cea

Rewarding Learning

Centre Number

71

Candidate Number

**General Certificate of Secondary Education
2013**

Technology and Design

Unit 2:
Systems and Control

Element 1: Electronic and
Microelectronic Control Systems

MV18

[GTD21]

FRIDAY 7 JUNE, AFTERNOON

TIME

1 hour, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces
provided at the top of this page.
Write your answers in the spaces provided in this question paper.
Answer **all** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.
Figures in brackets printed at the end of each question indicate
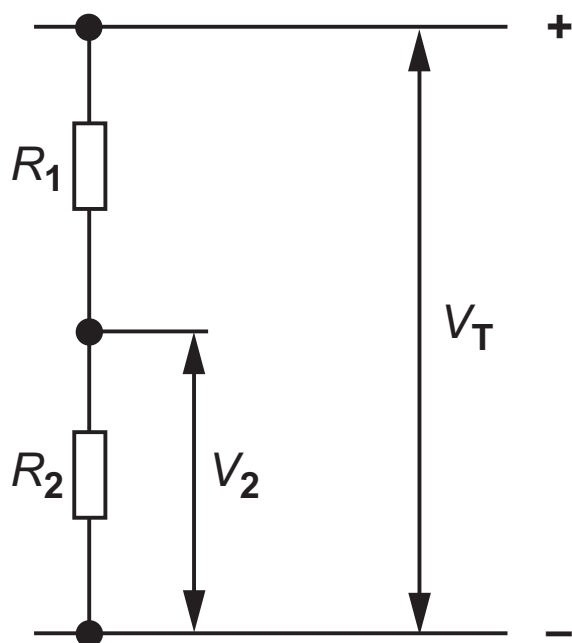the marks awarded to each question or part question.

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 $\dfrac{1}{R_T} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ or $R_T = \dfrac{R_1 \times R_2}{R_1 + R_2}$
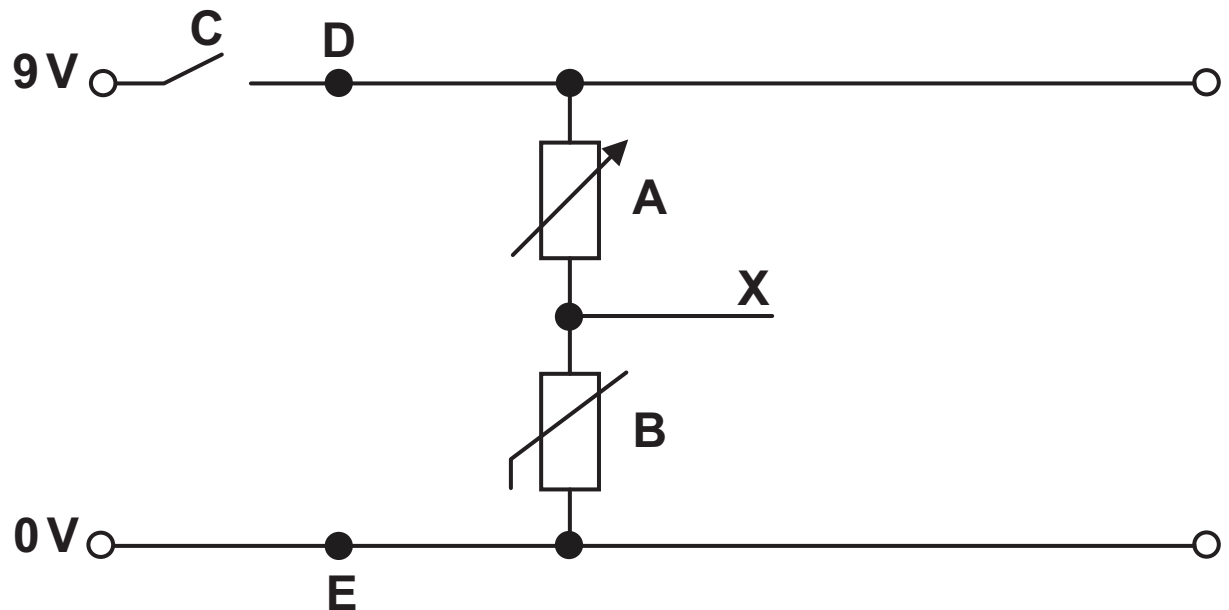
4 Time Constant $T = R \times C$

Answer **all** questions

1 **(a) (i)** In the space below produce a sketch of the symbol for an NPN transistor. [2]

(ii) Clearly label and name each of the **three** legs of the transistor. [3]

(iii) Outline how a transistor can be switched on when used in a circuit. [2]

_____

(b) Fig. 1 shows a Voltage Divider circuit diagram.

Fig. 1

(i) State another name for this circuit. [1]

_____

(ii) Name the components shown by their electronic symbols **A** and **B** in **Fig. 1**. [1 mark for each component]

A _____

B _____

(iii) What type of switch is shown at **C** in **Fig. 1**? [1]

_____

(iv) With reference to the labelled components **A**, **B** and **C** in **Fig. 1** explain how an output at point **X** is achieved. [4]

_____

_____

_____

_____

(c) The circuit in **Fig. 1** is to be developed by including a resistor and a LED between the **9 V** and **0 V** rails at points **D** and **E**.

(i) Show this addition to the circuit in **Fig. 1**. [4]

(ii) With reference to the labelled component **C** explain how the additional parts will function in the circuit. [4]

_____

_____

_____

(iii) What purpose will this additional part of the circuit serve? [1]

_____

(iv) If the LED used is rated at **2 V**, **6 mA** calculate in the space below the minimum value that should be used for the resistor. [4]

(d) A further development in the circuit is to add an NPN transistor to operate a relay when required.

(i) Develop the circuit in **Fig. 1** by adding the NPN transistor and relay coil to enable this operation. Include any additional components that may be required. Neatly label the relay coil. [7]

(ii) In the space below state the names of any additional components used and the reason for their use in the circuit. [4]

_____

_____

_____

_____

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[Turn over

(iii) Outline **one** possible use for the relay in this circuit. [1]

_____

_____

2 (a) Suggest a method of modelling an electronic circuit. [1]

_____

(b) Suggest a benefit of using this method of modelling. [2]

_____

_____

(c) Analogue and digital inputs are used in microcontroller circuits. They are usually defined by how they function within a circuit.

Outline the difference between a digital and analogue input signal. [2]

_____

_____

_____

_____

(d) Complete **Table 1** opposite to identify if the component is a digital or an analogue component. [4]

Table 1

Component	Digital/Analogue
7 Segment Display	
Toggle Switch	
LDR	
Reed Switch	

(e) Part of a basic PIC microcontroller circuit is shown in **Fig. 3**.

Insert on the part completed circuit in **Fig. 3**; the symbols for a 10 kΩ resistor at point **A**, an LDR at point **B**, a toggle switch at point **C** and a 1 kΩ resistor at point **D**. [4]

Fig. 3
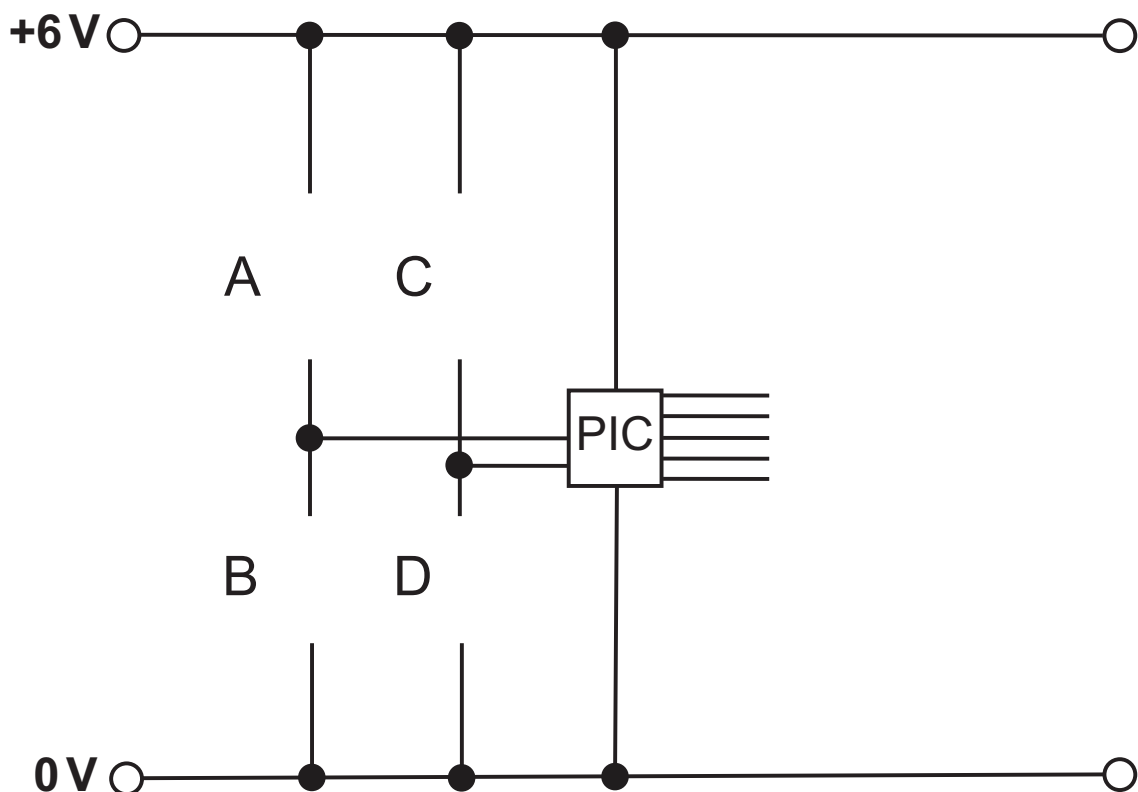
(f) A student is to design an electronic circuit for a rotating night-light using a PIC microprocessor. The night light is to operate automatically once the toggle switch is turned on. An LDR will act as a sensor to determine when the room becomes dark. The PIC microprocessor will control a motor and some LEDs.

The PIC has 2 inputs and 5 outputs.

The inputs and outputs are shown in **Tables 2** and **3**.

When the room is dark the LDR input will be high.

Binary 1 indicates high (on) and binary 0 indicates low (off).

Digital Panels

Table 2

BIT	1	0
PIC Input	Toggle Switch	LDR

Table 3

BIT	4	3	2	1	0
PIC OUTPUT	Motor	Blue LED	Green LED	Yellow LED	Red LED

Complete a series of flowcharts on pages 11 and 12 to represent the operating routines as follows:

(i) Complete a flowchart and its relevant bit patterns in **Fig. 4** to represent the LIGHTS macro as follows:

The red and yellow LEDs must turn on for 6 seconds. Two seconds after the red and yellow LEDs turn on the green and blue LEDs should turn on for 4 seconds. All LEDs should then switch off. After a delay of 2 seconds all LEDs should switch on and remain on for 10 seconds before they all switch off. The macro will then end. [9]

Fig. 4

	LIGHTS ↓			BIT PATTERN

(ii) Complete the flowchart in **Fig. 5** and its relevant bit patterns to represent the MOTOR LIGHTS macro as follows:

The motor will turn **on** for 2 seconds. The motor will then turn **on** for a further 10 seconds with all LEDs lit. The motor and LEDs will turn **off** and the macro will end. [6]

Fig. 5

	MOTOR LIGHTS ↓			BIT PATTERN

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(Questions continue overleaf)

(iii) Use **Fig. 6** to complete the flowchart for the full operation of the night light. [12]

Once the toggle switch is turned ON and the room has become dark, the following sequence should happen:

- The motor should turn ON for 25 seconds
- The LIGHTS macro should operate 20 times
- The MOTOR LIGHTS macro should operate
- The sequence should repeat as long as the room remains in darkness

Fig. 6

	START			BIT PATTERN

THIS IS THE END OF THE QUESTION PAPER

Sources

Pg 9, Q2(e), Fig. 3, Part of a circuit board with a PIC microcontroller circuit, Source: © New Wave Concepts Ltd

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