Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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General Certificate of Secondary Education
June 2004

ASSESSMENT and QUALIFICATIONS ALLIANCE

DESIGN AND TECHNOLOGY
SYSTEMS AND CONTROL TECHNOLOGY
Foundation Tier

3546/F

F

Friday 28 May 2004 Afternoon Session

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

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	
A8	
TOTAL	
SECTION B PNEUMATICS FOCUS	
Number	Mark
B1	
B2	
B3	
B4	
B5	
B6	
B7	
B8	
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 = πr^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.

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

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 toy maker is making a mechanical model. She needs to use the rotation of a shaft to cause a rod to move up and down once for a complete rotation of the shaft.

Modify **Figure 1** and **Figure 2** to show how each of the given mechanisms could be used to do this.

Add any components or links you feel necessary to make your solution work.

(a) Raising the rod using a cam mechanism.

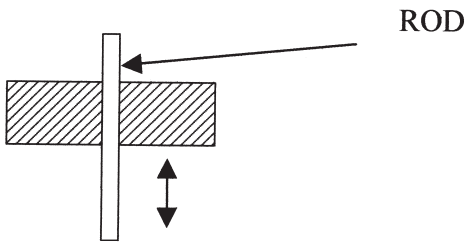
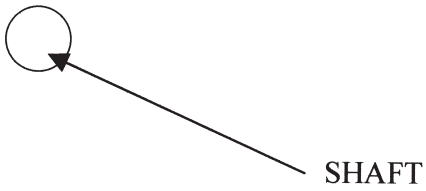


Figure 1



(4 marks)

(b) Raising the rod using a crank mechanism.

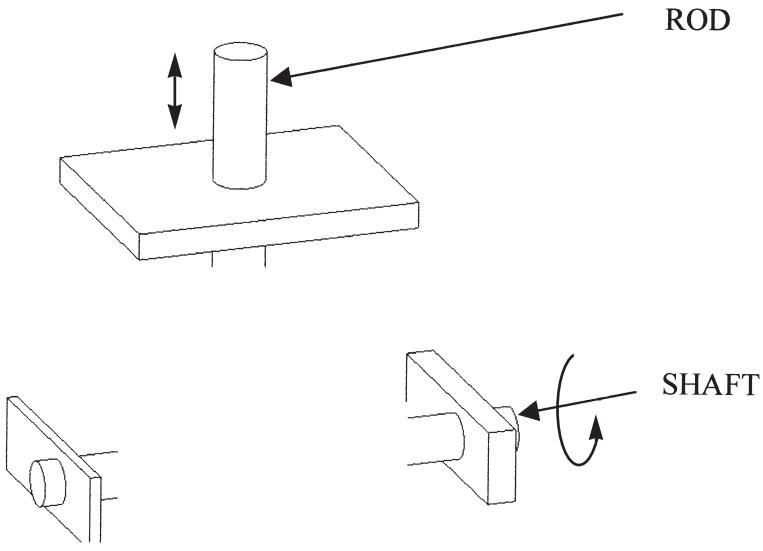


Figure 2

(4 marks)

(c) What is the name given for the up and down motion given to the rod in both cases?

.....

(2 marks)

(d) The model is used as part of a display that is started when someone stands near the table.

On each of **Figures 3 and 4** show **two** different methods of sensing the person to start the model.

Modify each diagram to show the sensing method and name the method used.

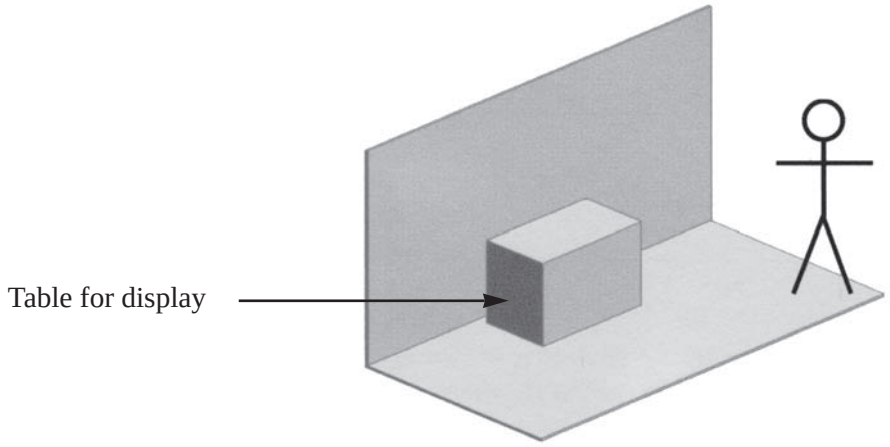


Figure 3

(2 marks)

(i) Method 1 – Sensing device used.

.....

(1 mark)

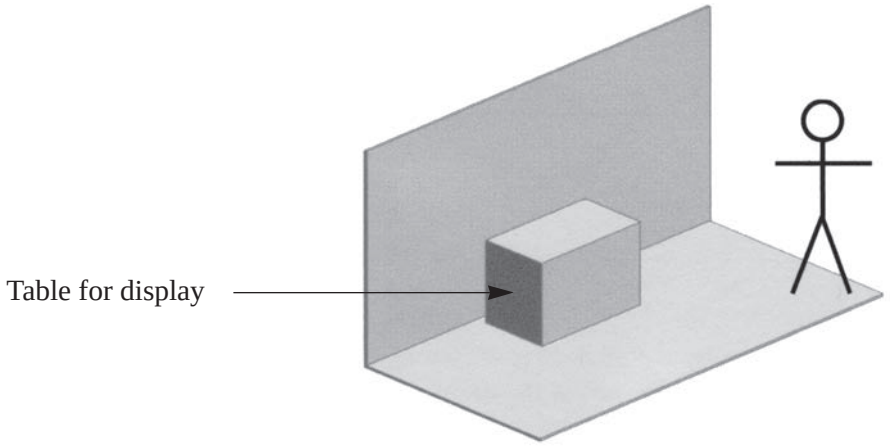


Figure 4

(2 marks)

(ii) Method 2 – Sensing device used.

.....

(1 mark)

16

A2 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 on. 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.

The circuit shown in **Figure 5** is the first astable circuit that was considered by the student.

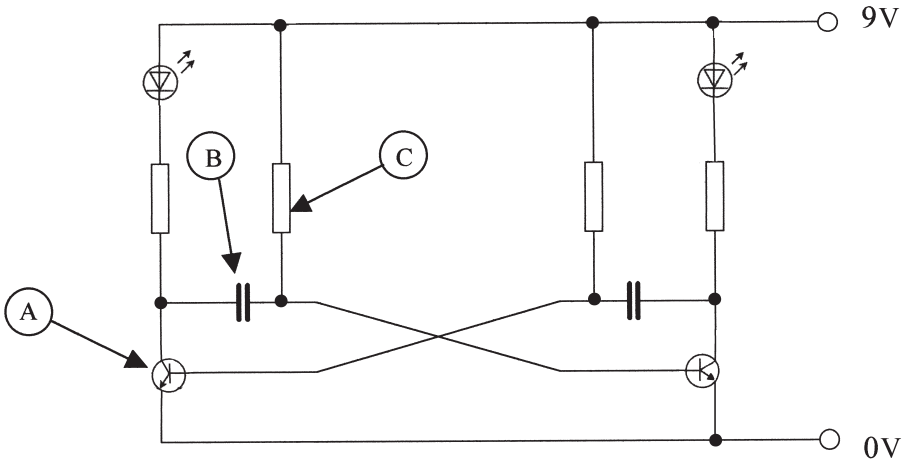


Figure 5

(a) Name 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 that 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 an integrated circuit. The circuit is shown in **Figure 6** and it uses a 555 timer integrated circuit together with two different coloured LEDs that flash alternately.

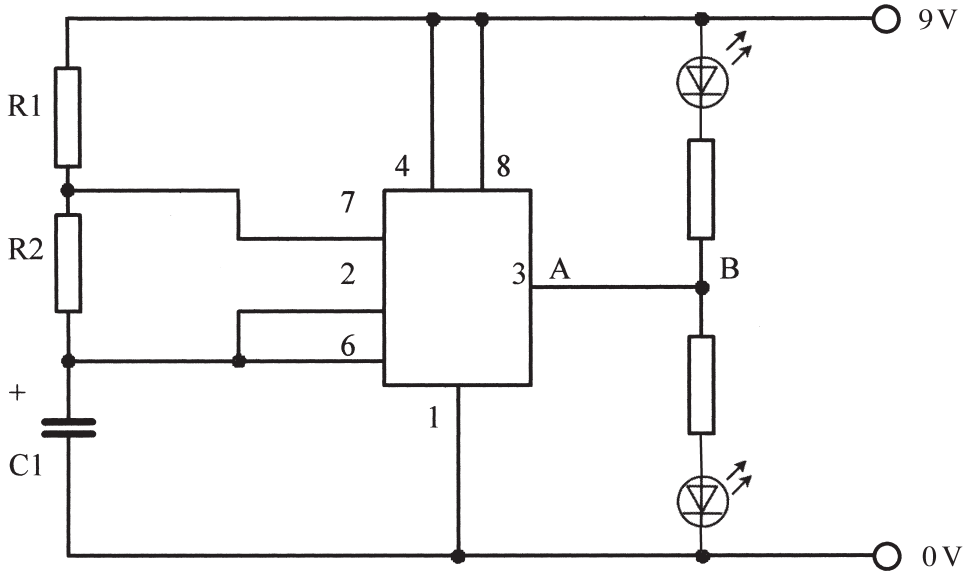


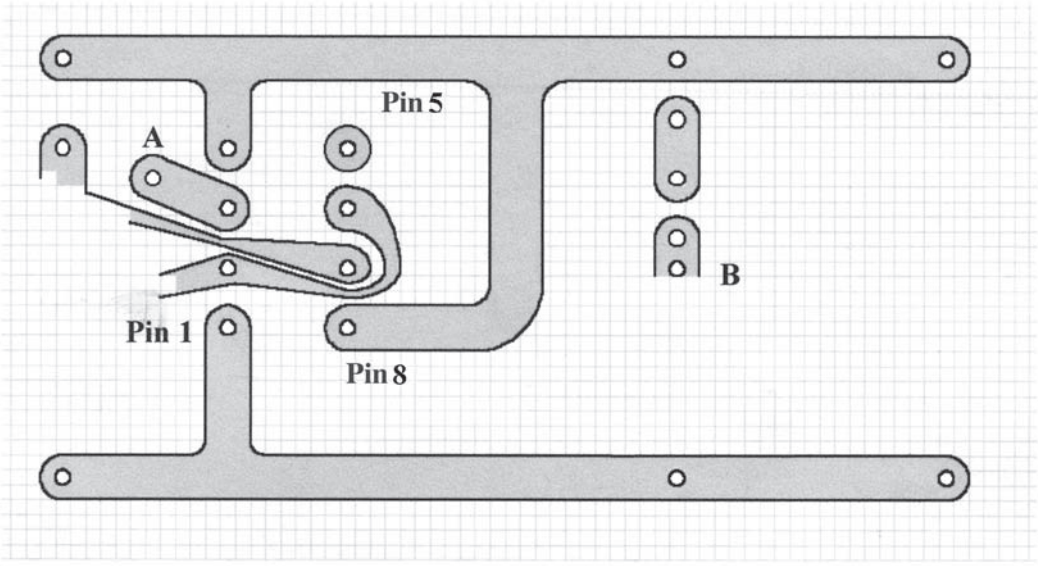
Figure 6

Complete the PCB layout in **Figure 7** using the circuit diagram given in **Figure 6**. Most of the layout mask has been drawn for you.

It is missing **two** resistors, **one** LED and **one** capacitor.

Ensure that tracks and pads are of a reasonable size. Show any drill holes.

PCB AS VIEWED FROM UNDERSIDE



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

Figure 7

(8 marks)

A3 *Prirton Garage Doors* require an animated shop display to demonstrate their product. Their doors slide horizontally on tracks which are fixed to the wall. In the model these tracks have been made by using an aluminium section as shown in **Figure 8**.

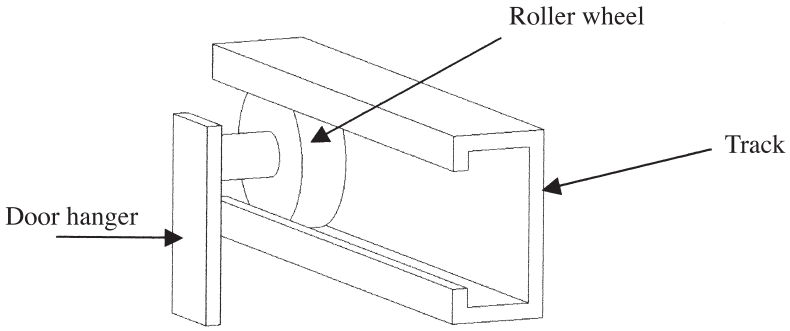


Figure 8

(a) Name **one** suitable material for the roller wheel.

.....

(1 mark)

(b) (i) Explain why this is a suitable material for the roller wheel.

.....

.....

(2 marks)

(ii) Name **one** method of making the track out of one piece of flat sheet material.

.....

(1 mark)

(c) Modify the drawing in **Figure 9** to show a method of stopping the roller wheel running off the end of the track.

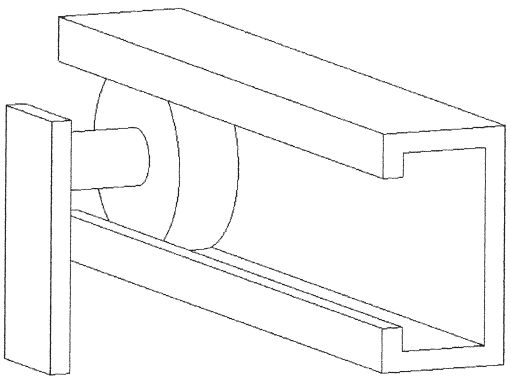


Figure 9

This question is worth 6 marks.

Marks will be awarded as follows:

Method;	*(2 marks)*
Notes;	*(2 marks)*
Quality of drawing.	*(2 marks)*

(6 marks)

(d) When the model is operating in the shop window the door has to slide open and closed. The designer needs to build a mechanism that is hidden below the model. **Figure 11** shows the key points of this mechanism when viewed from behind.

The rod shown moves from right to left.
The door is required to move from left to right.

Figure 10 shows this in three dimensions.

Add a mechanism to **Figure 11** that will produce the desired movement.

This question is worth 8 marks.

Marks will be awarded as follows:

Quality of drawing; *(2 marks)*
Practicality of idea. *(6 marks)*

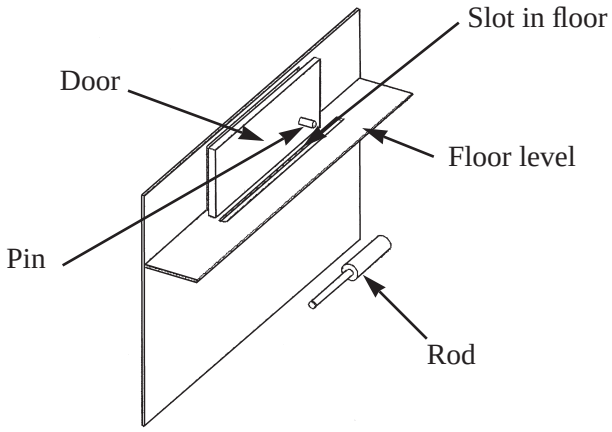
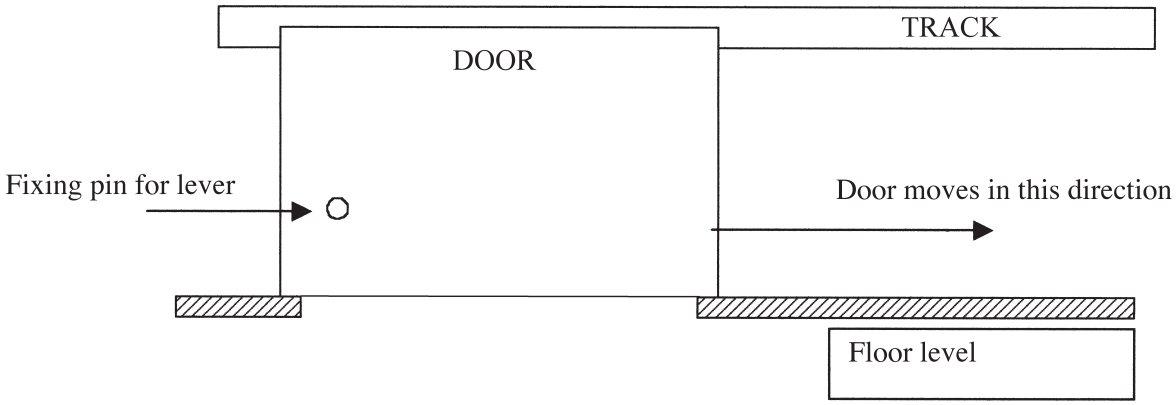


Figure 10



Rod moves from right to left and is drawn in extreme right hand position

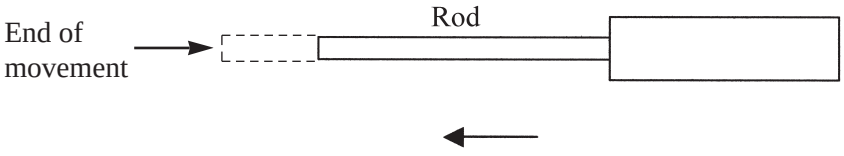


Figure 11

18

A4 *Prirton Garage Doors* wish to develop an electromechanical locking system for their 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 12** using the **three** correct terms from the list below:

- Feedback
- Keypad
- Logic check
- Solenoid

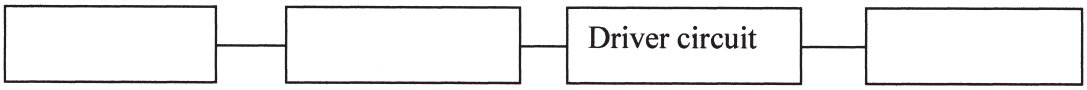


Figure 12

(3 marks)

(b) The section of the circuit diagram in **Figure 13** shows the solenoid and the relay.

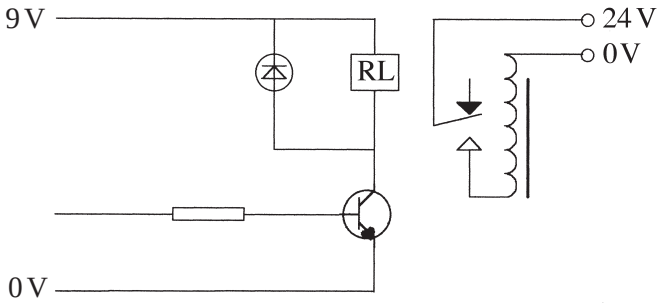


Figure 13

(i) Explain what a relay is used for.

.....

.....

.....

(2 marks)

(ii) Describe how a solenoid works.

.....

.....

.....

(2 marks)

(c) In the space below produce a design for a control panel and case for a door system. It must satisfy the following specification.

This question is worth 9 marks.

Marks will be awarded as follows:

Have a 10 digit number pad	*(1 mark)*
Have a screen to show the numbers entered	*(1 mark)*
Have a cancel button	*(1 mark)*
Have an on off button	*(1 mark)*
Quality of drawing	*(2 marks)*
Suitability of case with method of fixing panel to case	*(3 marks)*

QUESTION A4 CONTINUES ON THE NEXT PAGE

(d) Draw the inside of your case to show a method of fixing the type of battery shown in **Figure 14**.

This question is worth 6 marks.

Marks will be awarded as follows:

Appropriate method; *(3 marks)*
Quality of drawing. *(3 marks)*

Battery dimensions:
Length 50 mm
Width 28 mm
Thickness 18 mm

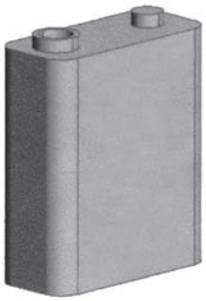


Figure 14

22

TURN OVER FOR THE NEXT QUESTION

A5 The company *Liftemhigh* produce a range of pulley systems for use in the motor trade. They are mainly used for lifting engines out of engine compartments.

Figure 15 shows a diagram of a pulley system.

Using a similar format design a pulley system that will lift an engine weighing 150 Newtons when a force of greater than 25 Newtons is applied to it.

(a) In the space alongside **Figure 15** draw the pulley system which will satisfy the requirements.

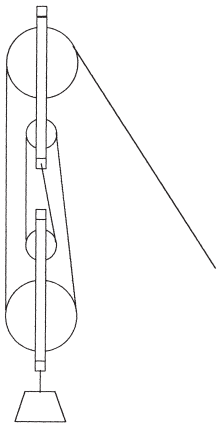


Figure 15

(7 marks)

(b) (i) *Liftemhigh* also produce a range of mechanical lifting devices that use gears to give the mechanical advantage.

In **Figure 16** add a second gear that will give a gear ratio of 4:1.

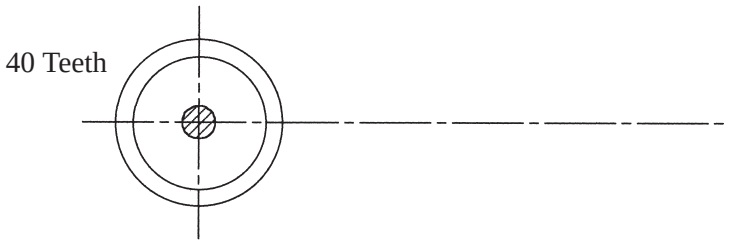


Figure 16

(3 marks)

(ii) Label the driver and driven gears in **Figure 16**.

(2 marks)

(iii) Calculate the number of teeth on the gear you have drawn to ensure it gives the correct gear ratio.

Formula .....

Calculation .....

.....

.....

Answer .....

(3 marks)

15

TURN OVER FOR THE NEXT QUESTION

A6 A local primary school has approached you to make a working model of a canal wharf cargo unloading gantry.

Figure 17 shows the basic system they wish to be designed.

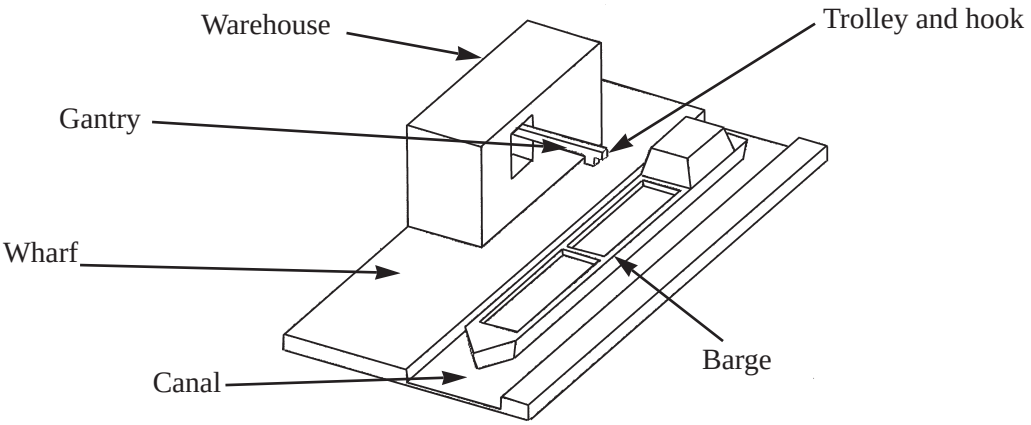


Figure 17

(a) The gantry protrudes over the barge and the trolley carrying the hook moves in and out of the warehouse. When the hook is over the barge a winch can lower the hook to lift items.

Place the following into the correct order in **Table 1**. A is the first operation.

- Move trolley to **IN** position
- Move trolley to **OUT** position
- Raise load
- Lower hook

A
B
C
D

Table 1

(4 marks)

(b) You need to make the model automated.

- The barge moves along until it reaches the docking position.
- An LDR (light dependent resistor) is covered
- The model starts working

Complete the circuit in **Figure 18** using an LDR and variable resistor to switch on the circuit when the LDR is covered.

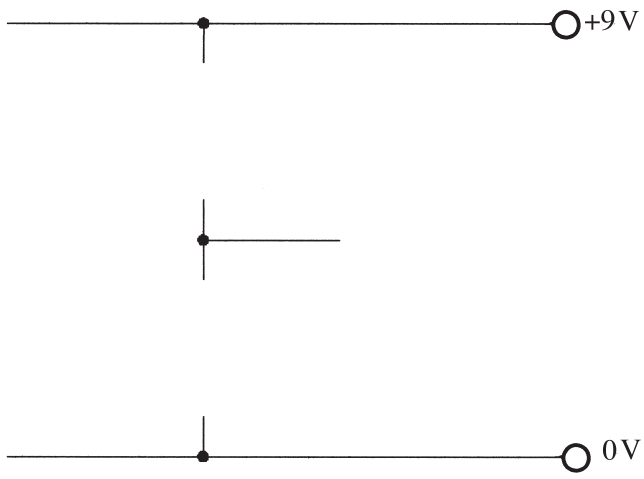


Figure 18

(4 marks)

(c) Explain why the variable resistor is used in this circuit.

.....

.....

.....

(2 marks)

QUESTION A6 CONTINUES ON THE NEXT PAGE

(d) (i) To work out the rest of the circuit you need to combine resistors to produce the values that are required. **Figures 19 and 20** show the combinations that were made.

For each of them calculate the resulting resistance.

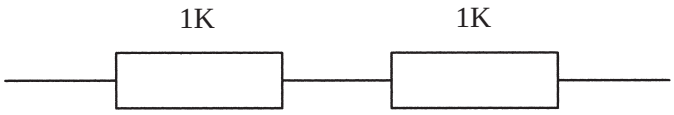


Figure 19

Formula .....

Calculation .....

.....

Answer .....

(3 marks)

(ii)

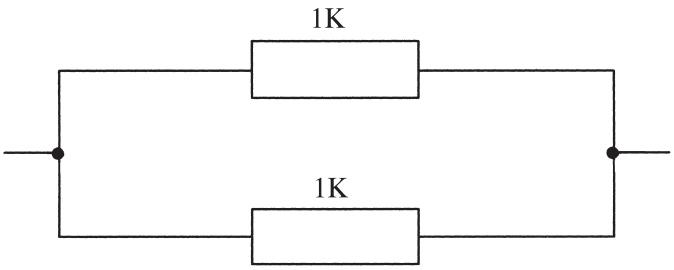


Figure 20

Formula .....

Calculation .....

.....

.....

Answer .....

(3 marks)

16

TURN OVER FOR THE NEXT QUESTION

A7 You have decided to develop the circuit for the electronic control box for the barge unloading model using a computer software package.

The software is also to be used to produce the PCB (printed circuit board) mask that would later be used in the etching process.

(a) Give **two** advantages of using a computer based program to design an electronic circuit.

(i) .....

(ii) .....

(2 marks)

(b) Give **one** disadvantage of using a computer based program to design an electronic circuit.

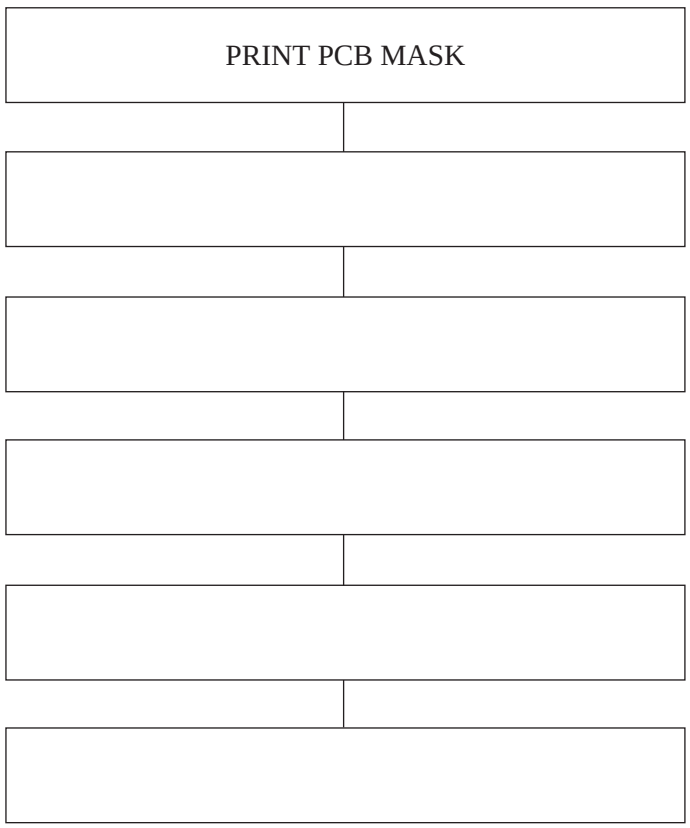
.....

(1 mark)

(c) You have etched a PCB.

Place the statements listed into the diagram in the correct order. The first stage has been given for you.

- Drill holes
- Expose to ultra violet light
- Place circuit board and mask into light box
- Place in etch tank
- Remove and clean



(5 marks)

LEAVE MARGIN BLANK

(d) Give **two** safety precautions when using an etching tank.

(i) .....

(ii) .....

(2 marks)

10

TURN OVER FOR THE NEXT QUESTION

A8 When batch producing electronic products it is necessary to use a quality control system. Quality control is concerned with inspecting the product throughout the entire manufacturing process from order to dispatch.

(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?

.....

Action to be taken if it fails the control check.

.....

(3 marks)

(ii) Quality control check 2.

.....

What is being checked?

.....

Action to be taken if it fails the control check.

.....

(3 marks)

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

Name **one** measurement that can be checked using this device.

.....

.....

(1 mark)

(c) Many electronic devices use a combination of small circuit boards.

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

.....

.....

(1 mark)

(d) Products sometimes fail quality control checks. After a failure a product can be *scrapped*, *reworked* or *recycled*.

In the spaces below place the most appropriate missing term.

scrapped	**reworked**	**recycled**

(i) Badly soldered components can be .....
(1 mark)

(ii) The components on a damaged circuit board should be .....
(1 mark)

(iii) A transistor that has been damaged by heat can be .....
(1 mark)

(iv) An over-etched PCB should be .....
(1 mark)

12

END OF SECTION A

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 – Pneumatics Focus** (pp. 4–23).

B1 A toy maker is making an automated model. She needs to use a single acting cylinder with a spring return to cause a rod to move up and down.

Complete **Figure 1** to show the cylinder positioned to give the required motion. Add any components or links you feel necessary to make your solution work.

(a) Raising the rod using a single acting cylinder.

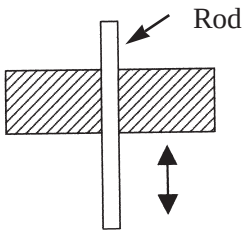


Figure 1

(4 marks)

(b) The cylinder drawn in **Figure 1** is part A of the partially drawn circuit shown below in **Figure 2**. It is to be operated by either push button operated valve.

Add a suitable valve in the space indicated as Part B to allow this to happen.

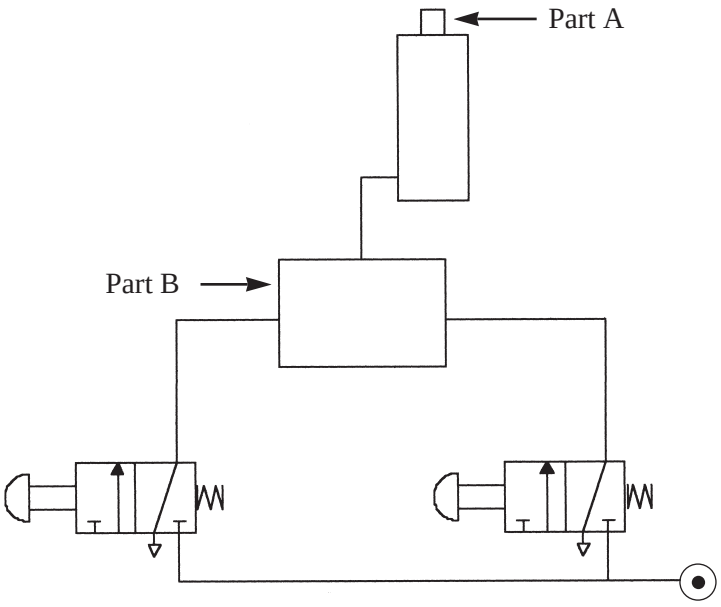


Figure 2

(4 marks)

(c) Name the up and down motion given to the piston.

.....

(2 marks)

(d) The pneumatic system is used as part of a display that is started when someone stands near to the table.

On each of **Figures 3 and 4** show **two** different methods of sensing the person to start the system.

Modify each diagram to show the sensing method and state the method used.

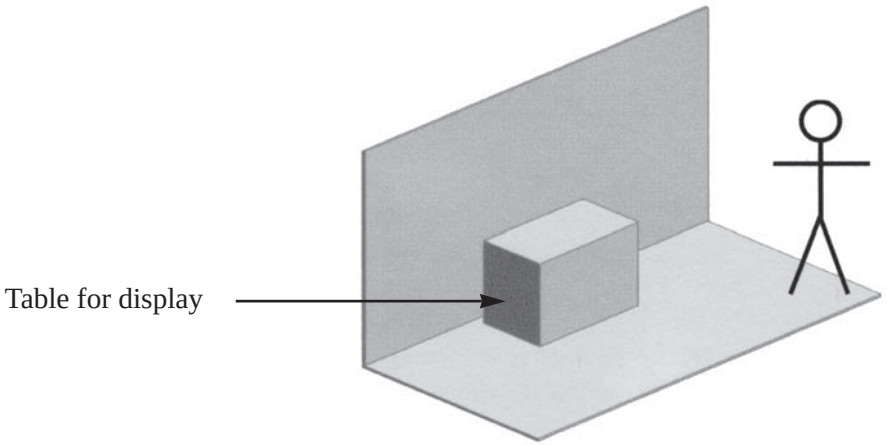


Figure 3

(2 marks)

(i) Method 1 – Sensing device used

.....

(1 mark)

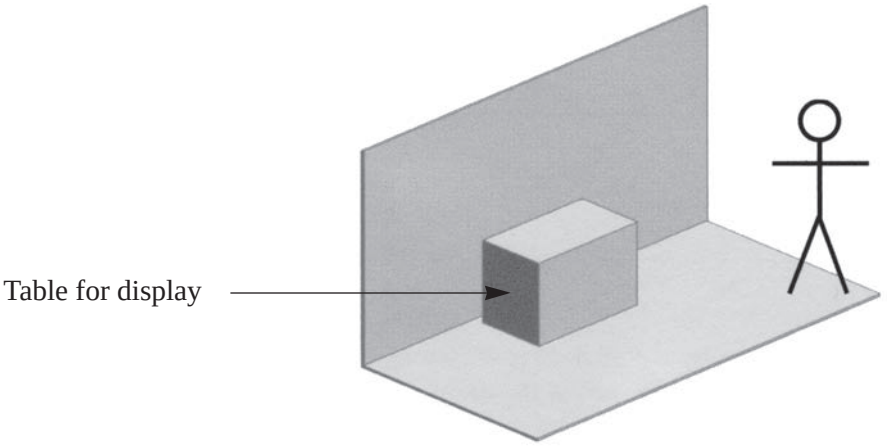


Figure 4

(2 marks)

(ii) Method 2 – Sensing device used.

.....

(1 mark)

B2 A school student has decided to design a dummy car burglar alarm. It will use two LEDs (light emitting diode) that flash alternately to suggest an alarm is on. 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 5 is the first astable circuit that was considered by the student.

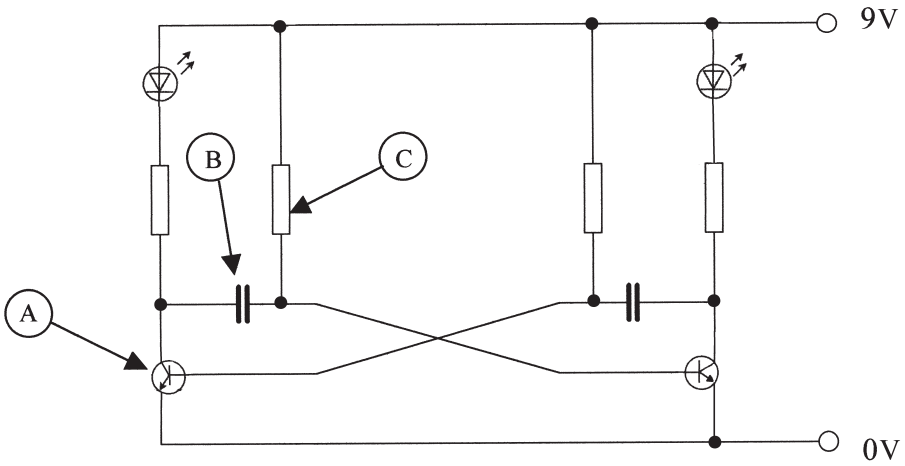


Figure 5

(a) Name 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 that 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 an integrated circuit. The circuit is shown in **Figure 6** and it uses a 555 timer integrated circuit together with two different coloured LEDs that flash alternately.

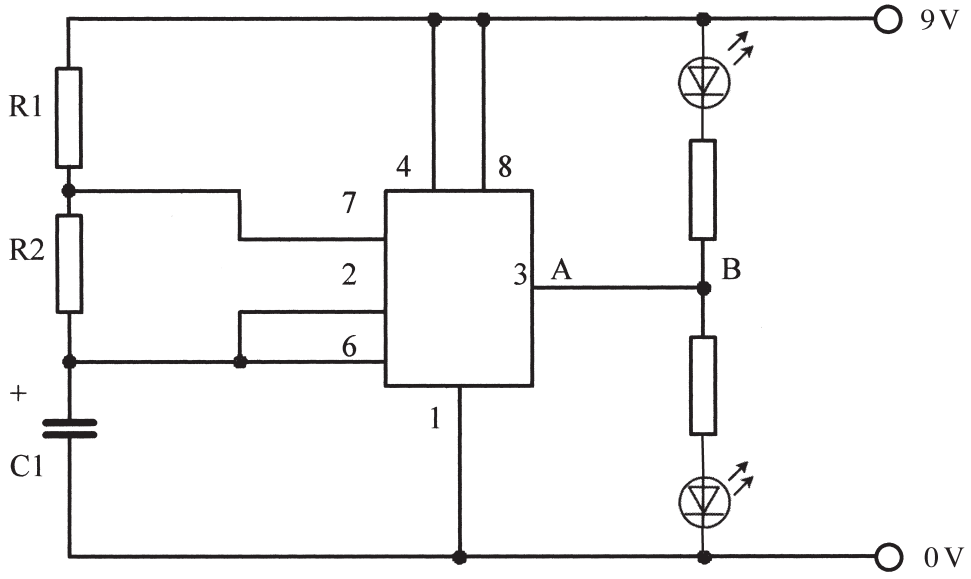


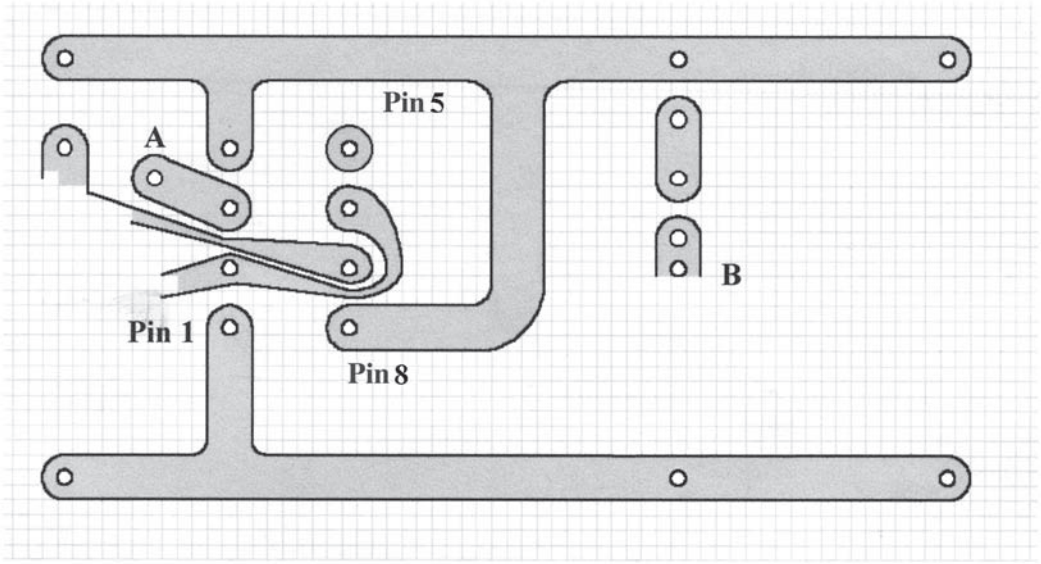
Figure 6

Complete the PCB (printed circuit board) layout below using the circuit diagram given in **Figure 6**. Most of the layout has been drawn for you.

It is missing **two** resistors, **one** LED and **one** capacitor.

Ensure that tracks and pads are of a reasonable size. Show any drill holes.

PCB AS VIEWED FROM UNDERSIDE



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

Figure 7

(8 marks)

16

Turn over ►

B3 *Prirton Garage Doors* require an animated shop display to demonstrate their product. Their doors slide horizontally on tracks which are fixed to the wall. In the model these tracks have been made by using an aluminium section as shown in **Figure 8**.

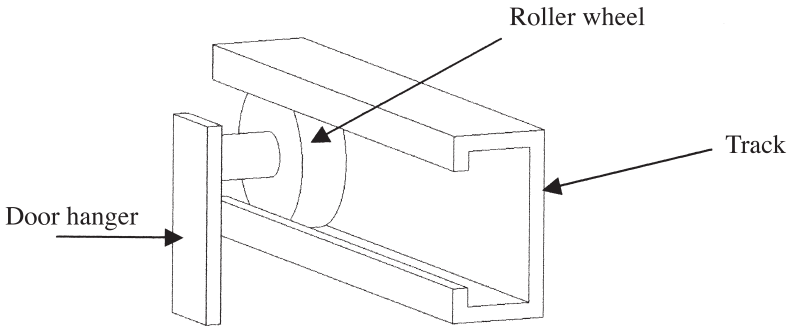


Figure 8

(a) Name **one** suitable material for the roller wheel.

.....

(1 mark)

(b) (i) Explain why this is a suitable material for a roller wheel.

.....

.....

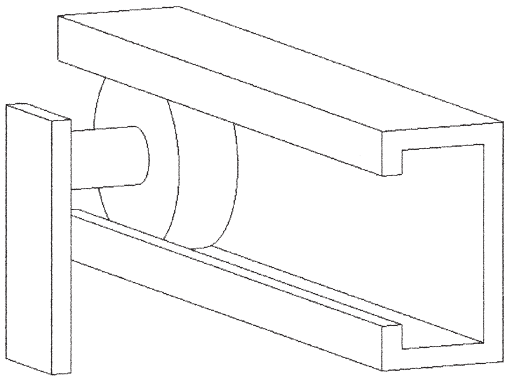
(2 marks)

(ii) Name one method of making the track out of one piece of flat sheet material.

.....

(1 mark)

(c) Modify the drawing in **Figure 9** to show a method of stopping the roller wheel running off the end of the track.



This question is worth 6 marks.

Marks will be awarded as follows:

Method	*(2 marks)*
Notes	*(2 marks)*
Quality of drawing	*(2 marks)*

Figure 9

(6 marks)

(d) When the model is operating in the shop window the door has to slide open and closed. The designer needs to build a mechanism that is hidden below the model. **Figure 11** shows the key points of this mechanism when viewed from behind.

The piston rod shown moves from right to left. The door is required to move from left to right.

The small diagram, **Figure 10** shows this in three dimensions.

Add a mechanism to **Figure 11** that will produce the desired movement.

This question is worth 8 marks.

Marks will be awarded as follows:

Quality of drawing *(2 marks)*
Practicality of idea *(6 marks)*

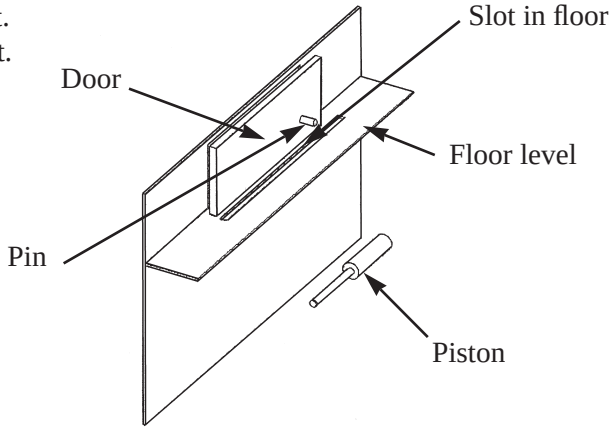


Figure 10

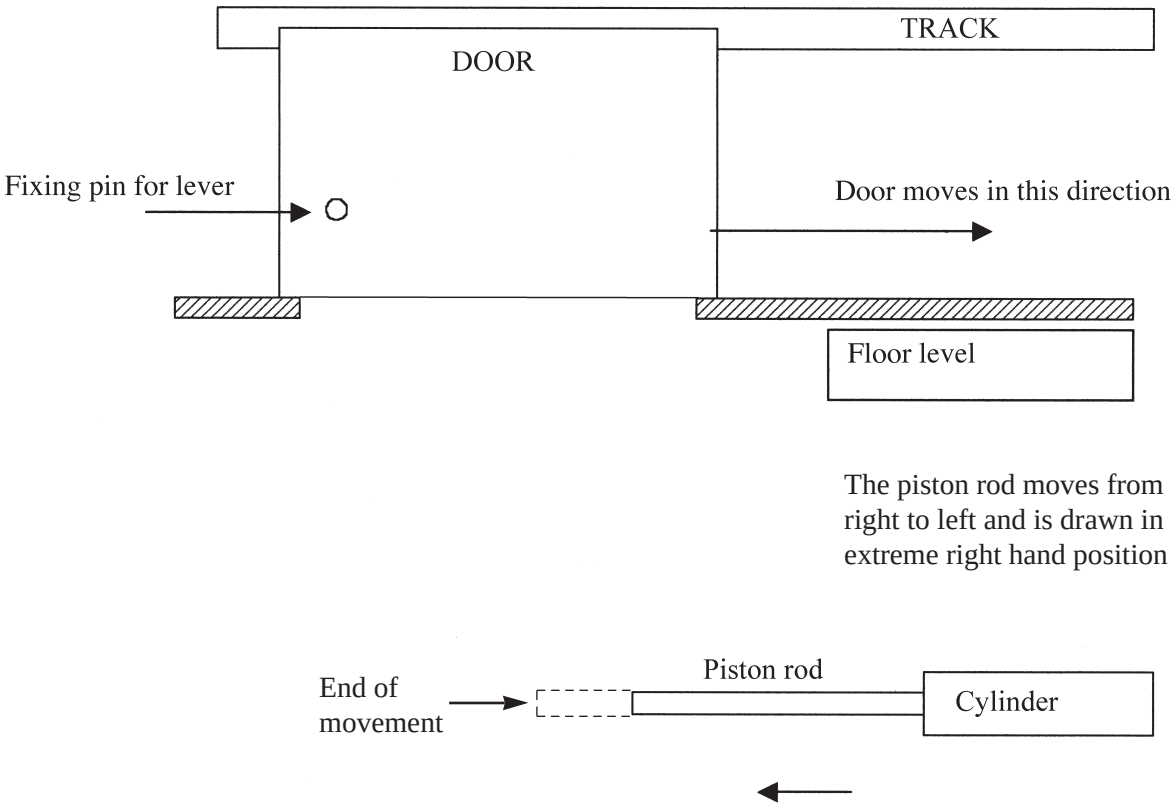


Figure 11

B4 *Prirton Garage Doors* wish to develop an electromechanical locking system for their 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 12** using the **three** correct terms from the list below

- Feedback
- Keypad
- Logic check
- Solenoid

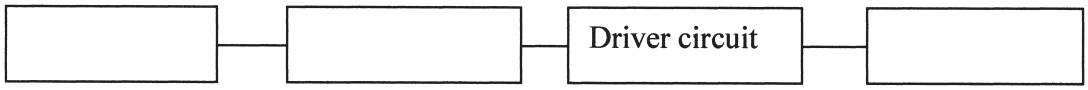


Figure 12

(3 marks)

(b) The circuit diagram in **Figure 13** shows the solenoid and the relay.

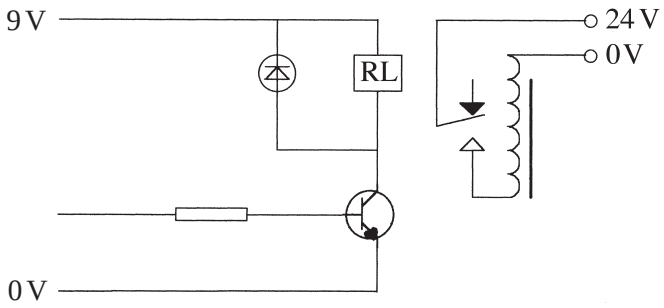


Figure 13

(i) Explain what a relay is used for.

.....

.....

.....

(2 marks)

(ii) Describe how a solenoid works.

.....

.....

.....

(2 marks)

(c) In the space below produce a design for a control panel and case for a door system. It must satisfy the following specification.

This question is worth 9 marks.

Marks will be awarded as follows:

Have a 10 digit number pad	*(1 mark)*
Have a screen to show the numbers entered	*(1 mark)*
Have a cancel button	*(1 mark)*
Have an on off button	*(1 mark)*
Quality of drawing	*(2 marks)*
Suitability of case with method of fixing panel to case	*(3 marks)*

QUESTION A4 CONTINUES ON THE NEXT PAGE

(d) Draw the inside of your case to show a method of fixing the type of battery shown in **Figure 14**.

This question is worth 6 marks.

Marks will be awarded as follows:

Appropriate method	*(3 marks)*
Quality of drawing	*(3 marks)*

Battery dimensions:

Length	50 mm
Width	28 mm
Thickness	18 mm

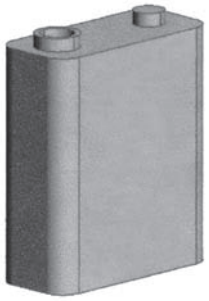


Figure 14

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TURN OVER FOR THE NEXT QUESTION

B5 The company *Adatyres* use air-powered equipment in their tyre depot. When removing a tyre from the rim a machine called a "bead breaker" is used. This is shown in **Figure 15**. The cylinder is pressured causing the top clamp to move toward the bottom clamp – this in turn breaks the seal between the tyre and the rim.

(a) If the area of the piston is 100 mm^2 and the air pressure is delivered at 1.5 Nmm^2, calculate the force exerted on the tyre.

Formula .....

.....

.....

.....

.....

Answer .....

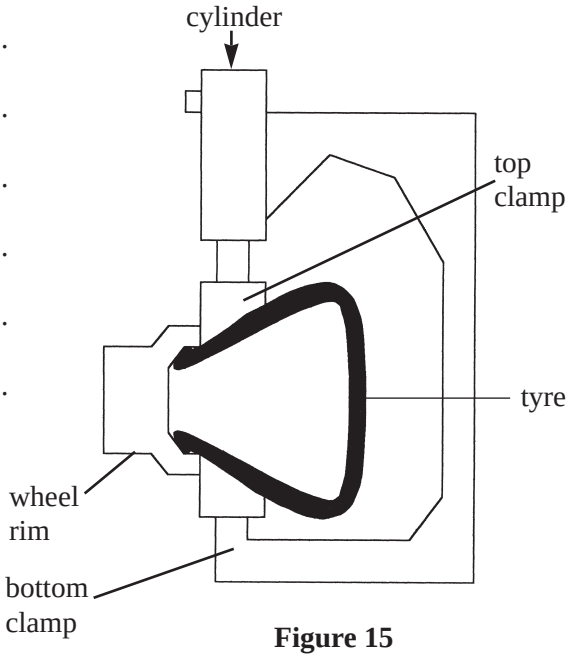


Figure 15

(4 marks)

(b) (i) The "bead breaker" is operated by a lever operated 3 port button valve which is in a normally closed position. The outline of the valve is shown below.

Complete the drawing of the circuit symbol.

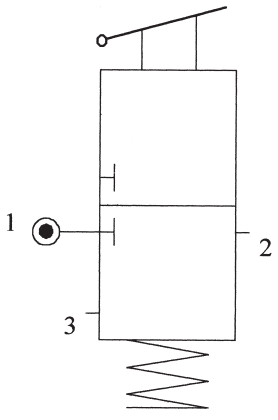


Figure 16

(4 marks)

(ii) Label the air inlet and the exhaust on **Figure 16**.

(2 marks)

(iii) The "bead breaker" in **Figure 15** uses high pressure air and has powered moving parts.

Give **two** safety precautions when using high pressure air lines.

Precaution 1

.....

.....

(1 mark)

Precaution 2

.....

.....

(1 mark)

(iv) An engineer is called to the company to replace a faulty valve in the "bead breaker". The valve is easily accessible so that no panels need to be removed to work on it.

Name **three** main stages in replacing a valve.

Stage 1

.....

.....

(1 mark)

Stage 2

.....

.....

(1 mark)

Stage 3

.....

.....

(1 mark)

15

B6 A local primary school has approached you to make a working model of a canal wharf cargo unloading gantry. **Figure 17** shows the basic system they wish to be designed.

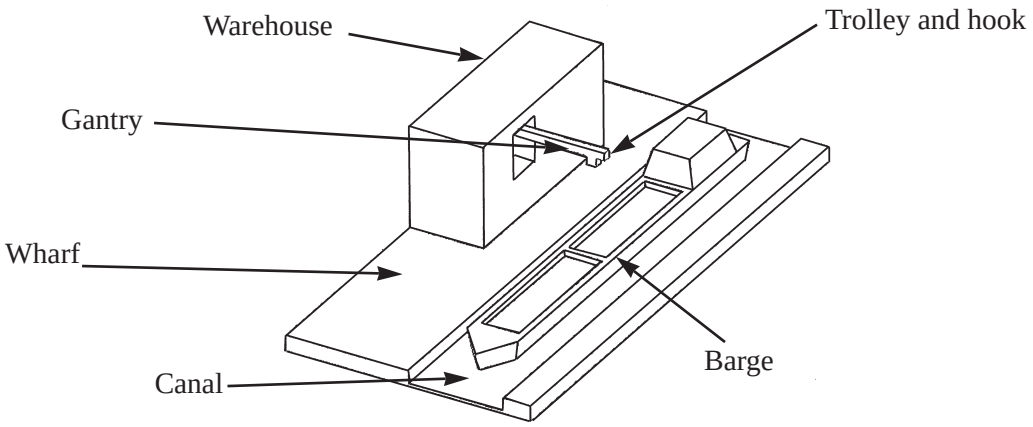


Figure 17

(a) The gantry protrudes over the barge and the trolley carrying the hook moves in and out of the warehouse. When the hook is over the barge a winch can lower the hook to lift items.

Place the following into the correct order in **Table 1**. A is the first operation.

- Move trolley to **IN** position
- Move trolley to **OUT** position
- Raise load
- Lower hook

A
B
C
D

Table 1

(4 marks)

(b) You need to make the model automated.

- The barge moves along until it reaches the docking position.
- An LDR (light dependent resistor) is covered
- The model starts working

Complete the circuit in **Figure 18** using an LDR and variable resistor to switch on the circuit when the LDR is covered.

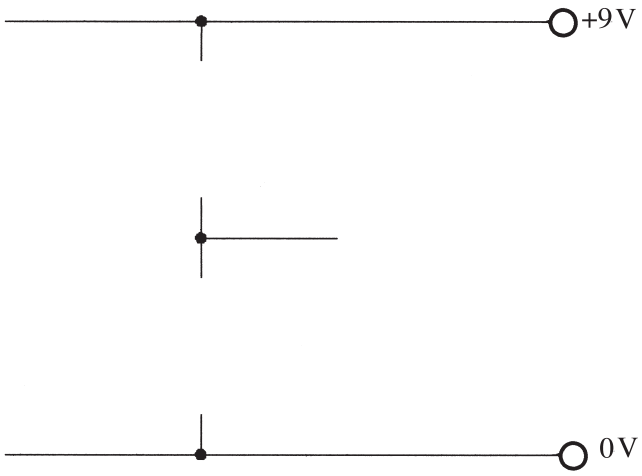


Figure 18

(4 marks)

(c) Explain why the variable resistor is used in this circuit.

.....

.....

.....

(2 marks)

QUESTION B6 CONTINUES ON THE NEXT PAGE

(d) (i) To work out the rest of the circuit you need to combine resistors to produce the values that are required. **Figure 19** shows the combinations that were made.

For each of them calculate the resulting resistance.

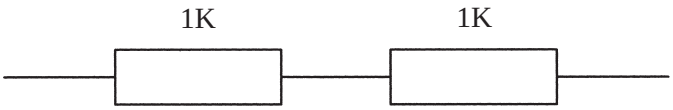


Figure 19

Formula .....

Calculation .....

.....

Answer .....

(3 marks)

(ii)

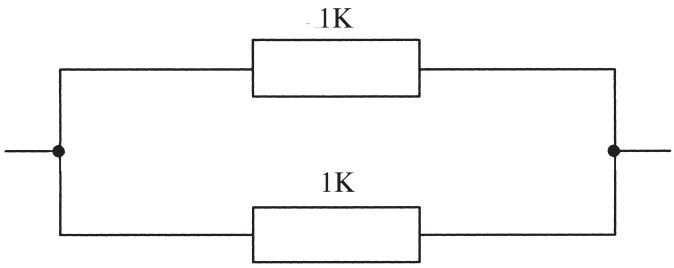


Figure 20

Formula .....

Calculation .....

.....

.....

Answer .....

(3 marks)

16

TURN OVER FOR THE NEXT QUESTION

B7 You have decided to develop the circuit for the electronic control box for the barge unloading model using a computer software package.

The software is also to be used to produce the PCB (printed circuit board) mask that would later be used in the etching process.

(a) Give **two** advantages of using a computer based program to design an electronic circuit.

(i) .....

(ii) .....

(2 marks)

(b) Give **one** disadvantage of using a computer based program to design an electronic circuit.

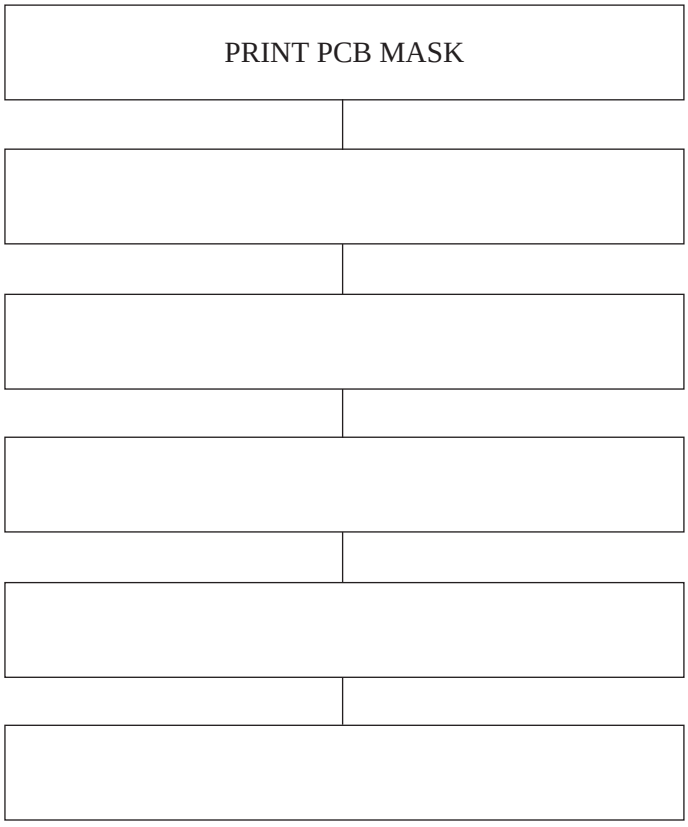
.....

(1 mark)

(c) You have etched a PCB.

Place the statements listed into the diagram in the correct order. The first stage has been given for you.

- Drill holes
- Expose to ultra violet light
- Place circuit board and mask into light box
- Place in etch tank
- Remove and clean



(5 marks)

LEAVE MARGIN BLANK

(d) Give **two** safety precautions when using an etching tank.

(i) .....

(ii) .....

(2 marks)

10

TURN OVER FOR THE NEXT QUESTION

B8 When batch producing electronic products it is necessary to use a quality control system. Quality control is concerned with inspecting the product throughout the entire manufacturing process from order to dispatch.

(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?

.....

Action to be taken if it fails the control check.

.....

(3 marks)

(ii) Quality control check 2.

.....

What is being checked?

.....

Action to be taken if it fails the control check.

.....

(3 marks)

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

Name **one** measurement that can be checked using this device.

.....

.....

(1 mark)

(c) Many electronic devices use a combination of small circuit boards.

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

.....

.....

(1 mark)

(d) Products sometimes fail quality control checks. After a failure a product can be *scrapped*, *reworked* or *recycled*.

In the spaces below place the most appropriate missing term.

scrapped	**reworked**	**recycled**

(i) Badly soldered components can be .....
(1 mark)

(ii) The components on a damaged circuit board should be .....
(1 mark)

(iii) A transistor that has been damaged by heat can be .....
(1 mark)

(iv) An over-etched PCB should be .....
(1 mark)

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END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE