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Centre Number

Candidate Number

General Certificate of Secondary Education
2018

Technology and Design

Unit 2:
Systems and Control

Element 1: Electronic and Microelectronic Control Systems

GTD21

[GTD21]
FRIDAY 25 MAY, AFTERNOON

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Questions which require drawing or sketching should be completed using an H.B. pencil.
All other questions must be completed using black ink only.
Do not write in pencil or with a gel pen.
Answer **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

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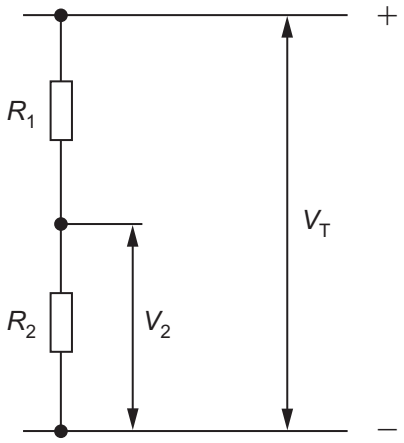
Formulae for GCSE Technology and Design

You should use, where appropriate, the formulae given below when answering questions which include calculations.

1 Potential Difference = current × resistance ($V = I \times R$)

2 For potential divider

$$V_2 = \frac{R_2}{R_1 + R_2} \times V_T$$



3 Series Resistors $R_T = R_1 + R_2 + R_3$ *etc*

Parallel Resistors $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ or $R_T = \frac{R_1 \times R_2}{R_1 + R_2}$

4 Time Constant $T = R \times C$

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Answer **all** questions

1 **(a)** **Fig. 1** shows a typical electronic input signal.

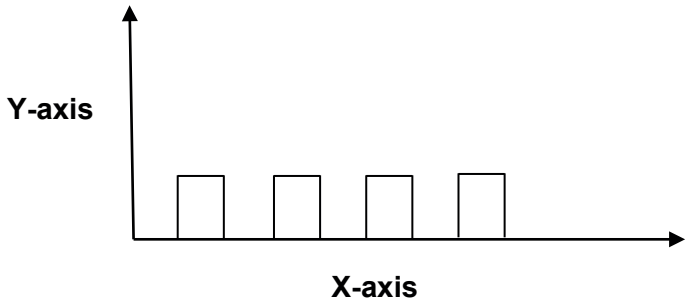

Fig. 1

(i) State the type of signal shown in **Fig.1**.

_____ [1]

(ii) Give a reason for your answer.

_____

_____ [1]

(iii) What does the X-axis represent in **Fig. 1**?

_____ [1]

(iv) What does the Y-axis represent in **Fig. 1**?

_____ [1]

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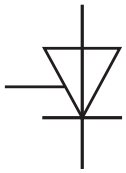
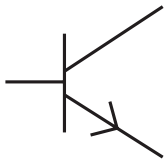
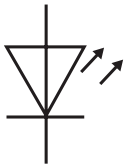
(b) (i) **Table 1** shows the symbols for **five** electronic components.
Insert the correct component name for each electronic symbol shown.

[5]

(ii) Each of the components function as either an input, process or output component. Complete **Table 1** by ticking (✓) the correct box for each component symbol. [5]

Table 1

Symbol	Component Name	Input	Process	Output
				
				
				
				
				

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(c) (i) **Fig. 2** shows a circuit in which **R1** = 10kΩ and **R2** = 2.2kΩ.

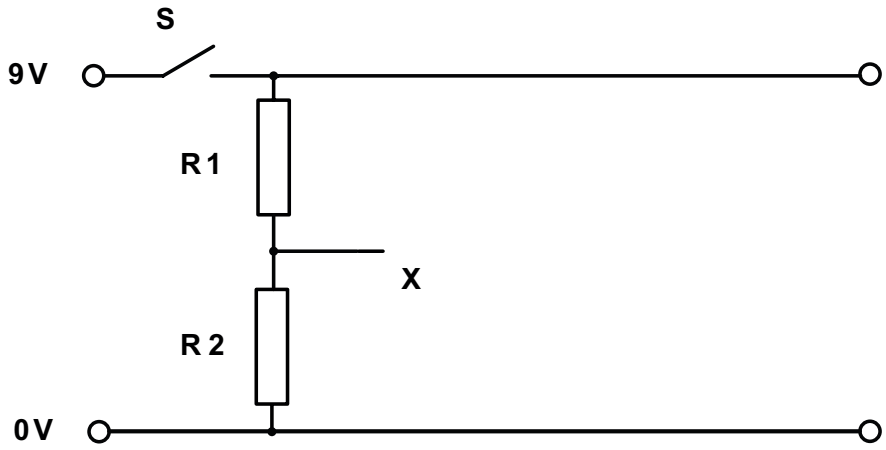

Fig. 2

In the space below calculate the expected output at **X** when the switch **S** is closed.

Calculation

Answer _____ [4]

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In **Fig. 3**, **R2** has been replaced with component **B** and an additional part of the circuit has been added between **C** and **D**.

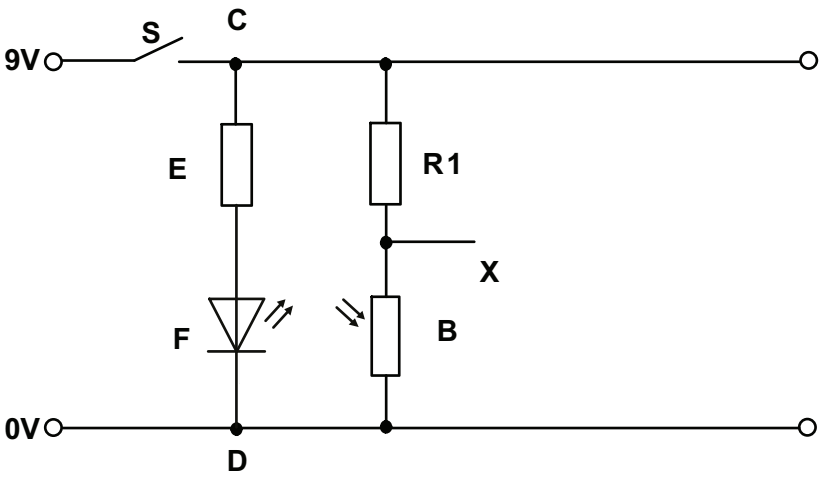

Fig. 3

(ii) Name the component labelled at **B** in **Fig. 3** and explain the effect it will have on the operation of the output.

Name _____ [1]

Effect _____

_____ [2]

(iii) Name the component labelled **F** in **Fig. 3** and outline its purpose in the circuit.

Name _____ [1]

Purpose _____ [1]

(iv) What does the resistor **E** protect component **F** against in **Fig. 3**?

_____ [2]

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(v) When the circuit in **Fig. 3** was tested by operating switch **S** component **F** was damaged and would not operate.

What is the likely cause of the damage to component **F**?

_____ [1]

(vi) If component **F** was rated at 2V, 6mA calculate in the space below the value of the resistance needed.

Calculation

Answer _____ [4]

(vii) The values for the E12 series of resistors are shown below. What is the value of the resistor that should be used as the replacement at **E** in **Fig. 3**?

1.0 1.2 1.5 1.8 2.2 2.7 3.3 3.9 4.7 5.6 6.8 8.2

Resistor _____ [1]

(viii) The resistor has a tolerance of 10%. What is the colour of the fourth band on the resistor?

_____ [1]

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(d) The circuit shown in **Fig. 3** is to be developed to enable a 12V motor to be operated from a separate circuit as shown in **Fig. 4**.

Complete **Fig. 4** to enable the 12V motor to operate as described.

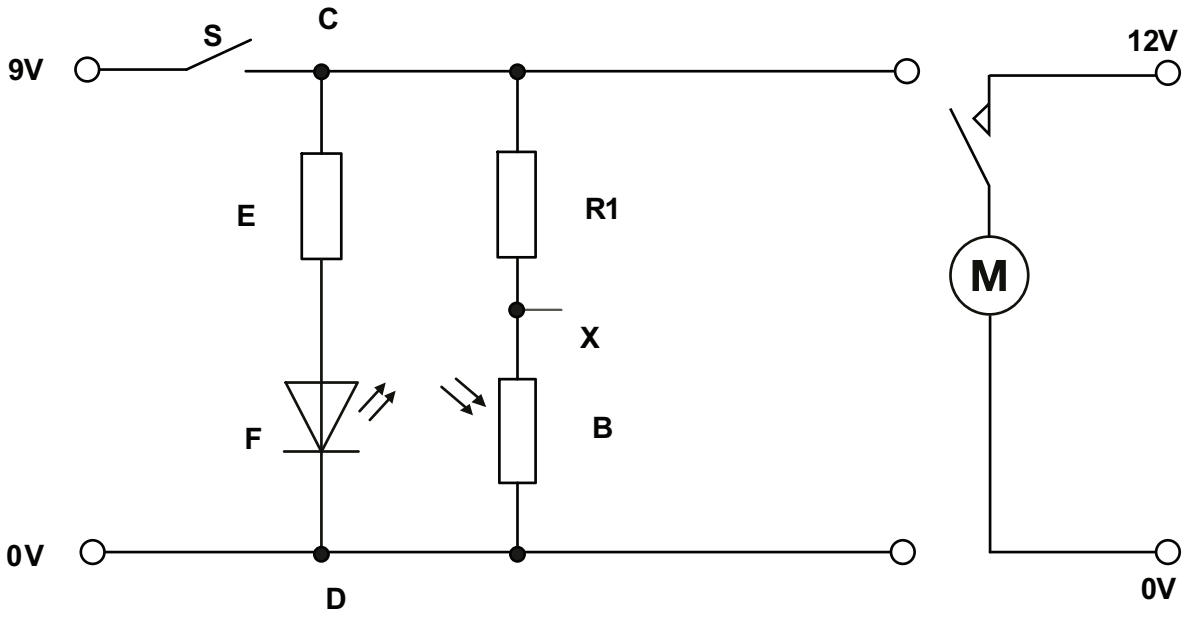

Fig. 4

[8]

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2 **(a)** **(i)** Outline **two** features of Microcontrollers (PICs).

1. _____

_____ [1]

2. _____

_____ [1]

(ii) Give **two** reasons why a macro is used in some flowchart designs.

1. _____

_____ [1]

2. _____

_____ [1]

(iii) In the space below sketch the electronic symbol for a relay coil.

[1]

(iv) What additional component is usually connected in parallel with a relay coil in a circuit?

_____ [1]

(v) Explain why the output signal from a PIC circuit may need to be amplified.

_____

_____

_____ [2]

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(vi) Name **one** output device that requires amplification when controlled by a PIC.

_____ [1]

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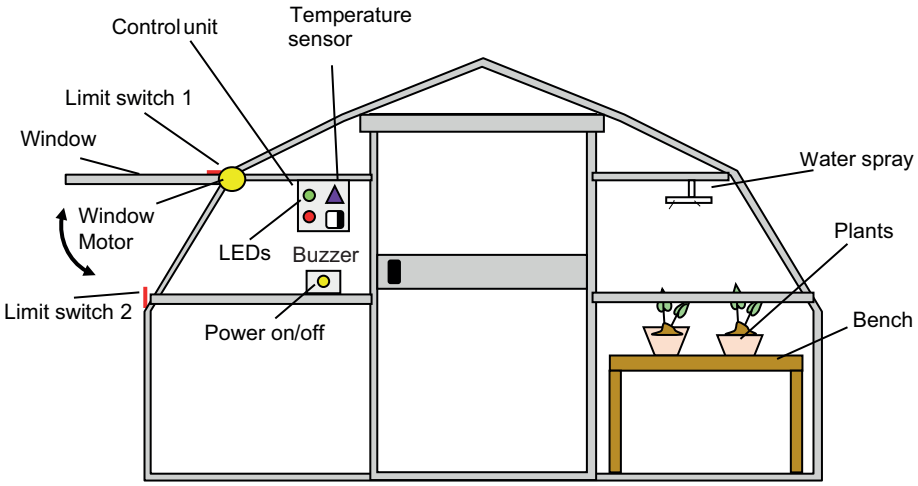
(b) **Fig. 5** shows a sketch of a model greenhouse. It is fitted with an automatic environmental climate control system programmed by a Microcontroller (PIC). The control system includes a control unit with two LEDs, a buzzer, a temperature sensor, window operating motor and control switch for the water spray.

The greenhouse window opens if the temperature inside is equal to or above 30°C and closes if the temperature is equal to or below 20°C. The plants will be watered if the temperature is above 30°C. The system has an overall power on/off switch.



Model Greenhouse
Fig. 5

Two of the PIC inputs and six of the PIC outputs are to be used to control the environmental climate system. The input connections are shown in **Table 2** and the outputs are shown in **Table 3**.

Table 2

PIC Inputs	Not used	Not used	Limit switch 2 '1' when activated	Limit switch 1 '1' when activated	Not used
BIT	4	3	2	1	0

Table 3

PIC Outputs	Not used	Window motor anticlockwise	Window motor clockwise	Water spray	Not used	Buzzer	Red LED	Green LED
BIT	7	6	5	4	3	2	1	0

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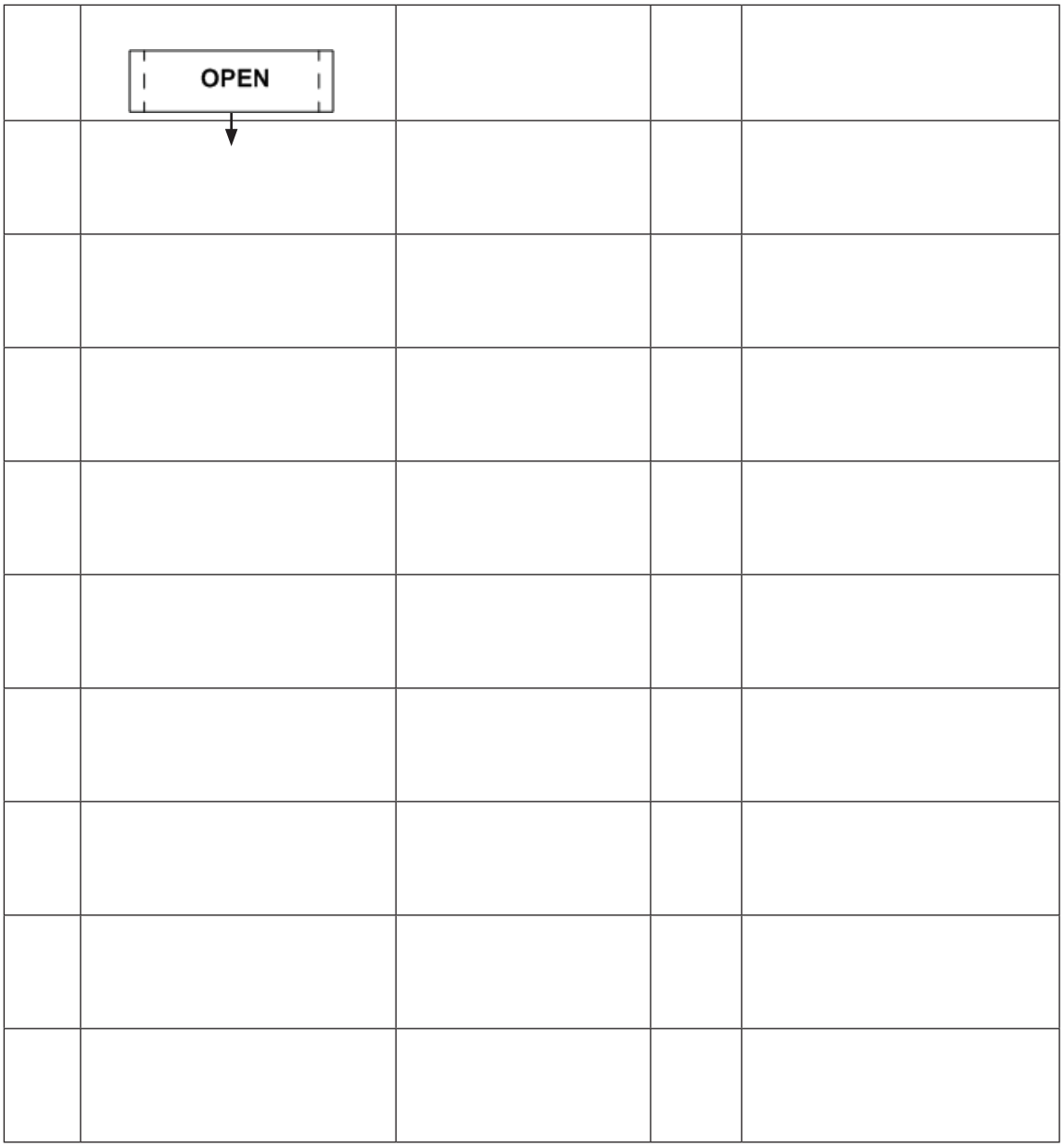
(i) Construct a series of flowcharts to represent the overall operating routine for the greenhouse climate control system:

Complete the macro flowchart **OPEN** in **Fig. 6** as follows:

The window motor will rotate clockwise to open the window and will turn off when limit switch 1 is activated. After three seconds the water spray will turn on for 10 seconds before the macro ends.

N.B. No BIT pattern required.



[10]

Fig. 6

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(c) Complete the flowchart and its output bit patterns in **Fig. 8** to show the full operation of the greenhouse climate control system:

When the power switch is turned on the program runs and the green LED will come on. When the temperature sensor reaches 30°C or more the red LED and buzzer will turn on and activate the **OPEN** macro. When the temperature drops to below 20°C or less the **CLOSED** macro is activated. After two seconds, the red LED and buzzer turn off. The system will repeat until the power switch is turned off. You may assume that the window is initially closed.

N.B. The full output bit patterns must be shown using: 'X' = not used; '0' = off and '1' = on.

	START			BIT PATTERN

[14]

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Fig. 8

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Question Number	Marks
1	
2	
Total Marks	

Examiner Number

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