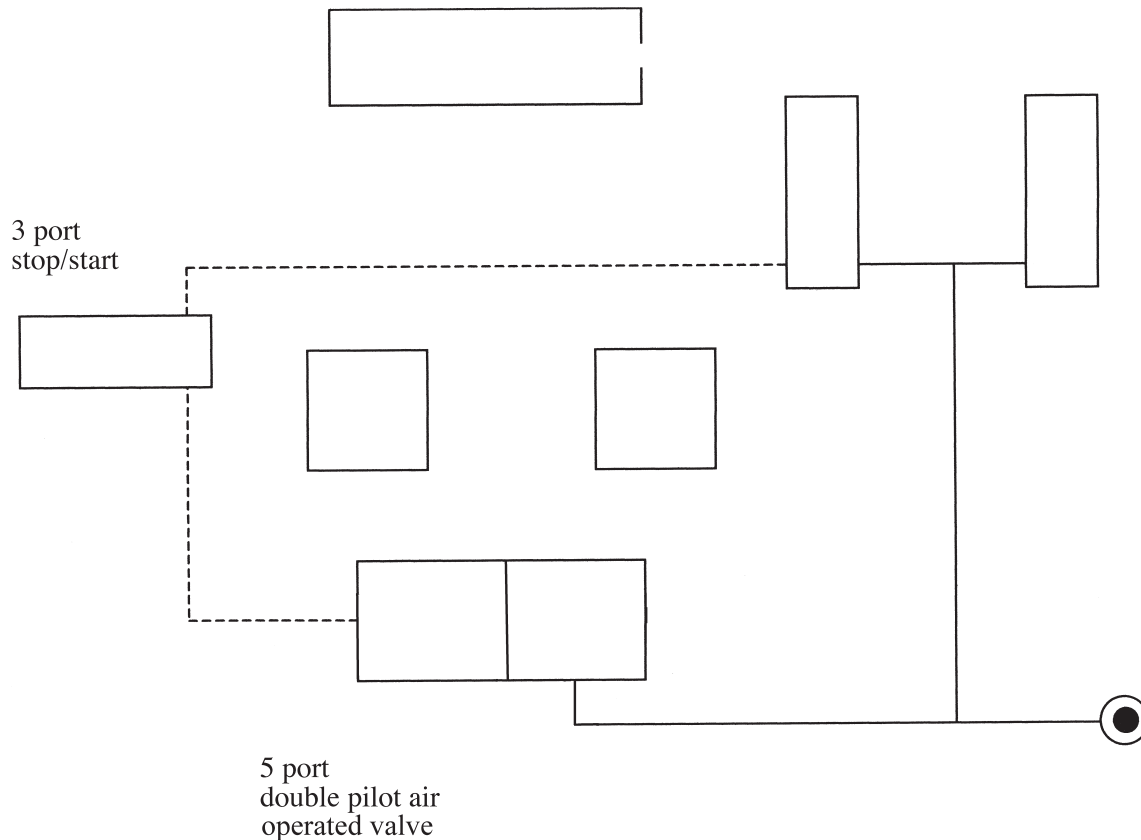
You also need to complete the button operated 3 port valve that is used to start the system.

All component outlines and some mains and pilot air lines are shown in **Figure 7**.

This question is worth 9 marks.

Marks will be awarded as follows:

Correct connections	(3 marks)
Correct completion of valves	(3 marks)
Correct use of roller valves	(3 marks)



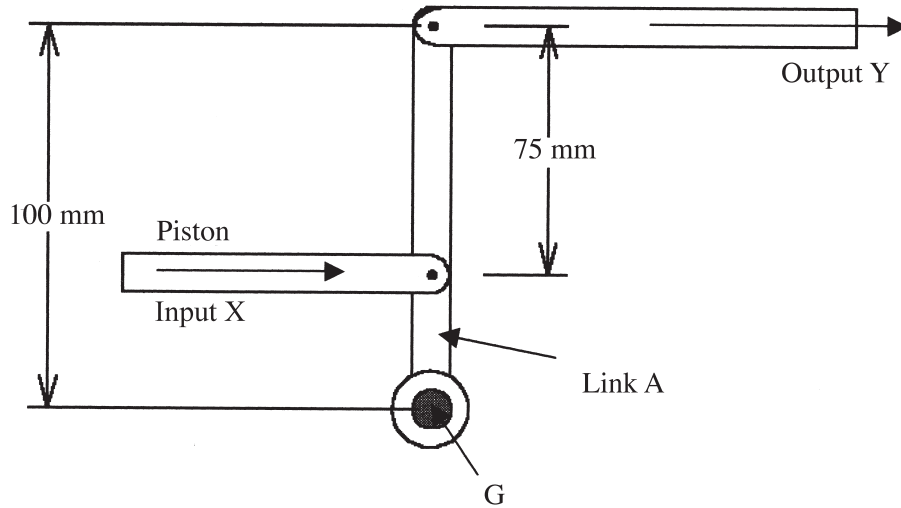
**Figure 7**

**QUESTION B3 CONTINUES ON THE NEXT PAGE**

**Turn over ►**

(c) The mechanism in **Figure 8** is part of a linkage that could have been used to move the door.

Calculate the force needed to be applied at input X if link A pivots at G to obtain an output force of 50 N at Y.



**Figure 8**

Formula and working.

.....

.....

.....

.....

(2 marks)

Answer

.....

(1 mark)

**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

**B4** *Pirton Garage Doors* wish to develop an electromechanical locking system for the garage doors. A low voltage electronic control box operates a high voltage solenoid moving a locking bolt for the garage door. This operates when the correct key pad sequence is entered at the control box.

The system is normally locked. The application of power to the solenoid releases the bolt and enables the door to be opened.

(a) Complete the system diagram in **Figure 9** using the **three** correct terms from the list below:

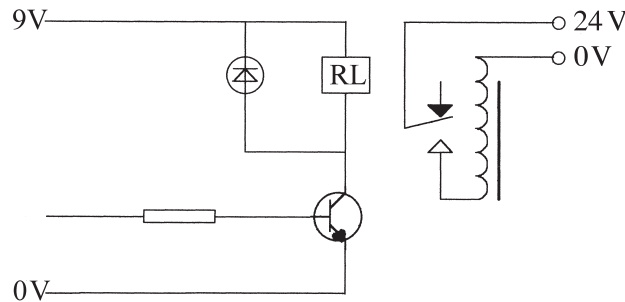
- Feedback
- Keypad
- Logic check
- Solenoid.



**Figure 9**

(3 marks)

(b) The section of the circuit diagram in **Figure 10** shows the solenoid and the relay.



**Figure 10**

Explain the purpose and operation of the diode in the circuit in **Figure 10**.

.....

.....

.....

(4 marks)



- (c) The door is opened from the outside using the keypad and solenoid operating valve.

The door is opened from the inside using a pneumatic button operated 3 port valve.

The company has decided that the door system should also be able to be opened from the inside.

- (i) Using a button operated 3 port valve, a single acting cylinder with a spring return and a shuttle valve, design a pneumatic circuit that will allow the door to be opened from the inside or from the outside of the building.

(8 marks)

- (ii) The air supply system delivers air to the cylinder at a pressure of  $0.75 \text{ N/mm}^2$ . The piston used in the cylinder is 50 mm in diameter.

Calculate the force that the cylinder applies.

Formula

.....

.....

.....

.....

.....

.....

Answer

.....

(5 marks)

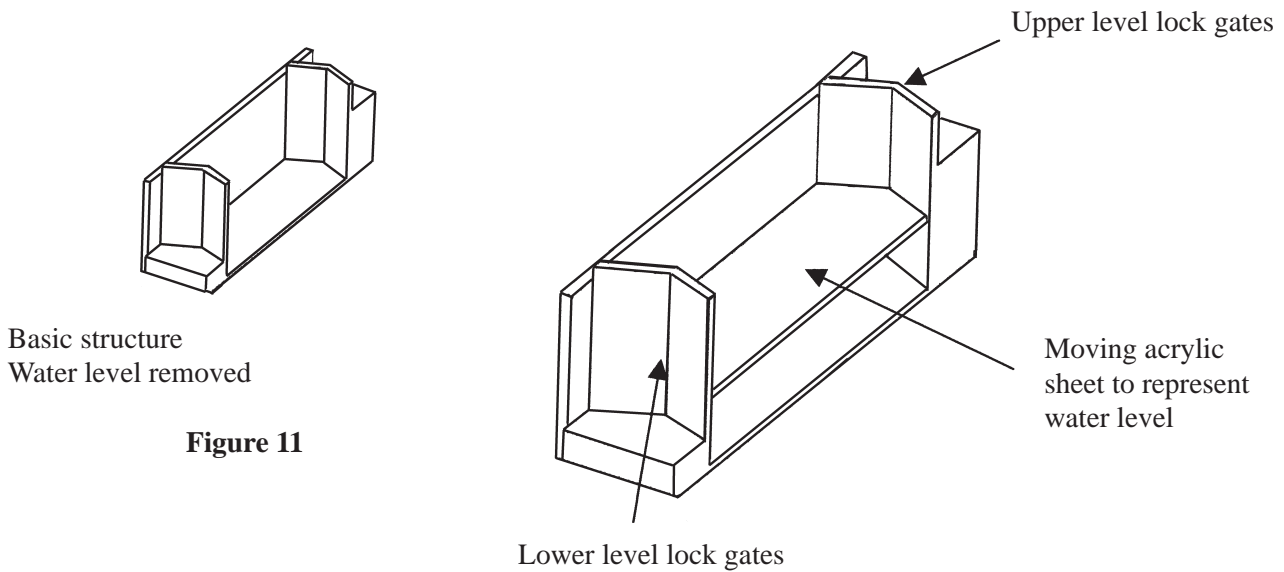
20

**Turn over** ▶

**B5** A local primary school has approached you to make a working model to show children how a canal lock works.

- It will not use any water in the construction of the model
- The water level is represented by a piece of opaque blue acrylic sheet
- The sheet is free moving and can be seen in the mid position in **Figure 12**
- The model is electrically powered

The basic design of the model is shown in **Figure 11** and **Figure 12** below.

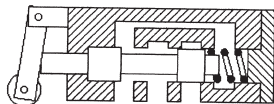


Basic structure – showing raising and lowering water platform.

**Figure 12**

**In both of these views one side has been removed to allow you to see inside.**

- (a) **Figure 13** shows a cross sectional view of a valve that could be used to sense that the water level platform has reached the bottom of its travel and change the internal air connection. Name this valve and the method of operation.



**Figure 13**

.....

.....

.....

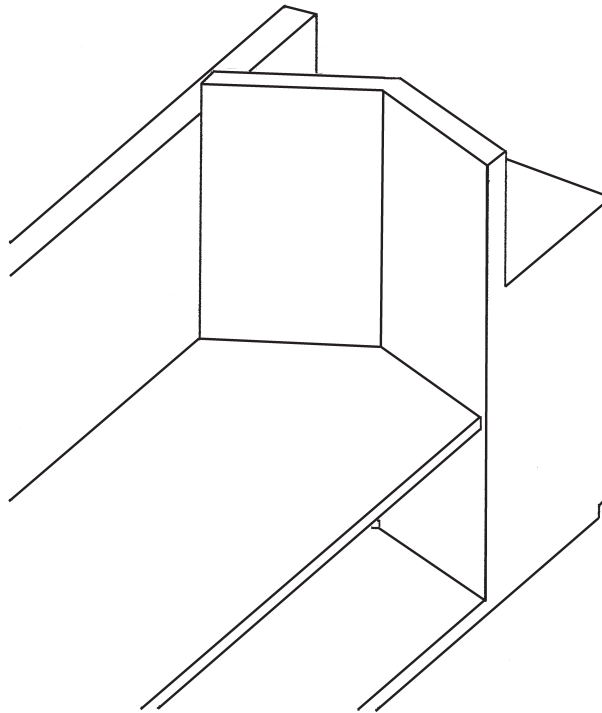
.....

(3 marks)

- (b) Draw the circuit symbol of the valve shown in **Figure 13**.

(3 marks)

- (c) Using the diagram in **Figure 14** and any additional diagrams necessary show how you would locate the device you named in part (b) to ensure that the “water level” stops at the correct lower level when the model is operating.



**Figure 14**

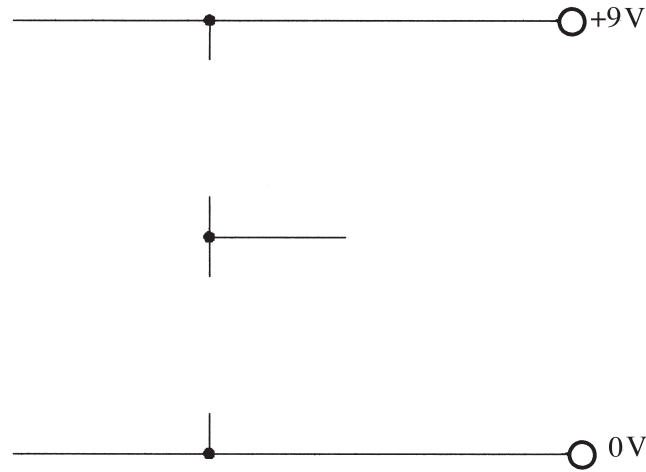
(5 marks)

**QUESTION B5 CONTINUES ON THE NEXT PAGE**

**Turn over ►**

- (d) The maker of the model has decided to use an LDR (light dependent resistor) to detect the upper level. When the acrylic sheet platform reaches the correct height the LDR will be in darkness.

Complete the circuit diagram in **Figure 15** below to show the components required to detect the upper level.



**Figure 15**

(4 marks)

**B6** The student making the electronic control box for the lock gate model decided to develop the circuit using a computer software package. The software was also used to produce the PCB mask that would later be used in the printed circuit board etching process.

(a) Give **two** features of computer based programs to design an electronic circuit. For each of the features explain its advantage to the designer.

(i) Feature 1

.....  
.....

Advantage to the designer

.....  
.....

(2 marks)

(ii) Feature 2

.....  
.....

Advantage to the designer

.....  
.....

(2 marks)

**QUESTION B6 CONTINUES ON THE NEXT PAGE**

**Turn over ►**

- (b) Having produced a design for the circuit the student makes the circuit on copper clad board.

Describe, using notes and diagrams where appropriate, a process for producing a PCB on copper clad board.

.....

.....

.....

.....

.....

.....

*(6 marks)*

- (c) CAM can be used to produce circuit boards using a milling process.

Give **two** reasons why this may be a better way of producing printed circuit boards than etching.

- (i) Reason 1

.....

.....

*(1 mark)*

- (ii) Reason 2

.....

.....

*(1 mark)*

- (d) When assembling the circuit the student found that the school was short of some of the resistor values that were required. Rather than delay production it was decided to combine resistors to make the required resistance.

The only resistors available were 1K5, 1K8 and 2K2. There were plenty of each of these values so any combinations and quantities could be used.

- (i) Calculate how the student could have used the available resistors to produce a resistance of 3K3.

*Space for working*

.....  
 .....  
 .....

The resistors used are ..... and .....

*(3 marks)*

- (ii) This will require the resistors to be joined in .....

*(1 mark)*

- (iii) Calculate how the student could have used the available resistors to produce a resistance of 750R.

*Space for working*

.....  
 .....  
 .....

The resistors used are ..... and .....

*(3 marks)*

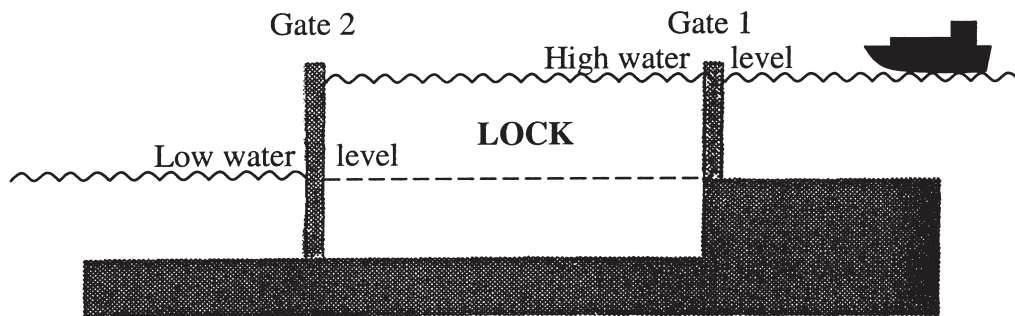
- (iv) This will require the resistors to be joined in .....

*(1 mark)*

20

**Turn over ►**

**B7** A lock gate system uses a PIC to control the opening and closing of the gates.



Part of the lock system works in the following way:

- A sensor detects the boat as it approaches Gate 1.
- Gate 1 opens and the boat enters the lock.
- A sensor detects the boat is in the lock and closes Gate 1.
- A sensor detects Gate 1 is closed and a valve opens to allow the water to flow out of the lock at the low water end.
- A sensor detects when the water level reaches the low water level and Gate 2 opens. The boat exits the lock.
- A sensor detects the boat is outside Gate 2 and Gate 2 closes.

On page 41, produce a flow chart that could be used to help write the PIC control program.

This question is worth 15 marks.

Marks will be awarded as follows:

Starting the lock operation	(2 marks)
Opening entrance gates	(3 marks)
Changing water level and exit sequence	(6 marks)
Presentation of flow chart	(4 marks)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over ►**

15

**B8** When batch producing electronic products it is necessary to use a quality control and quality assurance system. Quality control is concerned with inspecting the product throughout the entire manufacturing process from order to dispatch. Quality assurance is establishing working practices to ensure that the product is manufactured in a consistent and controlled way.

(a) Give **two** quality control checks that can be applied to components that have been soldered onto a circuit board.

(i) Quality control check 1

.....

What is being checked?

.....

*(2 marks)*

(ii) Quality control check 2

.....

What is being checked?

.....

*(2 marks)*

(b) When purchasing resistors for use as components in accurate electronic measuring equipment what quality assurance step could be taken to ensure a high degree of accuracy to purchase specification?

.....

.....

*(1 mark)*

(c) (i) Testing an electronic circuit over a long period of time is commonly used.

Why is this form of testing used?

.....

*(1 mark)*

(ii) Give **one** example of where it would be appropriate.

.....

*(1 mark)*

(d) A multimeter is often used to check circuits.

Name **two** checks that can be made using this device.

1 .....

2 .....

(2 marks)

(e) Many electronic devices use a modular construction using several small circuit boards.

Give **one** advantage of having several small boards rather than one large one.

.....

.....

(1 mark)

**END OF QUESTIONS**

10

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