Surname

Other Names

Candidate Signature

AQA

General Certificate of Secondary Education
June 2010

Design and Technology: 45651
Systems and Control Technology

Unit 1   Written Paper

Tuesday 22 June 2010   9.00 am to 11.00 am

For this paper you must have:
● a black pen, a pencil, a ruler, an eraser and a pencil sharpener.

Time allowed
● 2 hours

Instructions
● Use black ink or black ball-point pen. Use pencil only for drawing.
● Fill in the boxes at the top of this page.
● Answer **all** questions.
● You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
● Do all rough work in this book. Cross through any work you do not want to be marked.

Information
● The marks for questions are shown in brackets.
● The maximum mark for this paper is 120.
● You are reminded of the need for good English and clear presentation in your answers.
● Quality of Written Communication will be assessed in Question 4 (d).

You may use the following information when answering the questions.

Potential Difference $V = I \times R$

Series Resistance $R_T = R_1 + R_2$

Potential Divider $\text{Voltage 1} = \dfrac{R1}{R1 + R2} \times \text{Supply Voltage}$

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

Ratio of Simple Gears $\text{Gear ratio} = \dfrac{\text{Number of teeth on driven gear}}{\text{Number of teeth on driver gear}}$

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

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

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

Turn over for the first question

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ANSWER IN THE SPACES PROVIDED

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Section A

Question 1   You are advised to spend about 20 minutes on this question.

This question is about the design of a lift model to demonstrate control systems to students.

A company has asked you to design a portable lift model for schools.

The lift model will have a ground floor and a first floor.

1 (a)   The first stage is to produce a Design Specification.

Describe **three** issues which you need to consider before you begin to design the lift model.

For each issue give:

- a consideration   *(3 × 1 mark)*
- an explanation   *(3 × 1 mark)*
- a detailed statement for the Design Specification.   *(3 × 2 marks)*

An example has been given to help you.

Consideration   *The weight of the lift car.*
Explanation   *If it is too heavy it will be difficult to lift.*
Statement   *The lift car must weigh less than 100 g.*

Consideration 1 ....

....

Explanation 1 ....

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Statement 1 ....

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Consideration 2 ....

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Explanation 2 ....

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Statement 2 ....

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Consideration 3 ....

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Explanation 3 ....

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Statement 3 ....

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**Question 1 continues on the next page**

1 (b) Study the simplified view of the lift model below.

Sketch and label a design idea to show how the lift car could be raised and lowered by a powered control system.

Sketch larger details of any parts at the side of the main diagram.

Marks will be awarded for:

- a recognisable system   *(1 mark)*
- moving the lift between the ground and first floor   *(2 marks)*
- sensing when the lift is at the ground and first floor *(2 marks)*
- powering the system   *(1 mark)*
- clear sketching and all components labelled.   *(2 marks)*

First Floor

Lift Car

Guide rails

Ground Floor

20
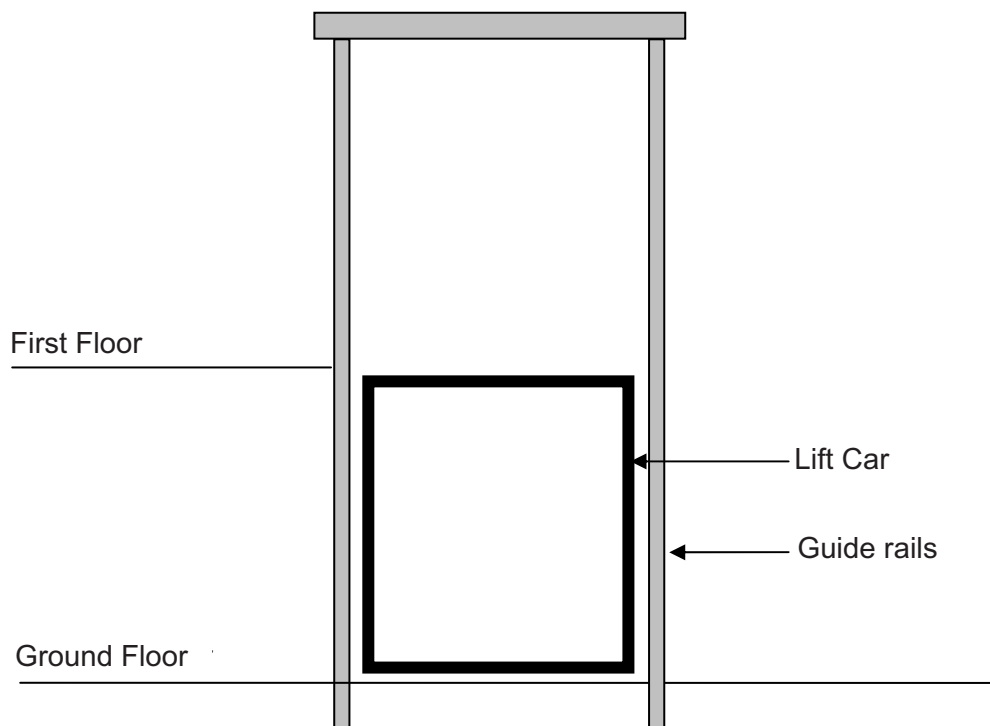
Question 2   You are advised to spend about 10 minutes on this question.

This question is about the design of a system to control the lift.

2   The lift should only go up when:

- the doors are shut

- the lift is **not** over loaded (ie there is **not** too much weight in the lift)

- the user presses the UP button.

Doors	Open	0	Shut	1
Overload	No	0	Yes	1
UP Button	Not pressed	0	Pressed	1

Using only one and two input logic gates, design a logic circuit that will operate the lift correctly.

Marks will be awarded for:

- logic gates symbols   *(3 marks)*
- inputs to gates   *(5 marks)*
- output to lift   *(1 mark)*
- clarity of drawing.   *(1 mark)*

Doors

Overload

Lift UP

UP Button

Turn over ▶

Section B	

Question 3   You are advised to spend about 20 minutes on this question.

This question is about identifying components and their uses.

INPUT	→	PROCESS	→	OUTPUT
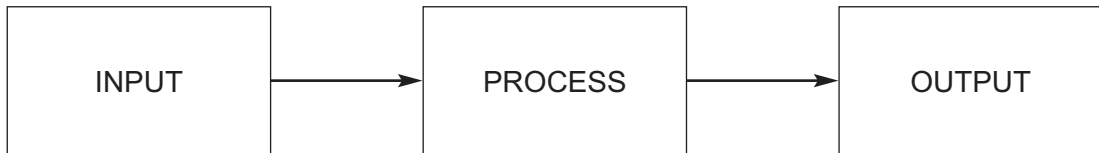
3 (a)   For the following electronic components, give the component name and the electronic building block it would be used for.

(10 marks)

No.	Component	Component name	Electronic building block
1			
2			
3			
4			
5			

3 (b) In the system diagram below, write the names of components that could make a system that indicates a change in temperature.

(3 marks)

3 (c) The following circuit diagram shows a simple potential divider light sensor circuit.
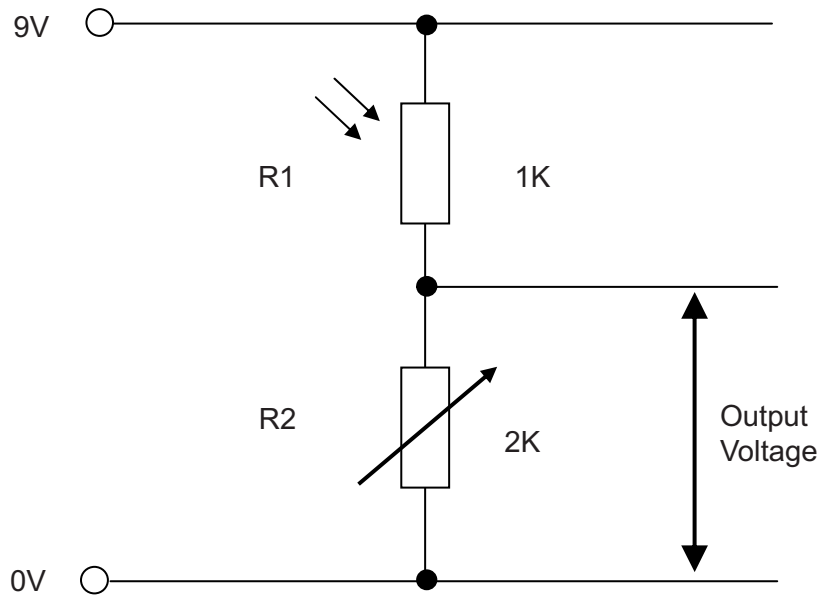
3 (c) (i) Name the component labelled R1.

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(1 mark)

3 (c) (ii) Name the component labelled R2.

....

(1 mark)

3 (c) (iii) Calculate the output voltage when R1 is 1KΩ and R2 is 2KΩ and the supply voltage is 9V.

Formula ....

Working ....

Answer with units ....

(4 marks)

19

Turn over ▶

Question 4   You are advised to spend about 30 minutes on this question.

This question is about Printed Circuit Board (PCB) design and construction.

4 (a)   It is best to test that a circuit works before building a PCB.

Describe **one** method of testing a circuit before building a PCB.

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(3 marks)

4 (b)   The circuit below pulses the speaker.

Figure 1
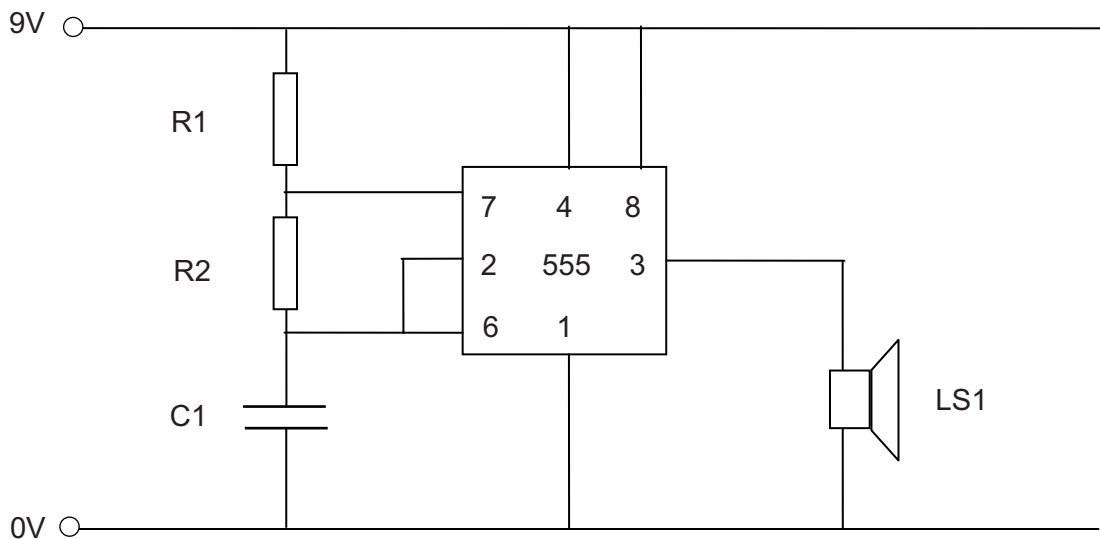
Complete the missing **five** PCB tracks on **Figure 2** for the circuit in **Figure 1**.

The pads and some of the tracks have been completed for you.

Your tracks should not cross at any point and should be drawn neatly.

Figure 2
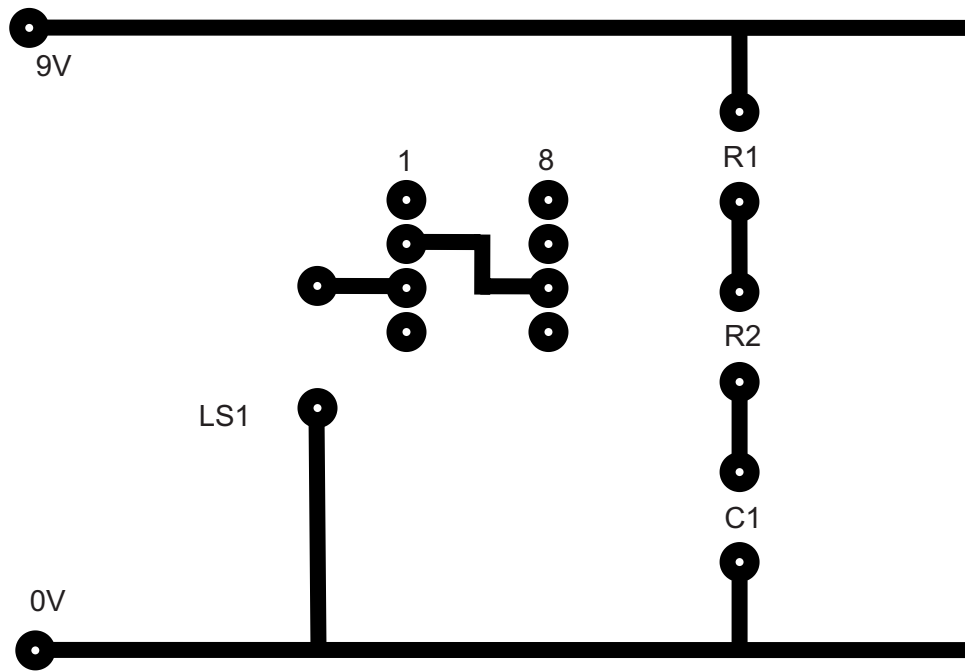
(6 marks)

4 (c) Give **two** advantages of using Computer Aided Design (CAD) to design PCBs.

Advantage 1 ....

....

Advantage 2 ....

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(4 marks)

4 (d) (i) List **four** main stages in a PCB production process.

1 ....

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2 ....

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3 ....

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4 ....

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(4 marks)

Turn over ▶

4 (d) (ii) Describe in detail the PCB production process outlined in part (d) (i).

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(8 marks)

25

Question 5   You are advised to spend about 25 minutes on this question.

This question is about programming a greenhouse temperature / environmental control system model.

The greenhouse model has:

- a heat sensor
- a roof vent that opens and closes to regulate the temperature.

5 (a) (i) Suggest a specific material for the greenhouse frame.

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(2 marks)

5 (a) (ii) Explain why the material that you have selected is suitable.

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(2 marks)

5 (a) (iii) Suggest a suitable component to sense that the roof vent is closed.

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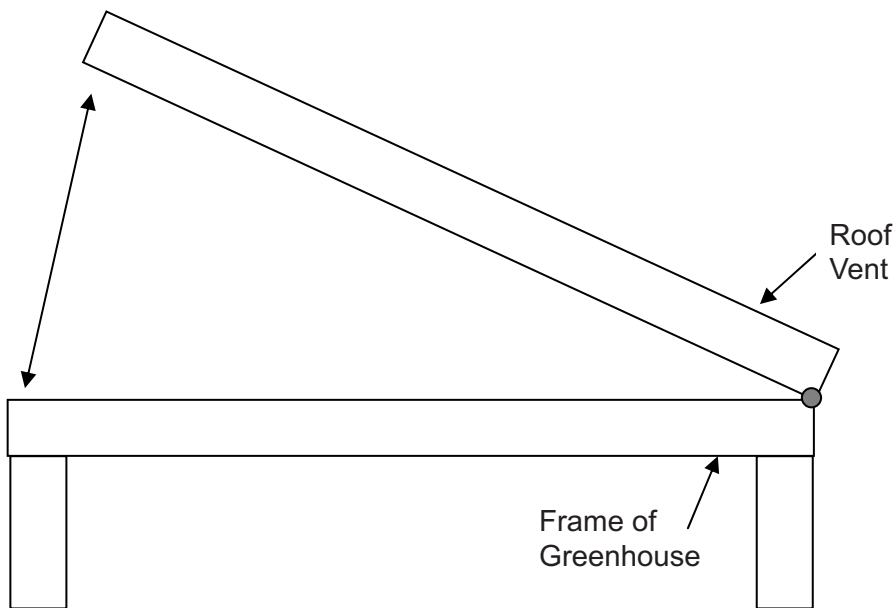
(2 marks)

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5 (a) (iv) Sketch on the diagram below how the component you have named in part (a) (iii) senses that the roof vent is closed.

Marks will be awarded for:

- a component mounted correctly   *(1 mark)*
- the ability to sense that the vent was closed   *(1 mark)*
- a good quality labelled sketch of the sensing system.   *(2 marks)*

Roof
Vent

Frame of
Greenhouse

5 (a) (v) Describe how your system in part (a) (iv) works.

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....

....

(3 marks)

5 (b)   The temperature control system operates as follows:

- The vent opens when the temperature is higher than 31 °C
- To fully open the vent takes 5 seconds going UP
- The vent closes when the temperature is less than 29 °C
- To close, the vent goes DOWN until closed
- This process is continuous (non stop).

Complete the flowchart of the program for the micro controller by adding:

- each correct output state of the decision boxes   *(6 marks)*
- Y for Yes and N for No

- the following statements to the correct Process Boxes   *(5 marks)*
    Vent motor OFF
    Vent motor OFF
    Vent DOWN
    Vent UP
    Wait 5 seconds
- each correct connecting line, there are four missing lines.   *(4 marks)*

Turn over ▶

28
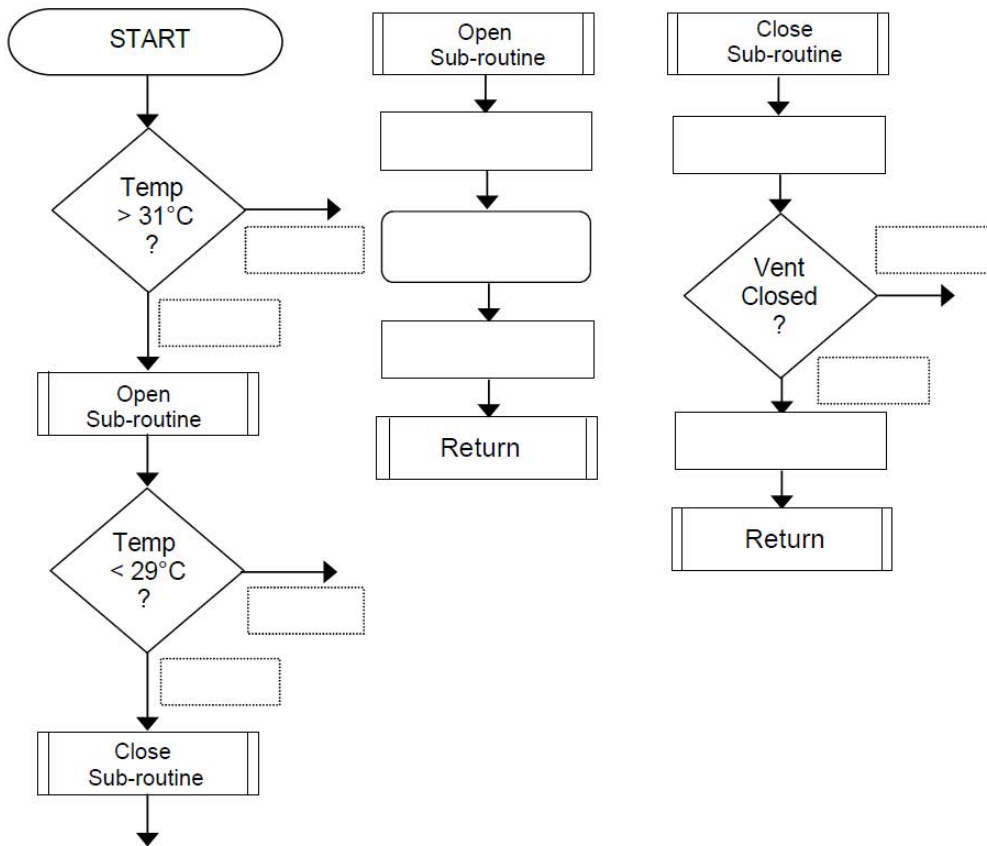
Question 6   You are advised to spend about 15 minutes on this question.

This question is about the analysis and evaluation of an existing product.

The product is an automatic curtain closing and opening system.

6 (a)   The proposed solution is shown below as a block diagram.

Timer	→	PIC	→	Motor

This solution does not control the curtains correctly.

Identify **two** possible problems with this proposal and state how each problem could be solved.

Problem 1 ....

....

Solution 1 ....

....

....

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Problem 2 ....

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Solution 2 ....

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(6 marks)

6 (b)   The curtains weigh 10 kg and the motor is connected directly to them with a belt.

The motor rotates too fast and cannot move the curtains.

Identify **two** problems with the drive system and suggest **two** possible modifications that could be made so that the existing motor can be used.

Problem 1 ....

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Modification 1 ....

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Problem 2 ....

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Modification 2 ....

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(4 marks)

6 (c) (i)   Discuss the impact on the environment of using electrically powered curtains.

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(3 marks)

Turn over ▶

6 (c) (ii) Suggest **two** environmentally friendly sources of mains electricity.

1 ....

2 ....

(2 marks)

6 (c) (iii) Give **three** advantages of environmentally friendly energy sources.

1 ....

2 ....

3 ....

(3 marks)

END OF QUESTIONS

18

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