

Surname						Other Names					
Centre Number						Candidate Number					
Candidate Signature											

For Examiner's Use
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General Certificate of Secondary Education  
June 2006

**DESIGN AND TECHNOLOGY  
(SYSTEMS AND CONTROL TECHNOLOGY)  
Written Paper  
Higher Tier**

3546/H

**H**



Wednesday 14 June 2006 1.30 pm to 3.30 pm

<p><b>For this paper you must have:</b></p> <ul style="list-style-type: none"> <li>a pen, pencil, ruler, eraser and pencil sharpener</li> </ul>
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Time allowed: 2 hours

**Instructions**

- Use blue or black ink or ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **either Section A** – Mechanisms Focus Technology **or Section B** – Pneumatics Focus Technology.
- Answer **all** questions in your chosen section.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

**Information**

- The maximum mark for this paper is 125.
- The marks for questions are shown in brackets.
- A list of formulae and other information, which you may wish to use in your answers, is provided on page 2.
- All dimensions are given in millimetres unless otherwise stated.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
SECTION A MECHANISMS FOCUS	
Question	Mark
A1	
A2	
A3	
A4	
A5	
A6	
A7	
A8	
A9	
<b>TOTAL</b>	
SECTION B PNEUMATICS FOCUS	
Question	Mark
B1	
B2	
B3	
B4	
B5	
B6	
B7	
B8	
B9	
<b>TOTAL</b>	
Examiner's Initials	

**You may use the following information when answering the questions.**

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

**EITHER**

**Turn over for Section A – Mechanisms Focus**

**OR**

**Turn to page 25 for Section B – Pneumatics Focus**

**Turn over ►**

**There are no questions printed on this page**

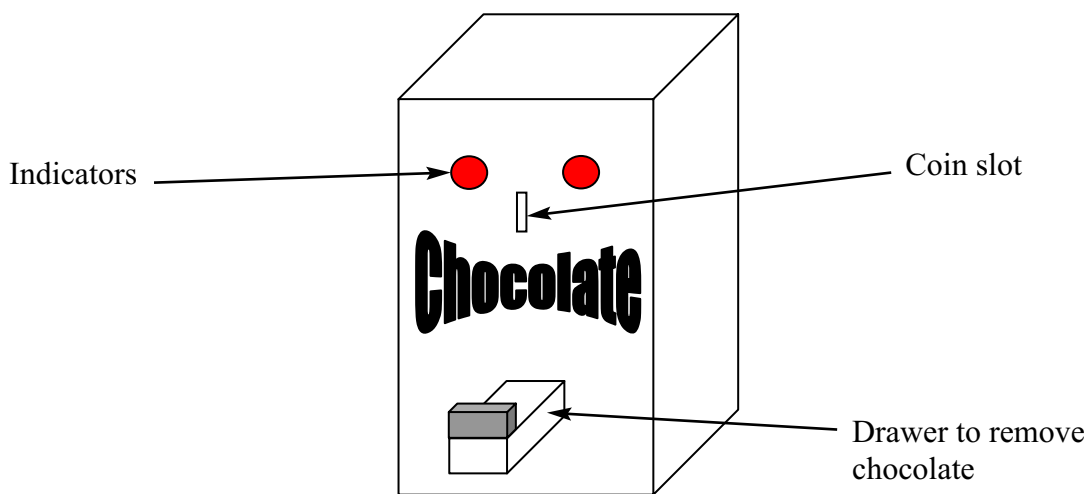
## SECTION A – MECHANISMS FOCUS

Answer **all** questions in this section.

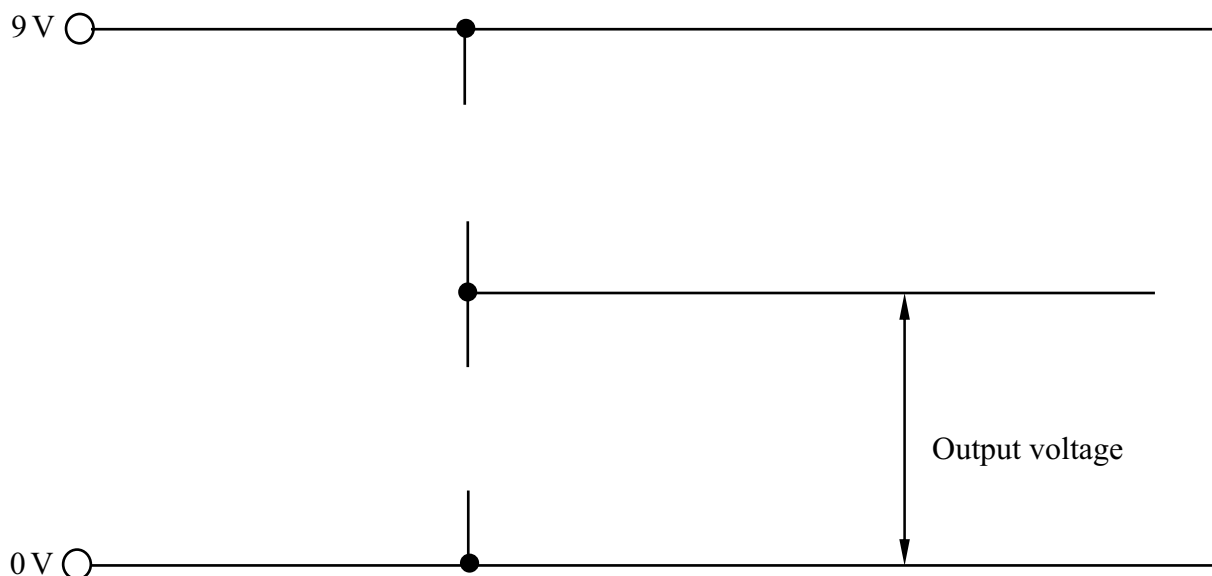
Do **not** answer these questions if you have answered the questions in **Section B – Pneumatics Focus** (pp. 25 – 44).

**A1** This question is about sensing.

The designer of a chocolate bar dispenser has chosen to use a light sensing circuit to indicate when it is low on chocolate bars and when it needs refilling.



(a) Complete the circuit diagram below by adding a Light Dependent Resistor (LDR) and a variable resistor to give an output voltage when light is sensed.



(3 marks)

Question A1 continues on the next page

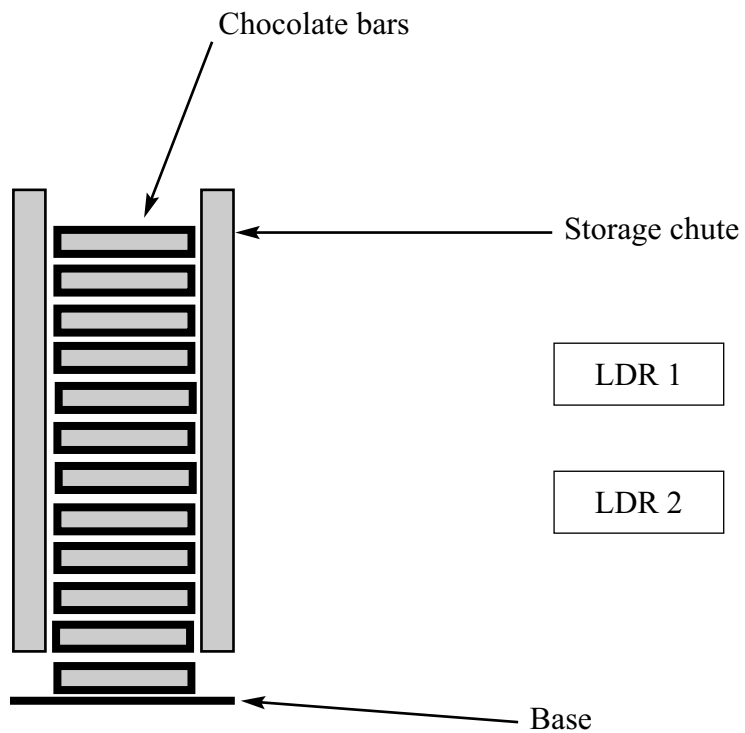
Turn over ►

- (b) The designer wants to use LDRs as sensors in **two** positions in the dispensing machine.

LDR 1 = LOW      This will sense when there are only four products left in the dispensing machine.

LDR 2 = EMPTY      This will sense when the container is completely empty.

Show with arrows where LDR 1 and LDR 2 would be positioned.



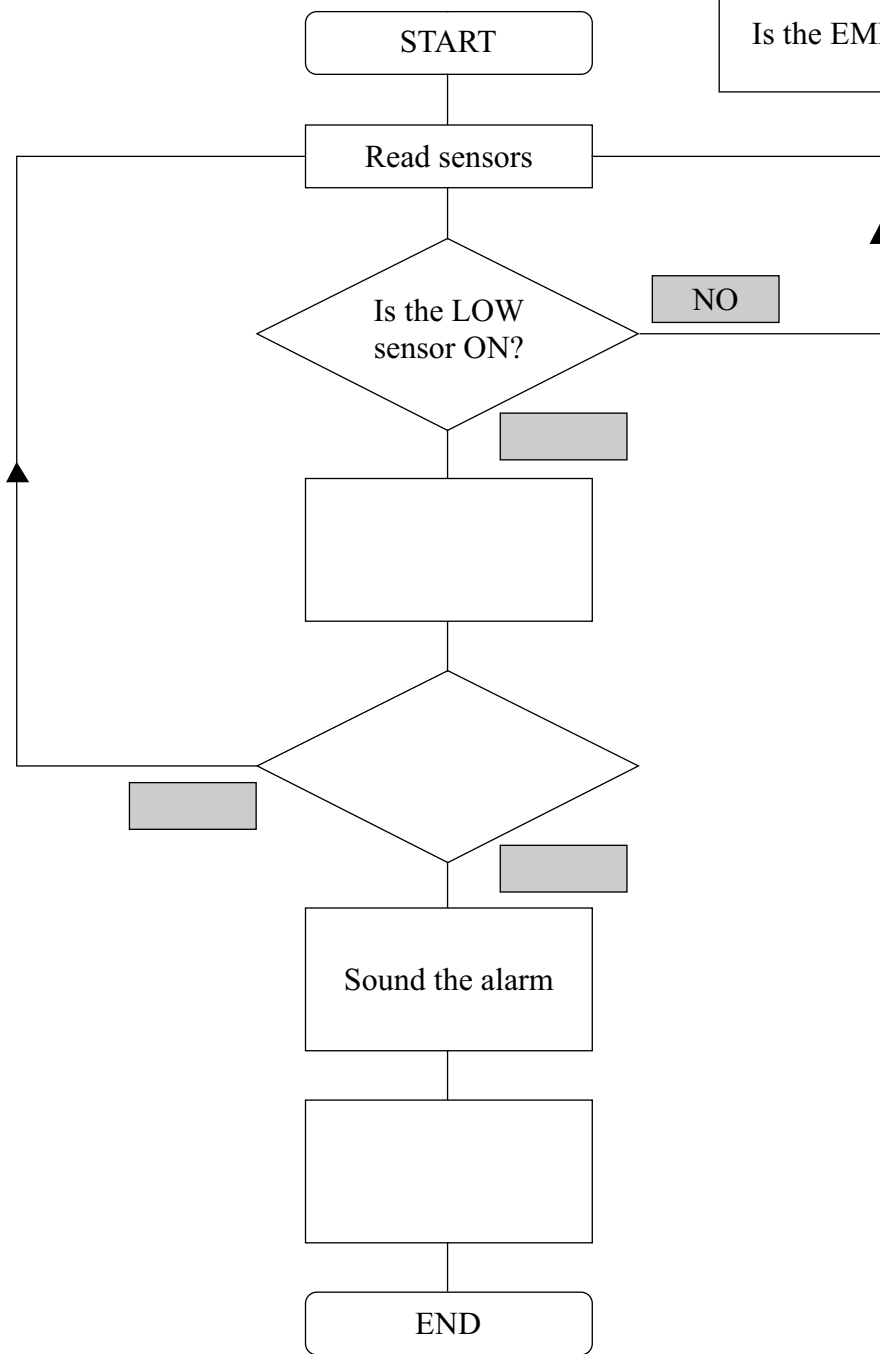
(2 marks)

(c) When the LOW sensor (LDR 1) is ON, a **WARNING** light comes on to show the shop staff that the dispensing machine needs refilling.

If the EMPTY sensor (LDR 2) is turned ON, an alarm sounds and the **EMPTY** light comes on.

- Complete the flow chart by filling in the missing stages using the statements given in the box below.
- Write YES or NO in the three shaded boxes.

Turn ON **EMPTY** light  
Turn ON **WARNING** light  
Is the EMPTY sensor ON?



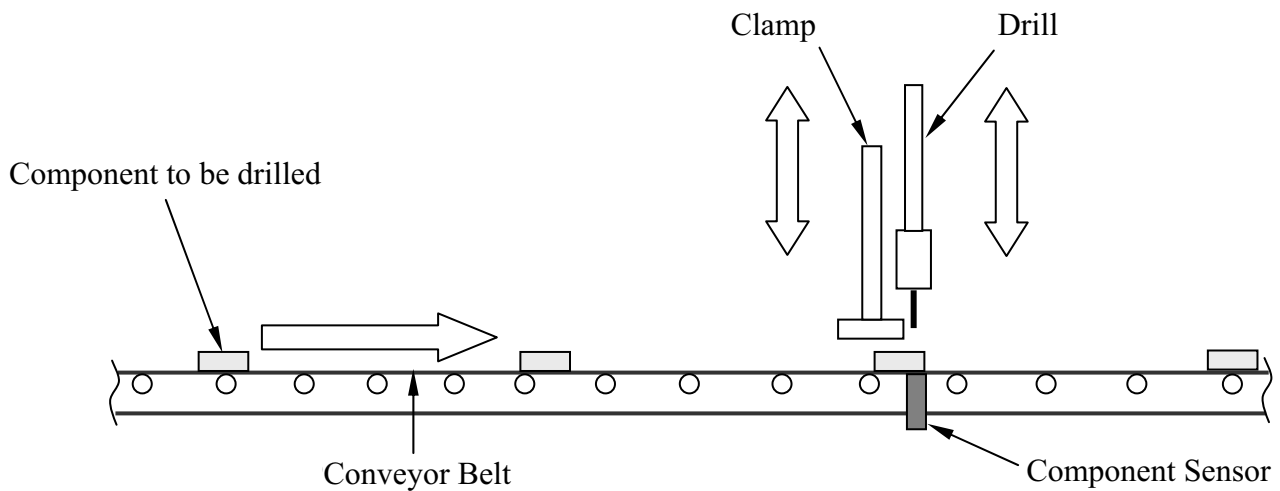
(6 marks)

Turn over ►

**A2** This question is about automated systems and production lines.

Components move along on a conveyor belt where they are sensed, clamped, drilled and released as shown below.

- The conveyor belt must be stopped during the drilling operation.
- The drill is continuously spinning.
- The whole process is controlled using a PIC (Peripheral Interface Controller) chip.



- (a) On the page opposite write a sequence of instructions that would act as the control program for this stage. The sequence of instructions to be used must be for continuous operation.

Operational instructions to be used:

Conveyor belt motor	ON
	OFF
Sensor detected component	YES
	NO
Clamp	UP
	DOWN
Drill	UP
	DOWN

Marks will be awarded for

Correct sequence

(6 marks)

Correct use of the sensor

(2 marks)

Use of continuous operation

(2 marks)



Answer part (a) on this page. You may answer using written instructions **or** as a flow chart.

The first instruction has been completed for you.

### Written Instructions

1. Conveyor belt motor ON

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

14.

15.

16.

17.

18.

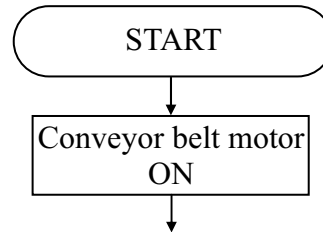
19.

20.

21.

22.

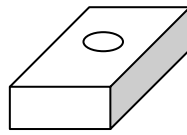
### Flow Chart



Question A2 continues on the next page

Turn over ►

(b) All of the components are the same rectangular size with a hole in the centre.



In the space below show a method of detecting whether the hole has been drilled in the component as part of the automated conveyor system.

Marks will be awarded for	Appropriate method of detection	(2 marks)
	Annotation/explanation	(2 marks)
	Quality of drawing	(2 marks)

(c) The designer of a production line chose to use a PIC with non-erasable memory. Explain why this is a better PIC to use than one with an erasable memory.

.....

.....

.....

(2 marks)

(d) State **two** advantages of using PIC chips in circuit design.

Advantage 1 .....

.....

Advantage 2 .....

.....

(2 marks)

**A3** This question is about timer circuits.

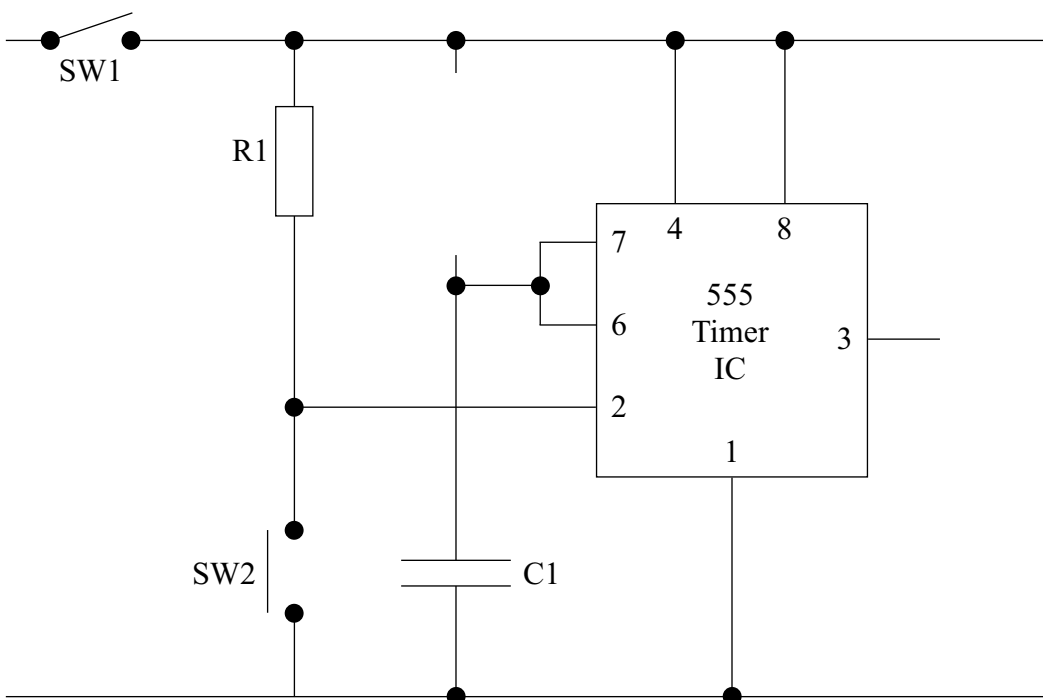
The circuit below shows a timer IC used as part of the production line control system to act as a timing circuit. The user presses the switch and the buzzer sounds for the timing period.

(a) Add the following circuit symbols to the circuit below.

(i) The 0 V and 9 V terminations (2 marks)

(ii) The variable resistor used to calibrate the timing (2 marks)

(iii) A buzzer that will sound during the timed period (2 marks)



**Question A3 continues on the next page**

**Turn over ►**

- (b) The sound was found to be inadequate therefore a higher voltage buzzer, controlled by a relay, was used.

To improve the circuit this component was added at gap A below.



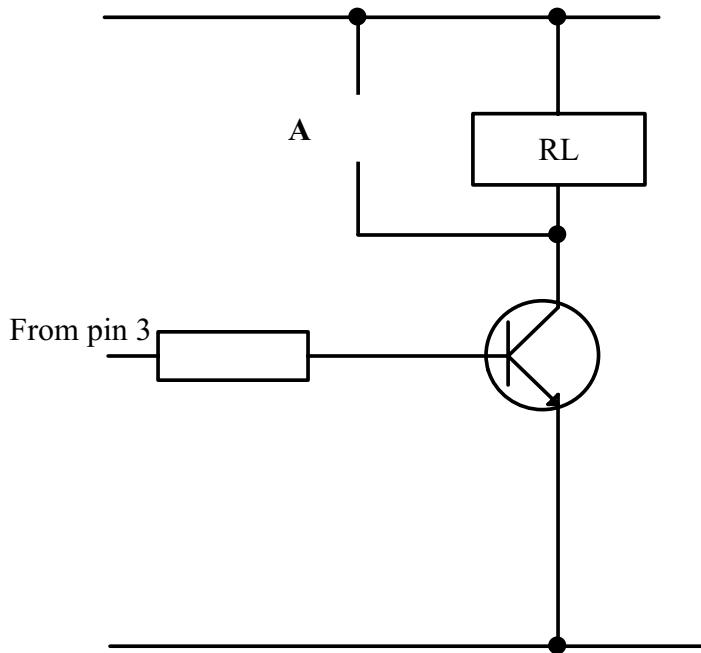
- (i) Name this component.

.....

(1 mark)

- (ii) Draw this component in gap A the right way round.

(1 mark)



- (iii) Explain why this component is required.

.....  
.....

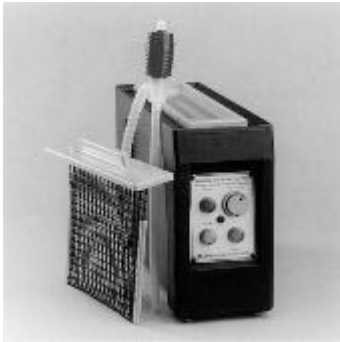
(2 marks)

**A4** This question is about using workshop equipment.

When making products in the workshop health and safety is very important.

(a) State **two** safety rules that should be followed for **each** of the following common items of workshop equipment.

Give **six different** rules.



**Etching Tank**

Rule 1 .....

.....

Rule 2 .....

.....

(2 marks)



**Pillar Drill**

Rule 1 .....

.....

Rule 2 .....

.....

(2 marks)



**Soldering Iron**

Rule 1 .....

.....

Rule 2 .....

.....

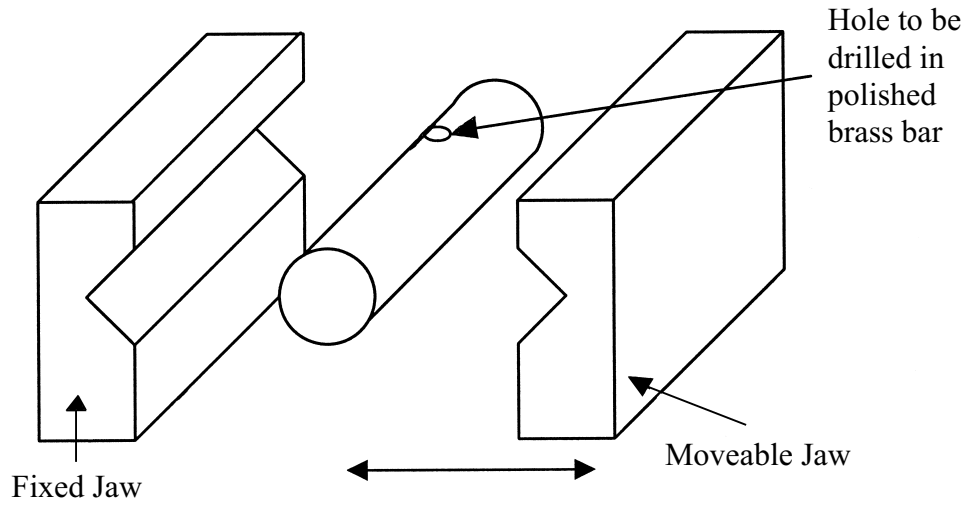
(2 marks)

**Question A4 continues on the next page**

**Turn over ►**

- (b) As part of a production process a hole is to be drilled in a polished brass bar using a drilling machine.

The bar is to be held by two jaws. The diagram below shows the bar and where the hole needs to be drilled.



- (i) In the space below design a mechanism that would be suitable for closing the moveable jaw.

Marks will be awarded as follows

Suitability of mechanism	(2 marks)
Appropriate for gripping	(2 marks)
Quality of drawing	(2 marks)

(ii) Give **two** reasons for your choice of mechanism.

.....  
.....

(2 marks)

(iii) Name a specific material for the jaws to be made of. ....

(1 mark)

(iv) Why is this material suitable?

.....  
(1 mark)

(c) To speed up the production line, an automatic clamping device was introduced.

As a safety measure the automatic clamping device has two inputs to control the system.

Input 1 A sensor which detects that a bar to be drilled is present.

Input 2 A microswitch which detects that a guard is in place.

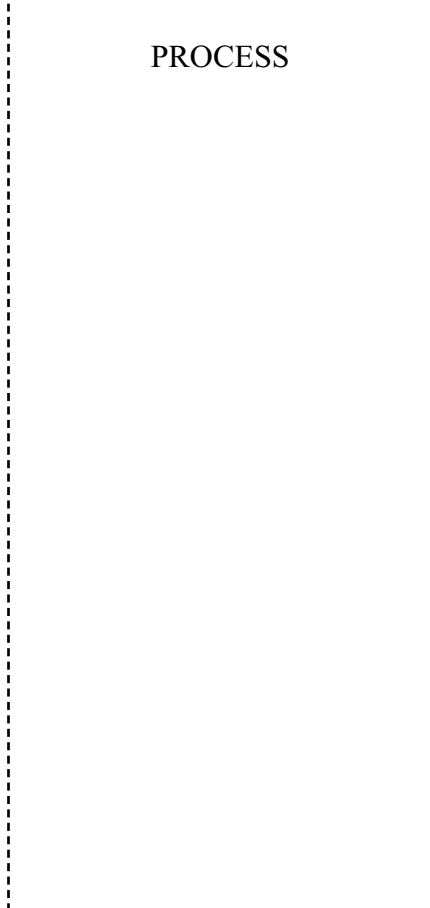
When both inputs are activated, the clamping mechanism operates.

Draw a system block diagram in the space below to represent this safety system.

INPUT

PROCESS

OUTPUT



(4 marks)

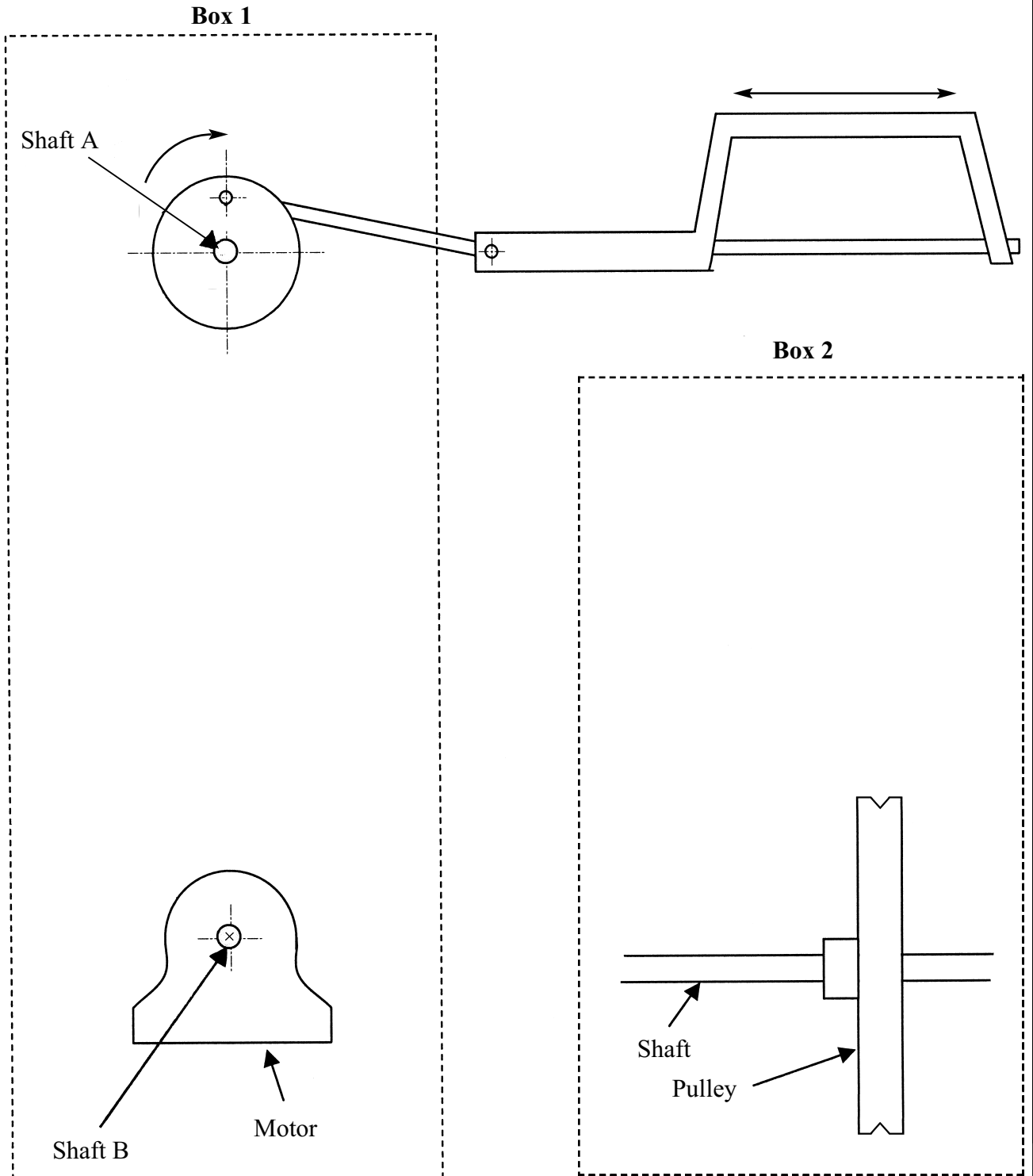
Turn over ►

**A5** This question is about pulley systems.

A powered hacksaw needs to move continuously backwards and forwards.  
In the diagram below, some of the details of the hacksaw have been omitted for clarity.

- (a) (i) In **Box 1**, add a pulley system that connects Shaft A and Shaft B and will enable the hacksaw operator to choose between two different speeds of operation. (4 marks)
- (ii) In **Box 2**, using notes and sketches, show how the pulley could be attached to the Shaft. (4 marks)

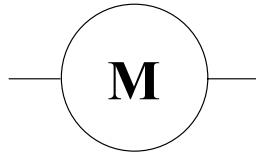
Marks will *also* be awarded for Quality of drawing (2 marks)  
Notes explaining system (2 marks)





(b) As a safety feature it has been decided that the operator needs to press two push-to-make (PTM) switches to operate the hacksaw.

- Complete the circuit below by adding a second PTM switch and show how they connect to the hacksaw motor (M).
- Show connections to a suitable power supply.



*(3 marks)*

(c) Why would the switches be placed at least 500 mm apart on the machine?

.....

.....

*(1 mark)*

**Turn over for the next question**

**A6** This question is about speed reduction.

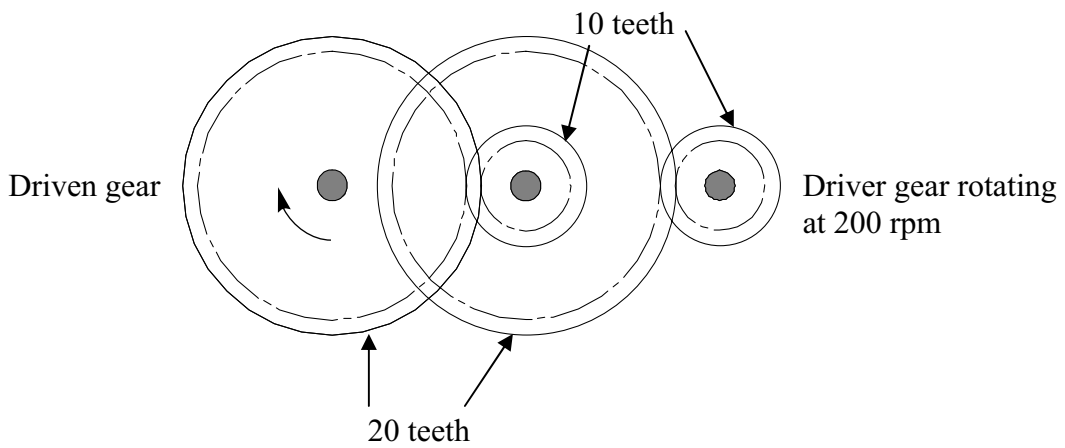
(a) Many electric motors rotate at very high speeds.

Give **two** advantages of reducing the output speed of an electric motor.

.....  
.....

(2 marks)

(b) Part of a gear system is shown below.



Calculate the speed of the driven gear.

Formula ..... (1 mark)

Calculation .....

.....

.....

..... (3 marks)

Speed of driven gear with units ..... (2 marks)

(c) State **two** operating advantages of using a *gear driven* system to power a machine.

**Advantage 1:** .....

**Advantage 2:** .....

(2 marks)

(d) Give an example of where a *pulley driven* system is used.

.....

.....

(1 mark)

**Turn over for the next question**

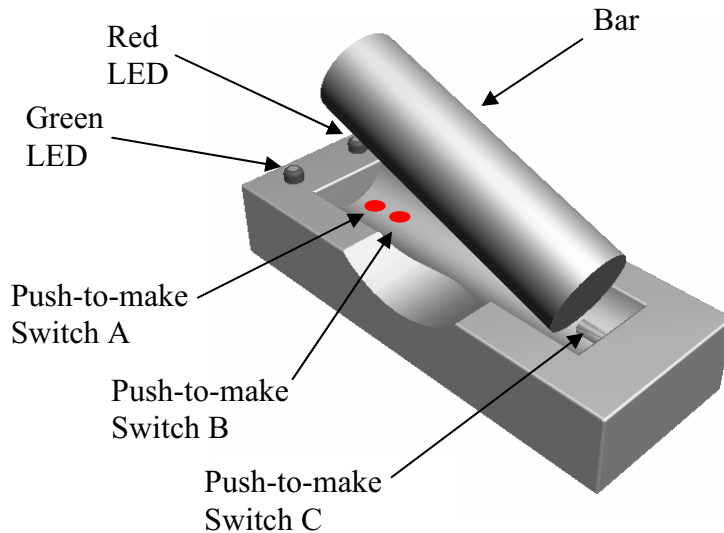
**11**

**Turn over ►**

**A7** This question is about checking the size of components.

The figure below shows a testing device. It is used to check the length of metal bars.

When a bar is inserted into the testing device as shown, various switches are operated and two LEDs show whether the bar is acceptable.



Sketch showing the bar being inserted into the testing device

- Push-to-make Switches A, B and C control the red and green LEDs.
- If Push-to-make Switch C is **not** pressed, neither LED should turn ON. This is to ensure that the bar is placed correctly in the testing device.
- The red and green LEDs are used to indicate whether the bar is too short, the correct length, or too long.

The table below shows the status of the Switches and the LEDs where **1** is *operated* and **0** is *not operated*.

	Switch A	Switch B	Switch C	Sketch	Red LED	Green LED
Bar not pushed against Switch C	1	1	0		0	0
Bar too short	0	0	1		0	0
Bar correct length	0	1	1		0	1
Bar too long	1	1	1		1	1

In the space below complete a simple circuit to show how push-to-make Switches A, B and C can be connected to operate the two LEDs as required.

The power rails have been drawn for you.

Marks will be awarded for the correct symbols and the correct connection of the following:

Push-to-make Switch A	<i>(2 marks)</i>
Push-to-make Switch B	<i>(2 marks)</i>
Push-to-make Switch C	<i>(2 marks)</i>
Red LED	<i>(2 marks)</i>
Green LED	<i>(2 marks)</i>
Any necessary resistors (value not needed)	<i>(2 marks)</i>

9 V

---

0 V

---

**A8** This question is about using Computer Aided Design (CAD) software.

- (a) (i) Explain how using a CAD package allows a circuit to be modelled and tested on the screen.

.....  
 .....  
 (2 marks)

- (ii) Give an advantage of computer modelling compared with using prototype board (bread board).

.....  
 .....  
 (2 marks)

- (b) Explain why symbol libraries are used for circuit diagram design.

.....  
 .....  
 .....  
 (2 marks)

- (c) Many printed circuit boards (PCBs) are designed using CAD software.

- (i) In producing a circuit mask, what is meant by auto-routing?

.....  
 .....  
 (2 marks)

- (ii) Give an advantage of using auto-routing for producing a circuit mask.

.....  
 .....  
 (2 marks)

- (iii) Name a material that would be suitable to use for a PCB mask.

.....  
 (1 mark)

(d) Computer Aided Manufacture (CAM) is often associated with CAD.

State **two** ways in which CAM can help to improve product quality in mass-produced items.

- 1. ....  
.....
- 2. ....  
.....

*(2 marks)*

**Turn over for the next question**

**13**

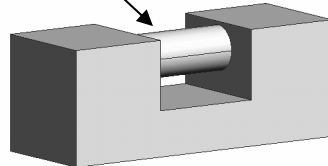
**Turn over ►**

**A9** This question is about the use of robots in industry.

A part of a production line requires a robot arm to grip a component.

The component is shown below. It has a mass of 1 kg.

The gripper must hold the  
round central bar



Mass 1 kg

In the space below, using notes and sketches, produce a design for a gripper to grip and release the components.

Marks will be awarded for:

Designing and labelling a suitable opening/closing mechanism	(4 marks)
Showing paths of travel of the parts of the mechanism	(2 marks)
Showing how the mechanism attaches to a suitable power source	(2 marks)
Quality of drawing/notes	(4 marks)

**END OF SECTION A QUESTIONS**



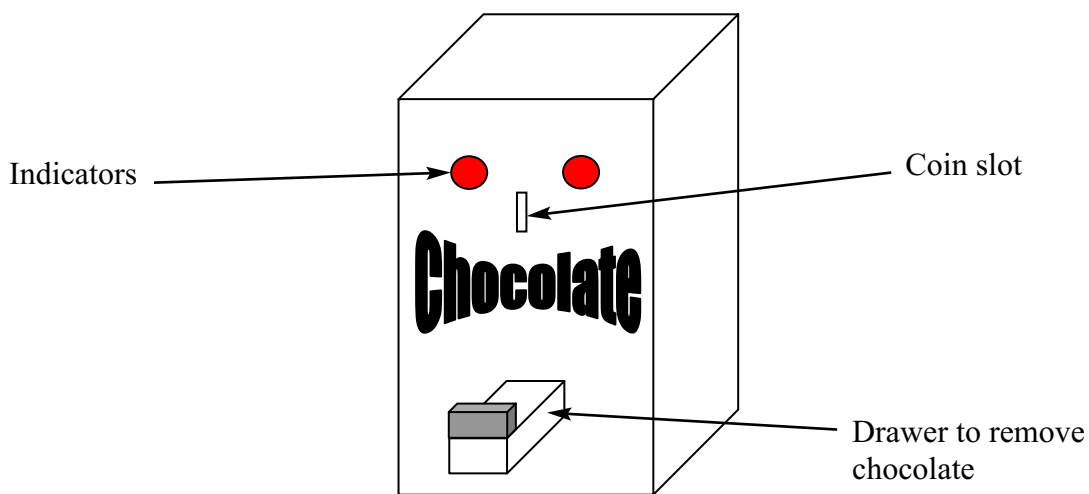
## SECTION B – PNEUMATICS FOCUS

Answer **all** questions in this section.

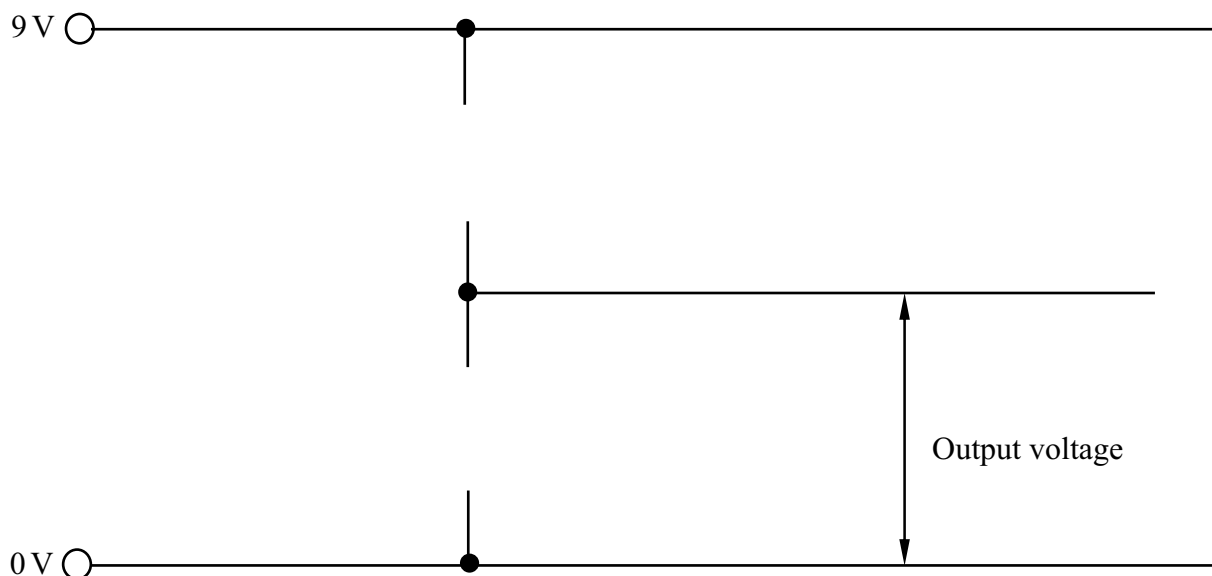
Do **not** answer these questions if you have answered the questions in **Section A – Mechanisms Focus** (pp. 5–24).

**B1** This question is about sensing.

The designer of a chocolate bar dispenser has chosen to use a light sensing circuit to indicate when it is low on chocolate bars and when it needs refilling.



(a) Complete the circuit diagram below by adding a Light Dependent Resistor (LDR) and a variable resistor to give an output voltage when light is sensed.



(3 marks)

Question B1 continues on the next page

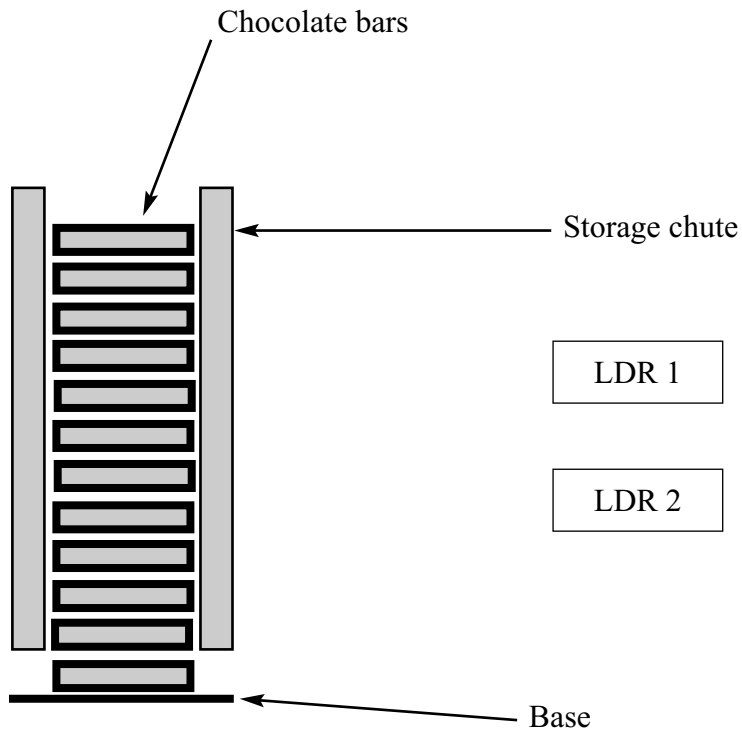
Turn over ►

- (b) The designer wants to use LDRs as sensors in **two** positions in the dispensing machine.

LDR 1 = LOW      This will sense when there are only four products left in the dispensing machine.

LDR 2 = EMPTY      This will sense when the container is completely empty.

Show with arrows where LDR 1 and LDR 2 would be positioned.



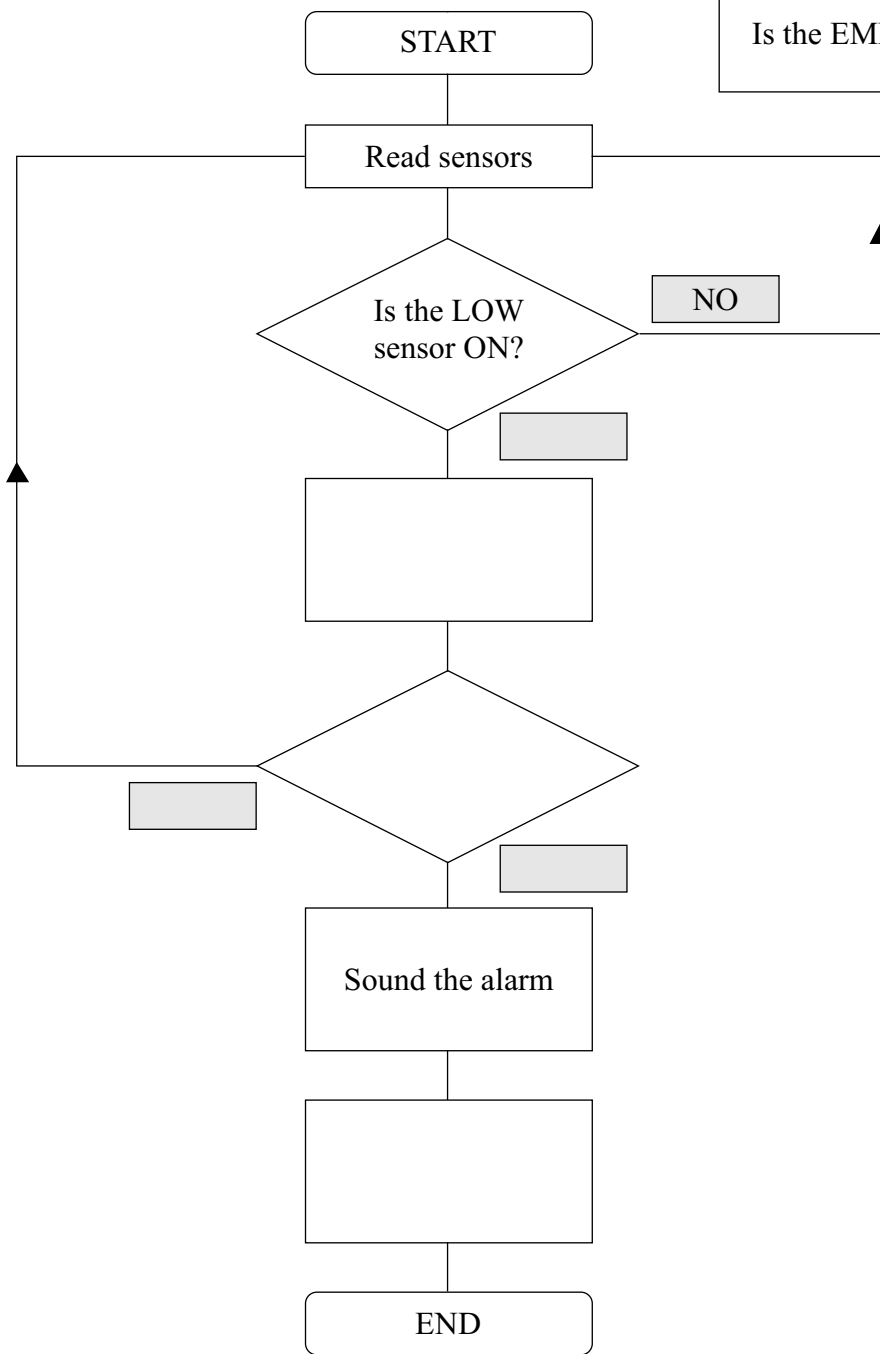
(2 marks)

(c) When the LOW sensor (LDR 1) is ON, a **WARNING** light comes on to show the shop staff that the dispensing machine needs refilling.

If the EMPTY sensor (LDR 2) is turned ON, an alarm sounds and the **EMPTY** light comes on.

- Complete the flow chart by filling in the missing stages using the statements given in the box below.
- Write YES or NO in the three shaded boxes.

Turn ON **EMPTY** light  
Turn ON **WARNING** light  
Is the EMPTY sensor ON?



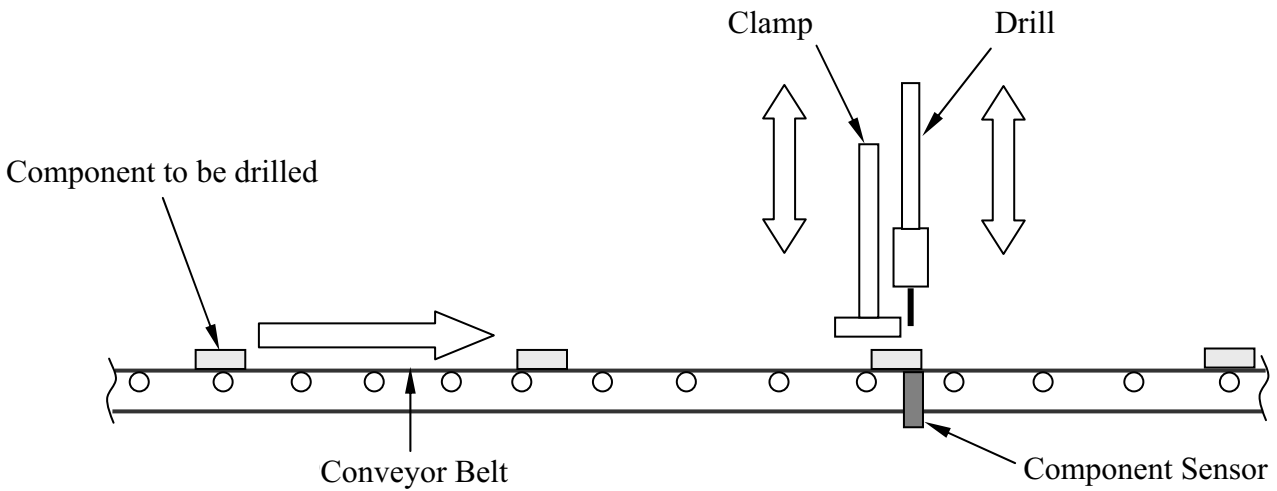
(6 marks)

Turn over ►

**B2** This question is about automated systems and production lines.

Components move along on a conveyor belt where they are sensed, clamped, drilled and released as shown below.

- The conveyor belt must be stopped during the drilling operation.
- The drill is continuously spinning.
- The whole process is controlled using a PIC (Peripheral Interface Controller) chip.



- (a) On the page opposite write a sequence of instructions that would act as the control program for this stage. The sequence of instructions to be used must be for continuous operation.

Operational instructions to be used:

Conveyor belt motor	ON
	OFF
Sensor detected component	YES
	NO
Clamp	UP
	DOWN
Drill	UP
	DOWN

Marks will be awarded for

Correct sequence

(6 marks)

Correct use of the sensor

(2 marks)

Use of continuous operation

(2 marks)

Answer part (a) on this page. You may answer using written instructions **or** as a flow chart.

The first instruction has been completed for you.

**Written Instructions**

- 1. Conveyor belt motor ON

---

- 2.

---

- 3.

---

- 4.

---

- 5.

---

- 6.

---

- 7.

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- 8.

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- 9.

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- 10.

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- 11.

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- 12.

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- 13.

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- 14.

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- 15.

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- 16.

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- 17.

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- 18.

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- 19.

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- 20.

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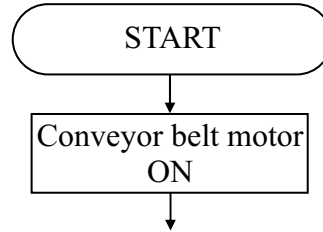
- 21.

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- 22.

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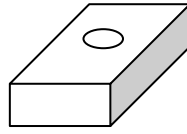
**Flow Chart**



**Question B2 continues on the next page**

**Turn over ►**

(b) All of the components are the same rectangular size with a hole in the centre.



In the space below show a method of detecting whether the hole has been drilled in the component as part of the automated conveyor system.

Marks will be awarded for	Appropriate method of detection	(2 marks)
	Annotation/explanation	(2 marks)
	Quality of drawing	(2 marks)

(c) The designer of a production line chose to use a PIC with non-erasable memory. Explain why this is a better PIC to use than one with an erasable memory.

.....

.....

.....

(2 marks)

(d) State **two** advantages of using PIC chips in circuit design.

Advantage 1 .....

.....

Advantage 2 .....

.....

(2 marks)

**B3** This question is about timer circuits.

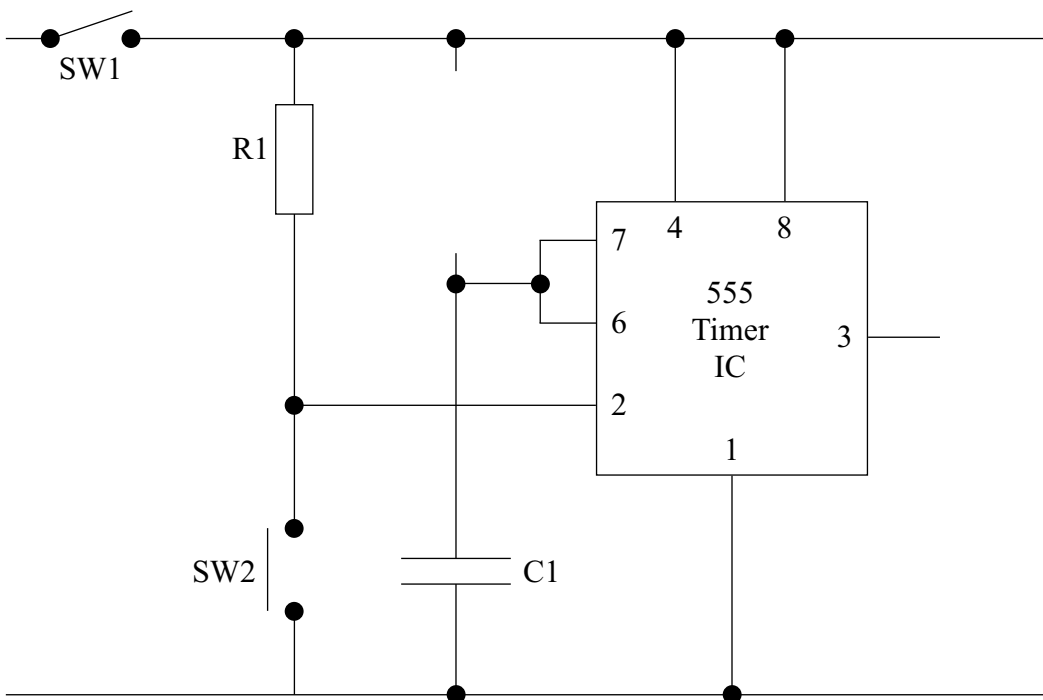
The circuit below shows a timer IC used as part of the production line control system to act as a timing circuit. The user presses the switch and the buzzer sounds for the timing period.

(a) Add the following circuit symbols to the circuit below.

(i) The 0 V and 9 V terminations (2 marks)

(ii) The variable resistor used to calibrate the timing (2 marks)

(iii) A buzzer that will sound during the timed period (2 marks)



**Question B3 continues on the next page**

**Turn over ►**

- (b) The sound was found to be inadequate therefore a higher voltage buzzer, controlled by a relay, was used.

To improve the circuit this component was added at gap A below.



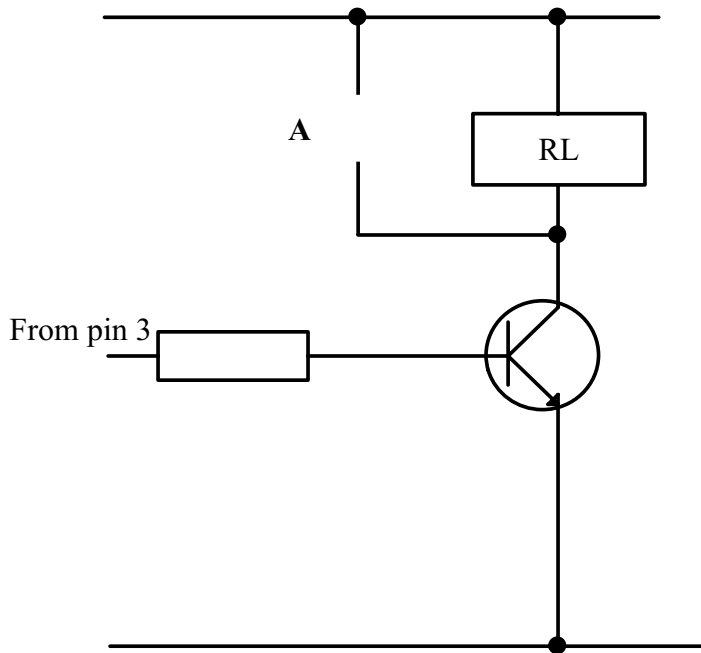
- (i) Name this component.

.....

(1 mark)

- (ii) Draw this component in gap A the right way round.

(1 mark)



- (iii) Explain why this component is required.

.....  
.....

(2 marks)

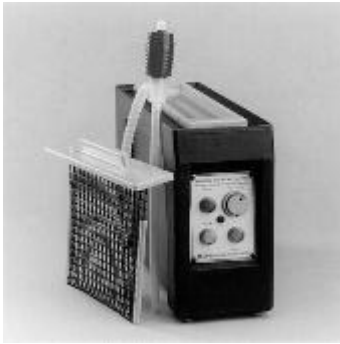


**B4** This question is about using workshop equipment.

When making products in the workshop health and safety is very important.

(a) State **two** safety rules that should be followed for **each** of the following common items of workshop equipment.

Give **six** *different* rules.



**Etching Tank**

Rule 1 .....

.....

Rule 2 .....

.....

(2 marks)



**Pillar Drill**

Rule 1 .....

.....

Rule 2 .....

.....

(2 marks)



**Soldering Iron**

Rule 1 .....

.....

Rule 2 .....

.....

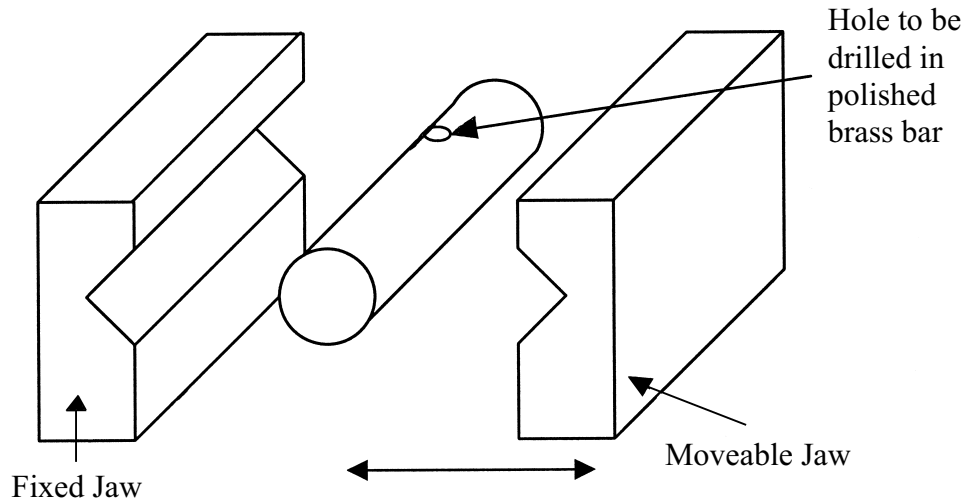
(2 marks)

**Question B4 continues on the next page**

**Turn over ►**

- (b) As part of a production process a hole is to be drilled in a polished brass bar using a drilling machine.

The bar is to be held by two jaws. The diagram below shows the bar and where the hole needs to be drilled.



- (i) In the space below design a pneumatically operated system that would be suitable for closing the moveable jaw.

Marks will be awarded as follows

Suitability of pneumatic system	(2 marks)
Appropriate for gripping	(2 marks)
Quality of drawing	(2 marks)

(ii) Give **two** reasons for your choice of pneumatic system.

.....  
.....

(2 marks)

(iii) Name a specific material for the jaws to be made of. ....

(1 mark)

(iv) Why is this material suitable?

.....  
(1 mark)

(c) To speed up the production line, an automatic clamping device was introduced.

As a safety measure the automatic clamping device has two inputs to control the system.

Input 1 A sensor which detects that a bar to be drilled is present.

Input 2 A microswitch which detects that a guard is in place.

When both inputs are activated, the clamping device operates.

Draw a system block diagram in the space below to represent this safety system.

INPUT

PROCESS

OUTPUT



(4 marks)

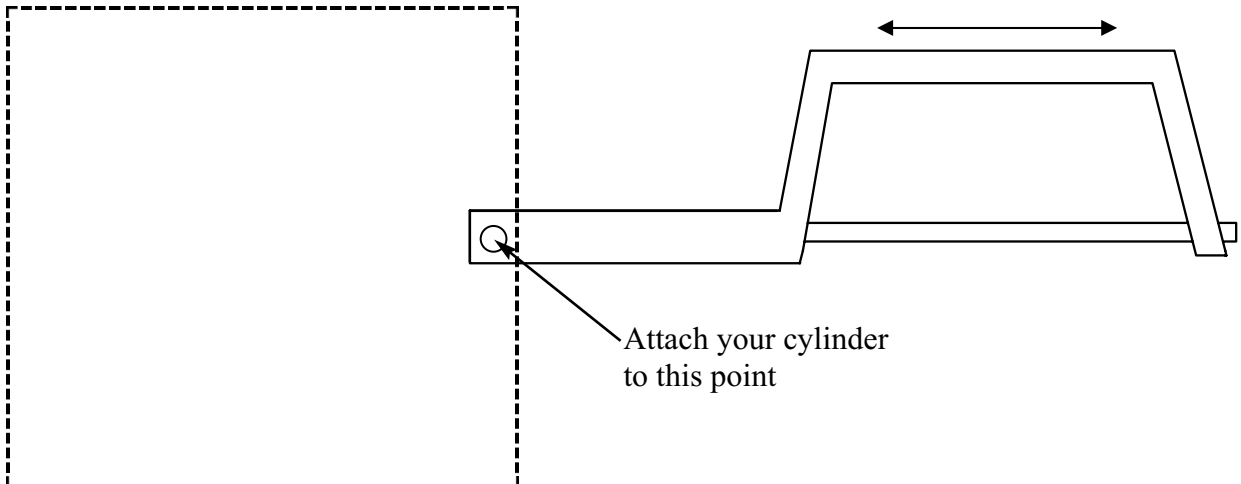
Turn over ►

**B5** This question is about a pneumatically powered hacksaw.

The hacksaw needs to move continuously backwards and forwards.

- (a) With the aid of a sketch, show how a cylinder could be attached to the left-hand end of the hacksaw frame.

Draw your answer in the box.



(2 marks)

- (b) Complete the diagram below by adding suitable ends to both three-port valves. Complete the drawing of the double acting cylinder. Add **all** air lines to the circuit.

Marks will be awarded for:

Suitable ends for both three-port valves

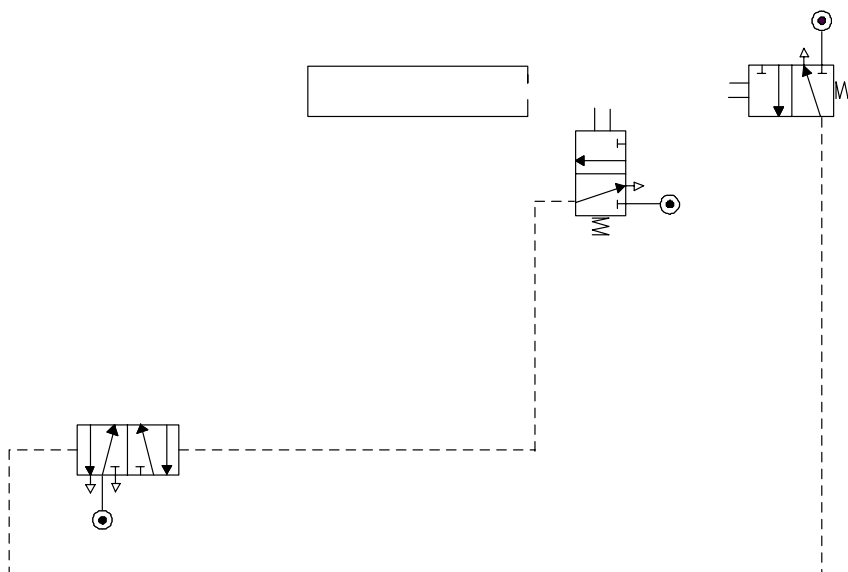
(3 marks)

Correctly completed cylinder

(4 marks)

Correct connections between cylinder and valves

(3 marks)

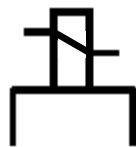
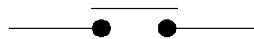


- (c) It has been decided to operate the hacksaw with solenoid operated valves which control the airflow to the system.

As a safety feature, the operator needs to press two push-to-make (PTM) switches to control the hacksaw.

Complete the circuit below by adding a second PTM switch and show how they control the airflow to the system.

Show connections to a suitable power supply.



(3 marks)

- (d) Why would the switches be placed at least 500 mm apart on the machine?

.....

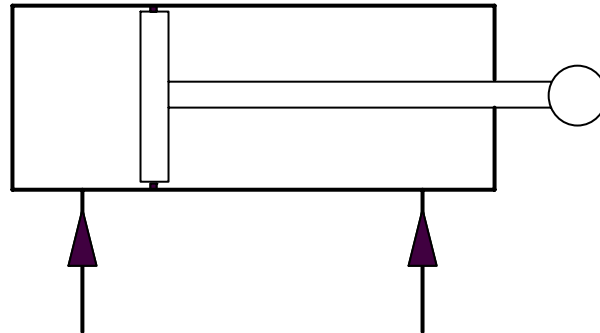
.....

(1 mark)

**Turn over for the next question**

**B6** This question is about pneumatic systems.

A pneumatic cylinder is shown below.



The input pressure to the cylinder is  $8 \text{ N/mm}^2$  and the internal diameter is 50 mm.

(a) Calculate the force of the output.

Formula ..... (1 mark)

Calculation .....  
.....  
.....

..... (3 marks)

Output force and units ..... (2 marks)

(b) State **two** operating advantages of using a pneumatic system rather than an electro-mechanical system for powering the hacksaw.

Advantage 1 .....

Advantage 2 .....  
(2 marks)

(c) State **one** safety advantage of using a pneumatically powered system.

.....  
(1 mark)

(d) Many pneumatic systems use a flow control valve to control the piston output movement.

How does a flow control valve work?

.....  
.....  
(2 marks)

**Turn over for the next question**

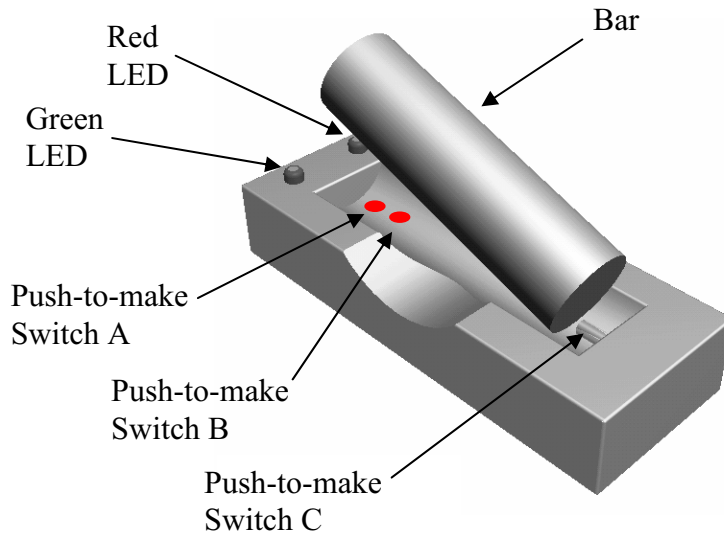
**11**

**Turn over ►**

**B7** This question is about checking the size of components.

The figure below shows a testing device. It is used to check the length of metal bars.

When a bar is inserted into the testing device as shown, various switches are operated and two LEDs show whether the bar is acceptable.



Sketch showing the bar being inserted into the testing device

- Push-to-make Switches A, B and C control the red and green LEDs.
- If Push-to-make Switch C is **not** pressed, neither LED should turn ON. This is to ensure that the bar is placed correctly in the testing device.
- The red and green LEDs are used to indicate whether the bar is too short, the correct length, or too long.

The table below shows the status of the Switches and the LEDs where **1** is *operated* and **0** is *not operated*.

	Switch A	Switch B	Switch C	Sketch	Red LED	Green LED
Bar not pushed against Switch C	1	1	0		0	0
Bar too short	0	0	1		0	0
Bar correct length	0	1	1		0	1
Bar too long	1	1	1		1	1



In the space below complete a simple circuit to show how push-to-make Switches A, B and C can be connected to operate the two LEDs as required.

The power rails have been drawn for you.

Marks will be awarded for the correct symbols and the correct connection of the following:

Push-to-make Switch A	<i>(2 marks)</i>
Push-to-make Switch B	<i>(2 marks)</i>
Push-to-make Switch C	<i>(2 marks)</i>
Red LED	<i>(2 marks)</i>
Green LED	<i>(2 marks)</i>
Any necessary resistors (value not needed)	<i>(2 marks)</i>

9V

---

0V

---

**Turn over for the next question**

12

**Turn over ►**

**B8** This question is about using Computer Aided Design (CAD) software.

- (a) (i) Explain how using a CAD package allows a circuit to be modelled and tested on the screen.

.....  
.....  
*(2 marks)*

- (ii) Give an advantage of computer modelling compared with using prototype board (bread board).

.....  
.....  
*(2 marks)*

- (b) Explain why symbol libraries are used for circuit diagram design.

.....  
.....  
.....  
*(2 marks)*

- (c) Many printed circuit boards (PCBs) are designed using CAD software.

- (i) In producing a circuit mask, what is meant by auto-routing?

.....  
.....  
*(2 marks)*

- (ii) Give an advantage of using auto-routing for producing a circuit mask.

.....  
.....  
*(2 marks)*

- (iii) Name a material that would be suitable to use for a PCB mask.

.....  
*(1 mark)*

(d) Computer Aided Manufacture (CAM) is often associated with CAD.

State **two** ways in which CAM can help to improve product quality in mass-produced items.

- 1. ....  
.....
- 2. ....  
.....

*(2 marks)*

**Turn over for the next question**

**13**

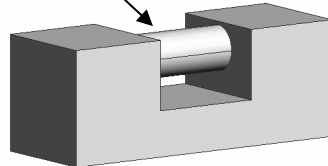
**Turn over ►**

**B9** This question is about the use of robots in industry.

A part of a production line requires a robot arm to grip a component.

The component is shown below. It has a mass of 1 kg.

The gripper must hold the  
round central bar



Mass 1 kg

In the space below, using notes and sketches, produce a design for a gripper to grip and release the components.

Marks will be awarded for:

- |  |           |
|--|-----------|
| Designing and labelling a suitable opening/closing pneumatically operated system | (4 marks) |
| Showing paths of travel of the parts of the system                               | (2 marks) |
| Showing how the system attaches to a suitable power source                       | (2 marks) |
| Quality of drawing/notes   | (4 marks) |

**END OF QUESTIONS**

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