Centre Number					Candidate Number				
Surname									
Other Names									
Candidate Signature									

Design and Technology: Systems and Control Technology

XXXX

Written Paper

Date: Time

For this paper you must have:
- a pen, a pencil, a ruler, an eraser, a pencil sharpener and coloured pencils.
- You may use a calculator.

Time allowed:
- 2 hours

Instructions
- Use black ink or black ball-point pen. Use pencil and coloured pencils only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show the working of your calculations.

Information
- The maximum mark for this paper is 120.
- The marks for questions are shown in brackets.
- All dimensions are given in millimetres unless otherwise stated.
- The question in Section A relates to the context referred to in the preparation sheet that was previously issued.
- A list of formulae and other information, which you may wish to use in your answers, is provided on page 2.
- You are reminded of the need for good English and clear presentation in your answers. Quality of Written Communication is assessed in Question 2(a) and Question 6(a).

Advice
- You are advised to answer the questions in the order in which they are written.

XXXX

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2

Formulae

Potential Difference $\qquad$ $V = I \times R$

Series Resistance $\qquad$ $R_T = R_1 + R_2$

Potential Divider

$$\text{Voltage 1} = \frac{R1}{R1 + R2} \times \text{Supply Voltage}$$

$$\text{Voltage 2} = \frac{R2}{R1 + R2} \times \text{Supply Voltage}$$

Ratio of Simple Gears

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

Velocity Ratio

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

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

Mechanical Advantage $\qquad$ $MA = \text{Load} / \text{Effort}$

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3

SECTION A

Context: Train door operation and construction

Section A is about an automated sliding carriage door.

You are advised to spend about 35 minutes on this question.

1 The door opens and closes by sliding on tracks at the top and bottom of the doorway.

1 (a) (i) Suggest a suitable material for the train door.

…………………………………………………………………………………………
(1 mark)

1 (a) (ii) Give one reason why this material is suitable.

…………………………………………………………………………………………

…………………………………………………………………………………………
(1 mark)

Question 1 continues on the next page

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1 (a) (iii) Bioglass has been used for the train door windows.

Give two advantages of using this material.

1…………………………………………………………………………..……

2…………………………………………………………………………..

(2 marks)

1 (a) (iv) Suggest a suitable material for the sliding door track.

……………………………………………………………………………….

(1 mark)

1 (a) (v) Give one reason why this material is suitable.

………………………………………………………………………..……

………………………………………………………………………..

(1 mark)

1 (b) Suggest **three** alternative systems that you could use to open and close the door.

1

………………………………………………………………………………

2

………………………………………………………………………………

3

………………………………………………………………………………

(3 marks)

In part (c) you will be asked to choose one of these systems to develop further.

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1 (c) (i) The simplified diagram below shows a sliding train door. It is in the open position.

Train Carriage
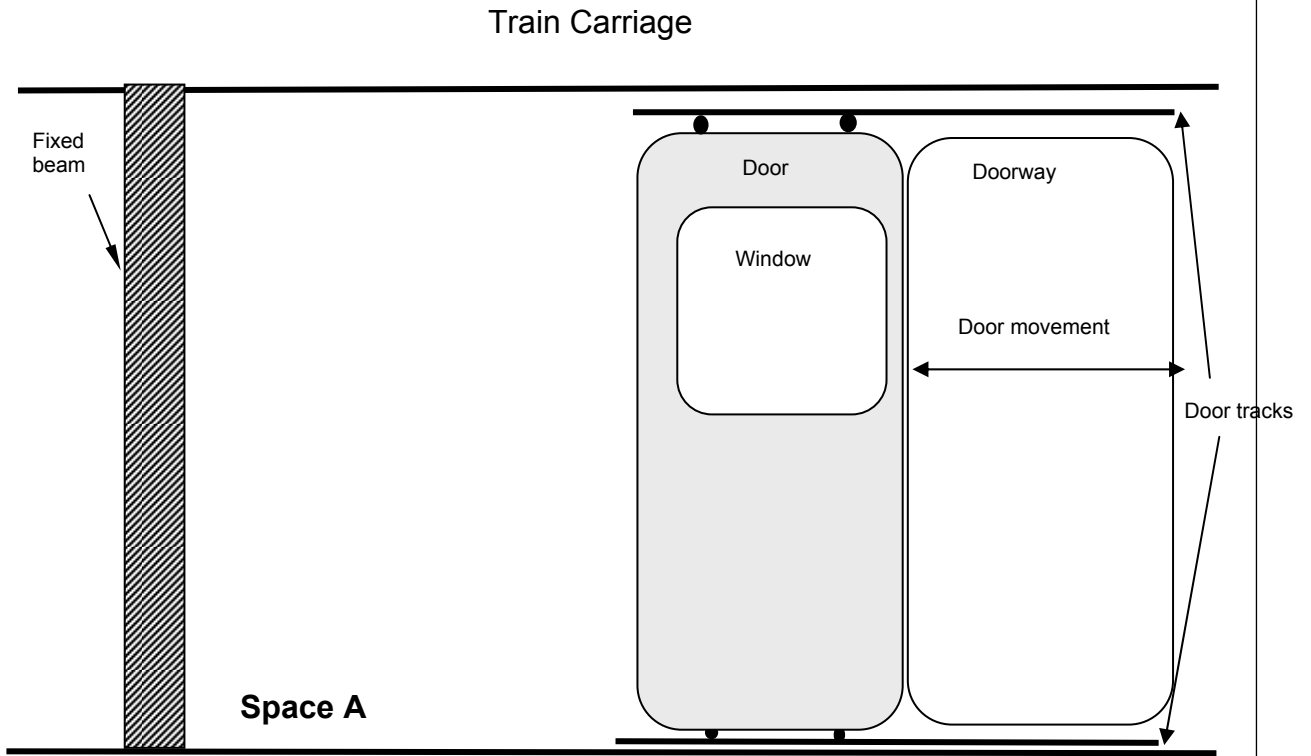
Choose one of the systems, you have given in part (b), to open and close the door. Name this system below.

……………………………………………………………………………………

Add your chosen system to the drawing above in **space A.**

Your design must show:

- a suitable device able to close and open the door   *(3 marks)*
- a suitable mounting of the device to the beam   *(1 mark)*
- a suitable mounting of the device to the door   *(1 mark)*
- a suitable power supply.   *(1 mark)*

You should draw and label all components and mountings.   *(2 marks)*

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1 (c) (ii) Describe the operation of the system that you have drawn in **space A.**

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………..

(4 marks)

1 (c) (iii) Give **two** advantages of your chosen system.

Advantage 1: …………………………………………………………………

(1 mark)

Advantage 2: …………………………………………………………………

(1 mark)

1 (d) (i) Name a specific component that could be used to sense that the door has hit an obstruction.

………………………………………………………………………………….

………………………………………………………………………………….

(2 marks)

1 (d) (ii) Give two other health and safety issues that should be considered when designing
the door system.

Issue 1:………………………………………………………………….

(1 mark)

Issue 2::………………………………………………………………….

(1 mark)

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1 (e)   It was found that the door opened and closed too quickly.

What could be added to your system to slow down the movement of the door?

………………………………………………………………………………………

………………………………………………………………………………………
(2 marks)

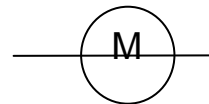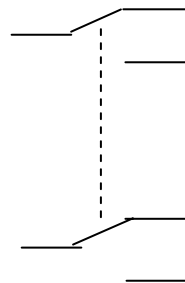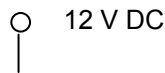**1 (f)**   A Double Pole Double Throw (DPDT) switch can be used to control the forward and reverse direction of a motor.

Complete the diagram below to show a reversing circuit.

A mark will be awarded for each correct link drawn.

- Power supply connected to switch   *(2 marks)*
- Switch connected to the motor   *(4 marks)*

○   12 V DC

M

○   0 V

35

Turn over ▶

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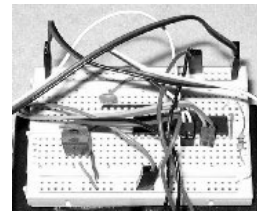
8

SECTION B
You should answer all questions in this section.

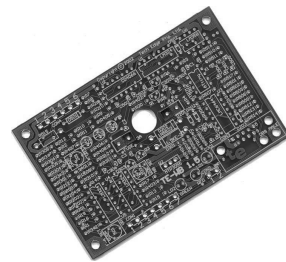Question 2 is about constructing circuits and using prototyping systems.

You are advised to spend about 10 minutes on this question.

2 (a) Compare and contrast the suitability of the following circuit construction techniques, making reference to specific strengths and weaknesses in each case.

- Breadboard (prototype board)

- Printed circuit board

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(6 marks)

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2 (b) Explain an advantage of modelling circuit designs on a computer rather than building them.

………………………………………………………………………………………

………………………………………………………………………………………….

(2 marks)

2 (c) Explain which circuit construction technique would be suitable to test an alarm circuit on a bicycle whilst being ridden.

………………………………………………………………………………………

………………………………………………………………………………………

(2 marks)

10

Turn over for the next question

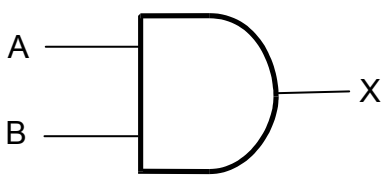GCSE Design and Technology: Systems and Control Technology / Specimen Assessment Material / Version 1.0 / For First Teaching 2009

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Question 3 is about logic gates.

You are advised to spend about 15 minutes on this question.

3 (a) (i) Complete the following table by naming the logic gate shown and adding the missing logic gate symbol. *(2 marks)*

Logic Gate Symbol	Type of Logic Gate	Truth Table		

Logic Gate Symbol row 1:

A ——[AND gate symbol]—— X (A and B inputs)

Truth Table 1:

A	B	X
0	0	
0	1	
1	0	
1	1	

Logic Gate Symbol row 2:

A ____ ____X B____

Type of Logic Gate: **OR**

Truth Table 2:

A	B	X
0	0	
0	1	
1	0	
1	1	

3 (a) (ii) Complete the truth tables above for the two logic gates. *(8 marks)*

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3 (b) It has been decided to operate a lift door with push button switches.

In this system:

- two push switches operate the system
- the door is opened by pressing a push button switch on the wall next to the door
- the door device opens the door.

The door should open when:

- Push Switch 1 **OR** Push Switch 2 is pressed **AND** the lift control states it is safe to open.

Input	State	Output
Push Switch	Button pressed by user	1
	Button not pressed	0
Lift control	Safe to open door	1
	Not safe to open door	0

Construct a logic circuit to open the door using two 2 input logic gates to complete the logic circuit.

Marks will be awarded for:

- Logic gates symbols *(2 marks)*
- Inputs to gates *(4 marks)*
- Output to door. *(1 mark)*

Push
Switch
1

Push
Switch
2

Door
Device

Lift
control

Turn over ▶

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12
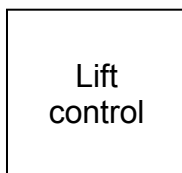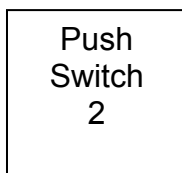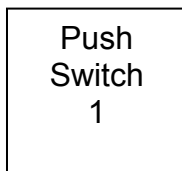
Question 4 is about constructing a flowchart to control a lift door.

You are advised to spend about 15 minutes on this question.

4 The signal from the lift control ensures that the doors can only open when it is safe. The person sensor on the edge of the door signals if it hits an obstruction.

The following inputs are available.

	Input	State
Push Button 1 (inside)	1	Button pressed by user
	0	Button not pressed
Push Button 2 (outside)	1	Button pressed by user
	0	Button not pressed
Signal from control	1	Safe for doors to open
	0	Not safe – doors stay closed
Obstruction Sensor	1	A person is in the way
	0	No person in the way
Door Sensor	1	Door is closed
	0	Door is not closed

Complete the flowchart on the opposite page that:

- waits until the signal from the lift control states that it is safe for the doors to open;

- opens the door when a person presses either push button;

- waits 10 seconds then closes the door;

- if the door hits an obstruction it should open and wait another 10 seconds before closing;

- repeats the cycle.

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Add the missing lines with arrowheads and the states to the decision box outputs to the flowchart on this page.

Marks awarded for:

- Each correct output state of the decision boxes *(8 marks)*
- Each correct connecting line drawn with arrows *(6 marks)*
  1 = YES, 0 = NO

START

Control Signal ? 0

1

Push Button 1 ?

Push Button 2 ?

OPEN Door

WAIT 10S

Close Door

Person Sensor ?

Door Sensor ?

14

Turn over ▶

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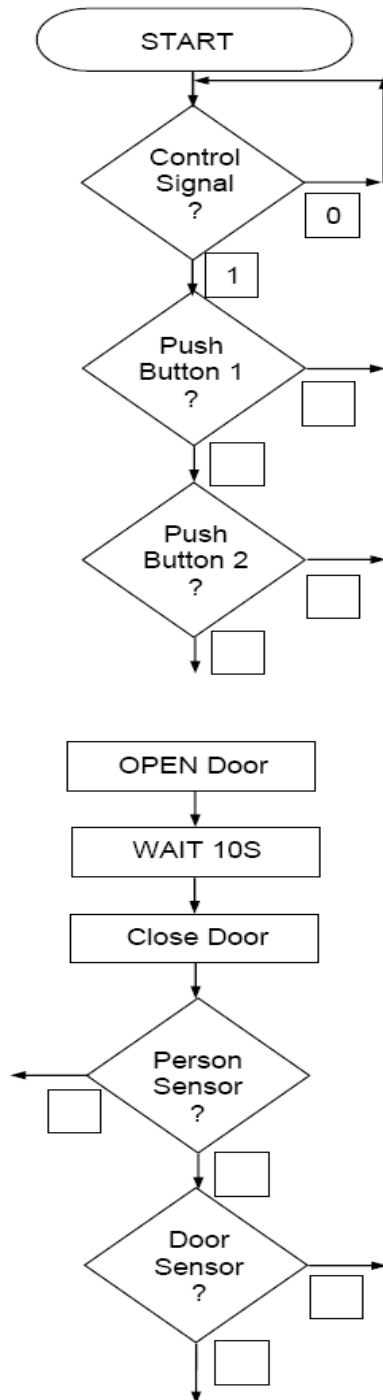
Question 5 is about a drive system for a pillar drill.

You are advised to spend about 15 minutes on this question.

The simplified diagram below shows two shafts.

Shaft A: the drive shaft of a motor

Shaft B: the shaft that leads to the drill chuck.

5 (a) On the diagram below add notes and sketches to show a drive system that will:

- transfer drive from Shaft A and Shaft B;   *(2 marks)*

- enable the operator to choose between two different speeds of operation.

(3 marks)

Shaft A   Shaft B

Motor   Chuck

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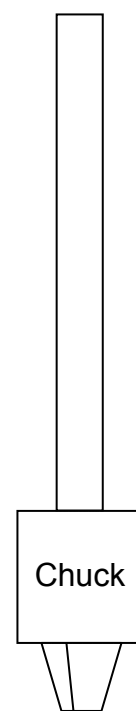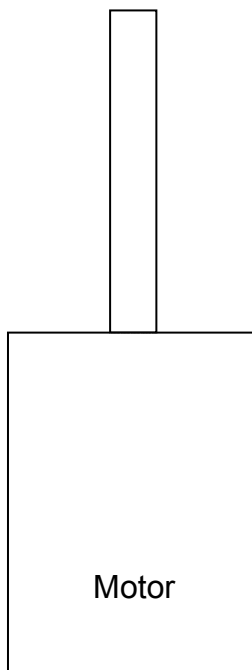
5 (b) The pillar drill is controlled by 2 push buttons.

The drill should operate when the start button is pressed and continue to run until the stop button is pressed.

5 (b) (i) State an advantage of this latching circuit, rather than the toggle switch to control a pillar drill.

....

....

(1 mark)

5 (b) (ii) Using the components below, draw a circuit in Box A that will give the above operation.

Marks will be awarded for:

- labelling each push switch correctly *(2 marks)*

- each correct connection. *(5 marks)*

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16

Vcc

Relay

M

0V

Box A

13

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Question 6 is about Quality Control and Testing.

You are advised to spend about 15 minutes on this question.

6 (a) You have been asked to perform a quality control check on a completed circuit board.

Give an explanation of what you would do.

....

....

....

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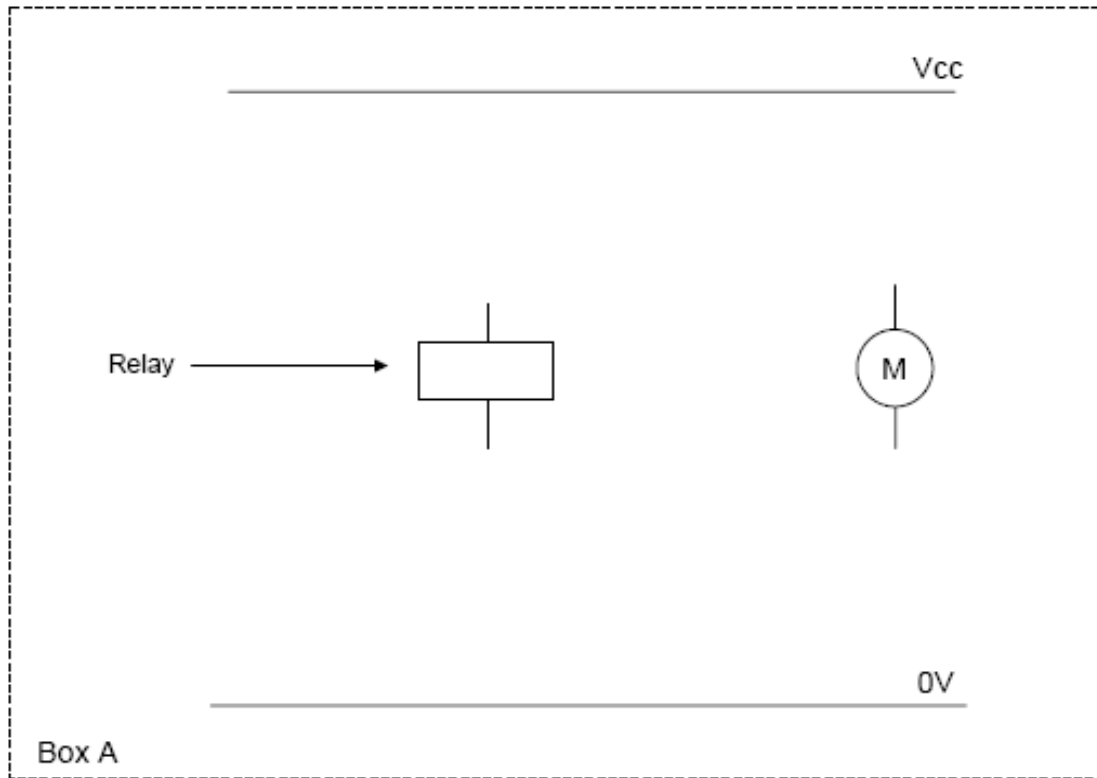
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....

(7 marks)

6 (b) Explain why measuring and test equipment only use very high tolerance resistors.

....

....

(2 marks)

6 (c) A multimeter is often used to check circuits.

Name two checks that can be made using this device.

1 ....

2 ....

(2 marks)

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6 (d) Many electronic devices use a modular construction using several small circuit boards.
Give **two** advantages of having several small boards rather than one large one.

....

....
(2 marks)

13

Turn over for the next question

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Question 7 is about a garage door lock.

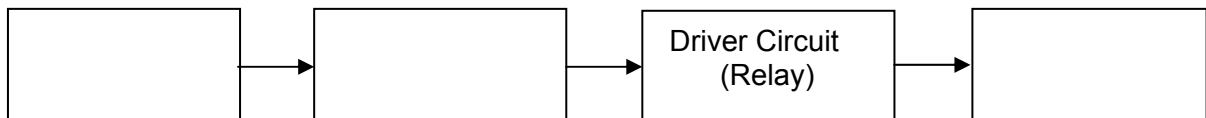You are advised to spend about 15 minutes on this question.

7 A garage door company wish to develop a locking system for garage doors.

A low voltage electronic control box operates a relay which switches 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.

7 (a) Complete the system diagram below using the **three** correct terms from the list:
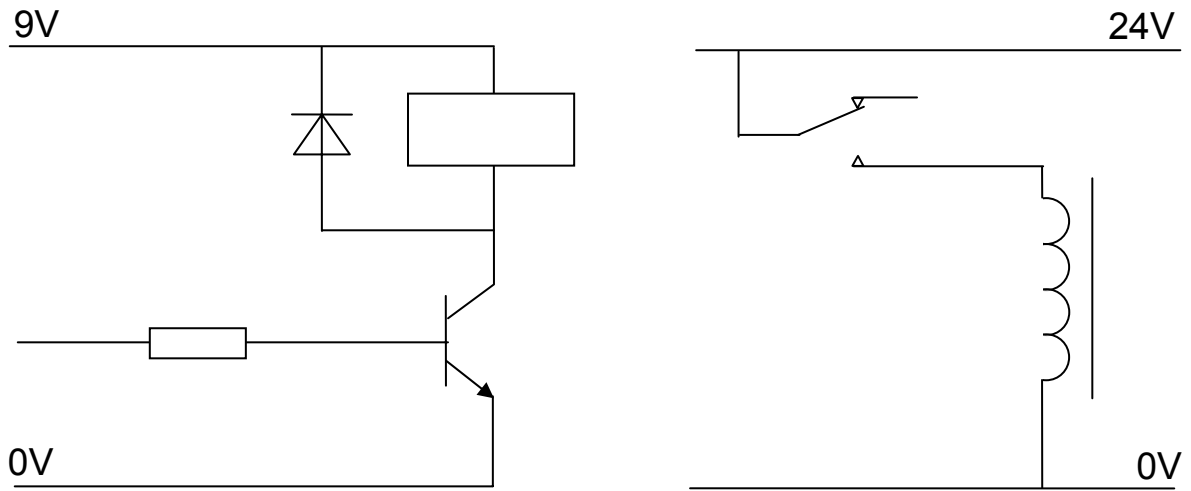
- Feedback
- Keypad
- Logic check
- Solenoid.

		Driver Circuit (Relay)	

(3 marks)

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7 (b) The section of the circuit diagram below shows the solenoid and the relay.

9V

24V

0V

0V

7 (b) (i) Label the diode on the diagram above.   *(1 mark)*

7 (b) (ii) Explain the purpose and operation of the diode in the circuit above.

....

....

....

....

....

(4 marks)

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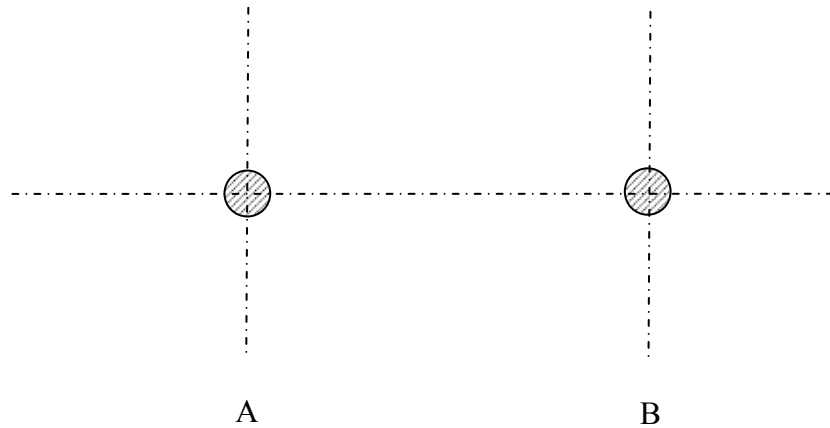**7** (c) The diagram below shows two shafts inside the lock that move the lock bolt.

By adding gears to the diagram, show one method of ensuring that a small force at **A** will be converted into a large force at **B**.

A   B

(4

marks)

7 (d) (i) An alternative method of moving the locking bolt is to use a pulley system with a toothed belt. If pulleys of 150mm diameter on shaft **A** and 30mm diameter on shaft **B** are used, what would be the velocity ratio of the pulley system?

....

....

....
(4 marks)

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

....

....

....
(2 marks)

END OF QUESTIONS

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