Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2016

Technology and Design

Unit 2:
Systems and Control

Element 1: Electronic and Microelectronic Control Systems

GTD21

[GTD21]
MONDAY 6 JUNE, 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 blue or 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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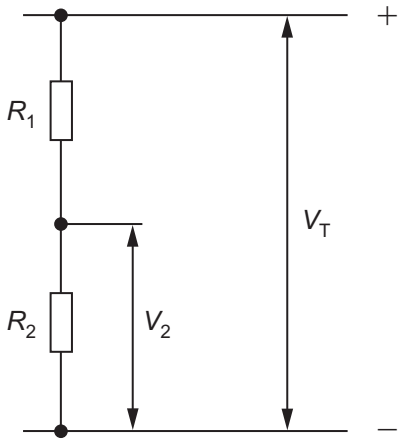
Formulae for GCSE Technology and Design

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 $T = R \times C$

[Turn over

Answer **all** questions

1 (a) (i) Ohm's Law can be expressed in three different ways. Complete the formula in each case below.

V =

I =

R =

[3]

(ii) Use Ohm's Law to calculate the current which goes through the resistor shown in **Fig. 1** and the resistor shown in **Fig. 2**.

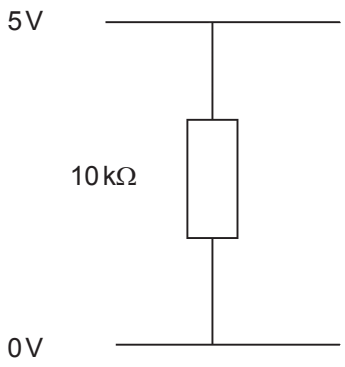


Fig. 1

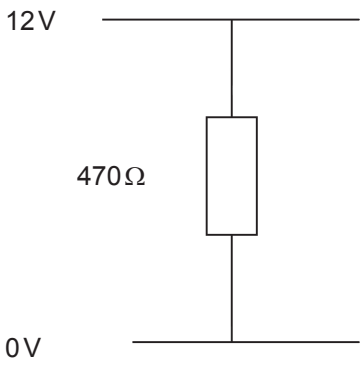


Fig. 2

Current Fig. 1 _____ [2]

Current Fig. 2 _____ [2]

(iii) State the function of an ammeter and a voltmeter when used in a circuit.

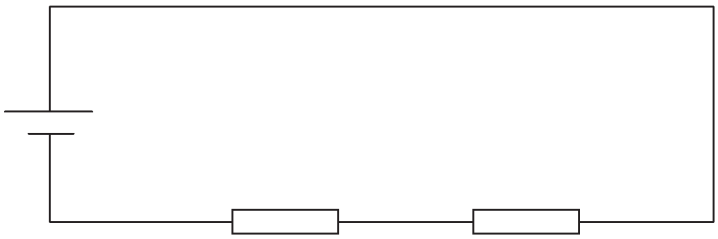
Ammeter _____

_____ [1]

Voltmeter _____

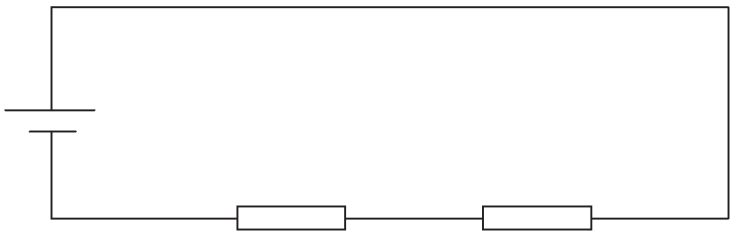
_____ [1]

(iv) Using the correct electronic symbol show how an ammeter could be connected in the circuit below.



[2]

(v) Using the correct electronic symbol show how a voltmeter could be connected in the circuit below.



[2]

[Turn over

(b) (i) Name the component labelled B in **Fig. 3** below.

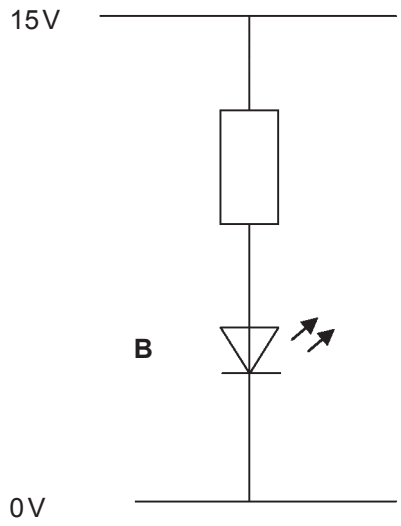


Fig. 3

_____ [1]

(ii) If component B is rated at 2 V, 20 mA, calculate in the space below the minimum value for the resistor in **Fig. 3**.

[3]

(iii) State the tolerance for the E12 series of resistors.

Tolerance _____ [1]

(c) (i) Name the electronic component represented by the symbol in **Fig. 4**.

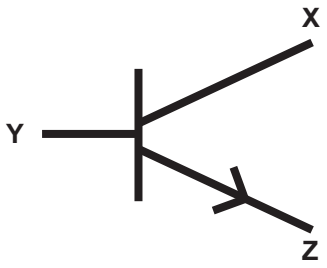


Fig. 4

_____ [1]

(ii) Name each part of the symbol labelled at **X**, **Y** and **Z**.

Point **X** _____ [1]

Point **Y** _____ [1]

Point **Z** _____ [1]

(iii) Explain how the component should operate or respond when connected in a circuit.

_____

_____ [2]

[Turn over

(d) A circuit is shown in **Fig. 5**. The power supply required is 9 V. Resistor R1 has a value of 1.8 kΩ and resistor R2 has a value of 2.2 kΩ.

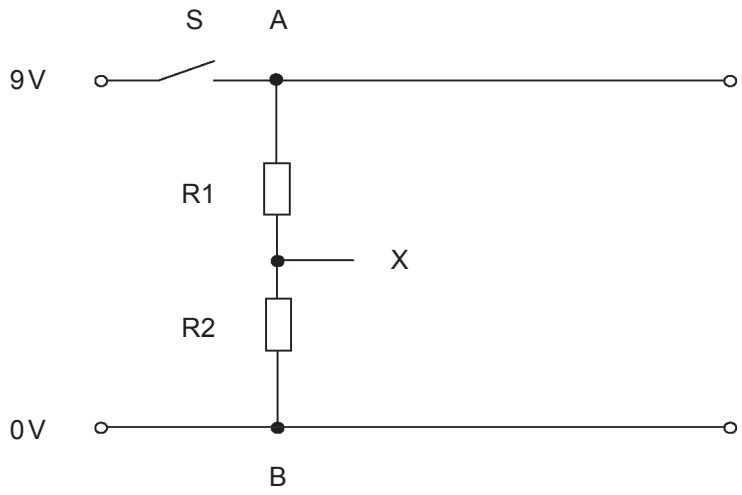


Fig. 5

A number of 1.5 V batteries are required to provide the 9 V supply for the circuit.

(i) State how they should be connected together.

_____ [1]

(ii) State the number of batteries required.

_____ [1]

(iii) Name that part of the circuit connected between A and B.

_____ [1]

(iv) Calculate the output voltage at point X when the switch S is pressed.

Output Voltage _____ [4]

(e) **Fig. 6** shows a circuit under construction.

(i) Complete the circuit to enable a buzzer to operate when required. Your solution should include the symbol shown in **Fig. 4**, a buzzer symbol, a diode symbol and the one additional component symbol needed. [6]

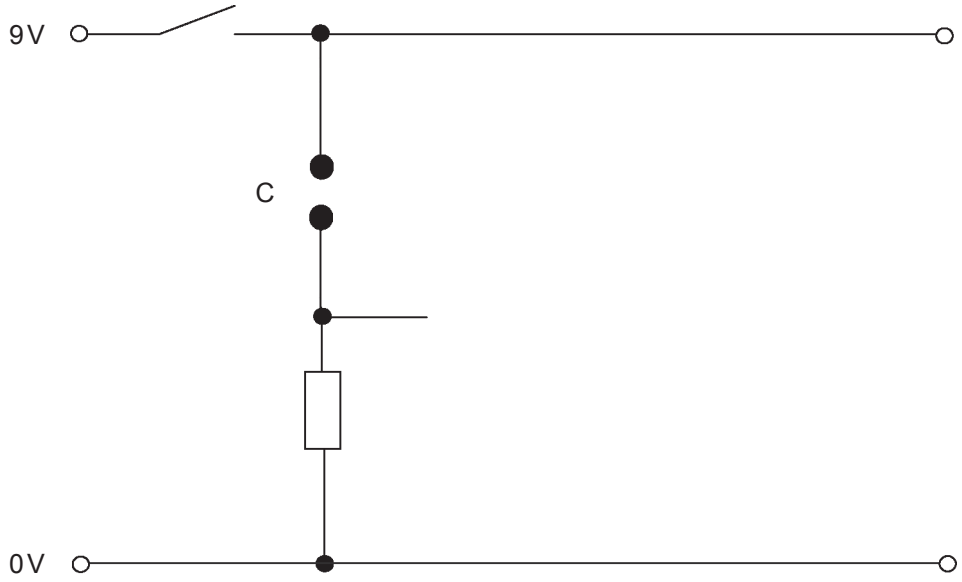


Fig. 6

(ii) Name the component symbol labelled C in **Fig. 6**.

_____ [1]

(iii) Briefly explain how the buzzer is activated in the completed circuit.

_____

_____

_____ [2]

[Turn over

2 **(a)** **Fig. 7** shows an incomplete PIC circuit. Complete the circuit as follows:

- add the power connections to the PIC;
- add the appropriate component symbols so that the PIC may control the motor. [5]

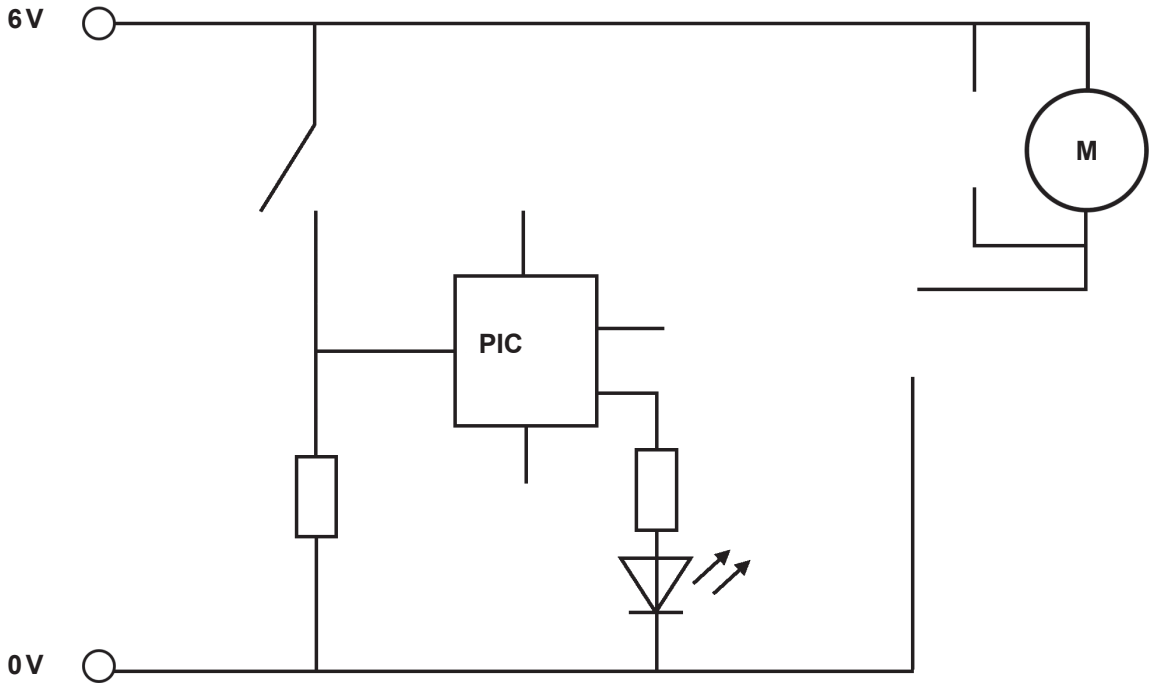


Fig. 7

(b) **(i)** What **two** digital numbers are used in Bit Patterns?

_____ [1]

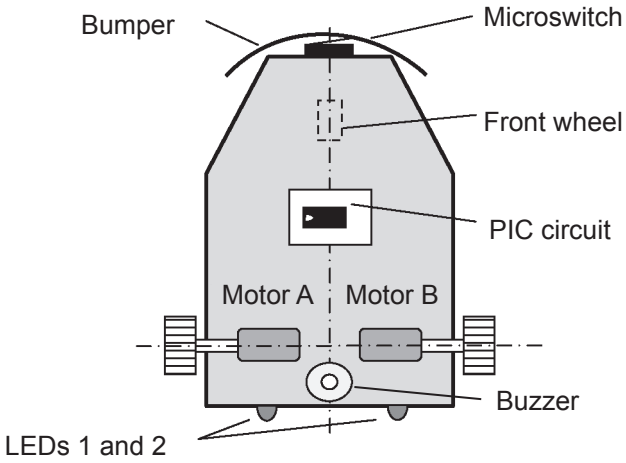
(ii) What is a main function of a Bit Pattern when used in a flow chart?

_____

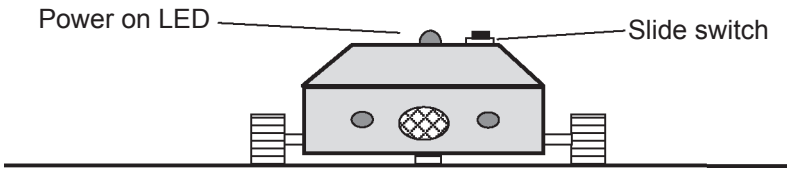
_____ [2]

(c) **Fig. 8** shows two views of a motorised buggy. The buggy is to be programmed using a Microcontroller (PIC). It is to travel in a set routine within a wooden box as shown in **Fig. 9**.

The slide switch is connected as an input to the PIC circuit. The “Power on” LED is also controlled by the PIC. The buggy has two small motors attached to the rear wheels to enable it to move and a front wheel for stability. The buggy is fitted with a microswitch which is attached to the front bumper to detect if the buggy comes into contact with the sides of the box. When this happens, the buggy will stop. Then LEDs 1 and 2 will flash and the buzzer will sound. The buggy will then reverse and turn to the right through 90° and move forward again. This process is continued until the slide switch is turned off.



Plan View (without body)



Rear View (with body)

Fig. 8

[Turn over

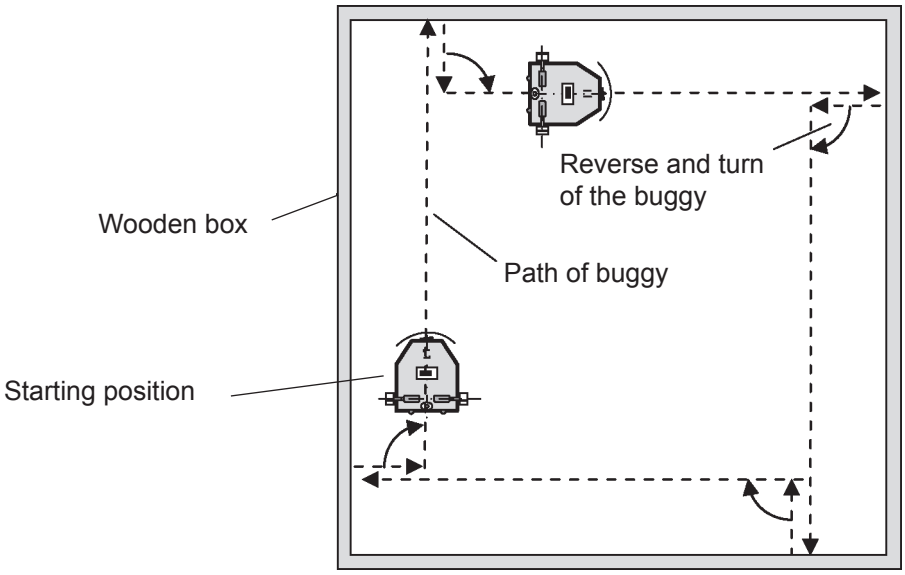


Fig. 9

Complete a series of flow charts for the buggy using the correct flow chart symbols.

(i) Complete the flow chart in **Fig. 10** to represent the **FORWARD** macro as follows:

The two motors **A** and **B** will come on and move the buggy forward. When the microswitch attached to the bumper is operated the two motors will stop and end the macro.

	FORWARD			

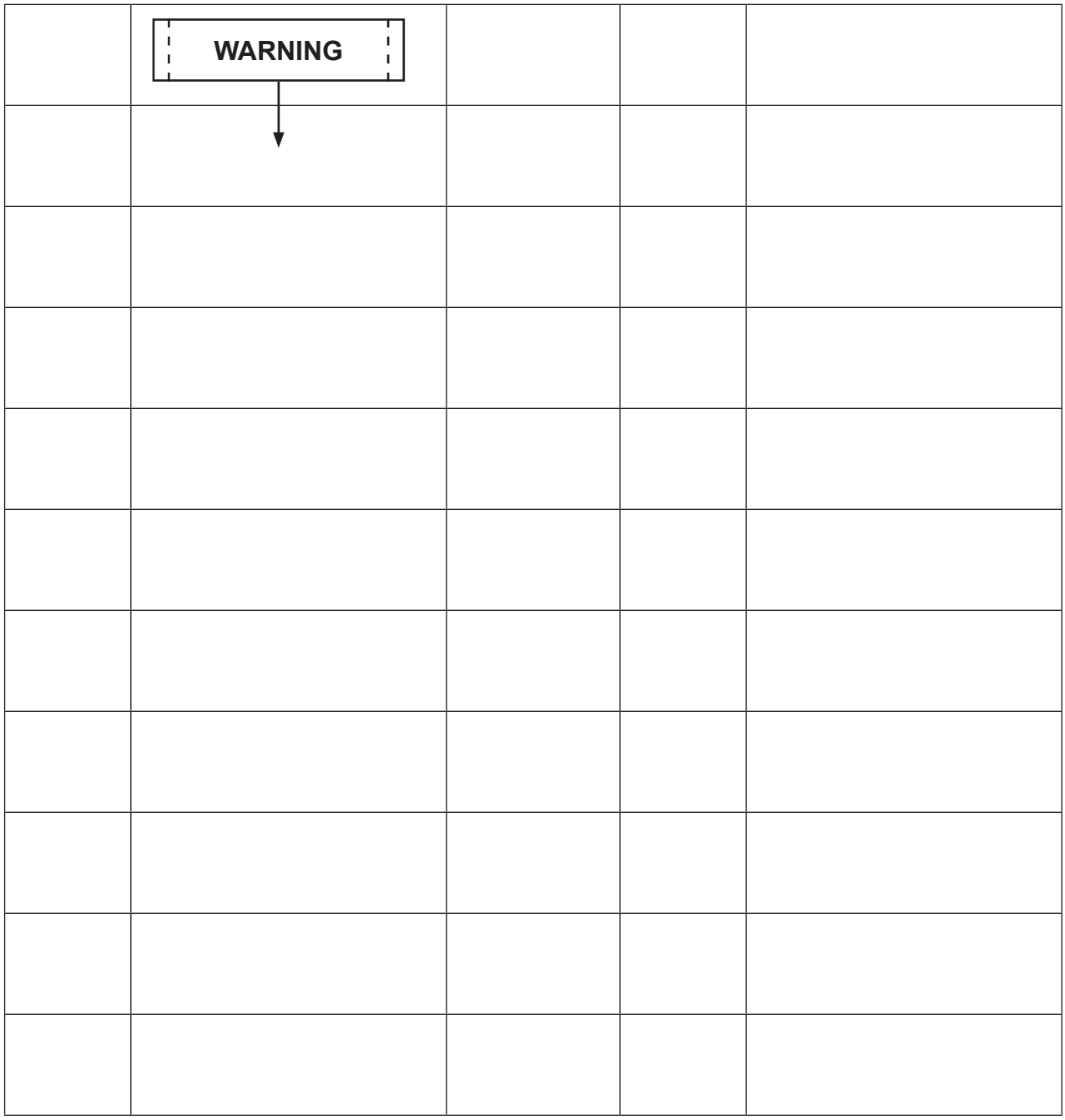
[4]

Fig. 10

[Turn over

(ii) Complete the flow chart in **Fig. 11** to represent the **WARNING** macro as follows:

The buzzer with LEDs **1** and **2** will come on for one second and then switch off for one second. This sequence should operate **four** times before ending.

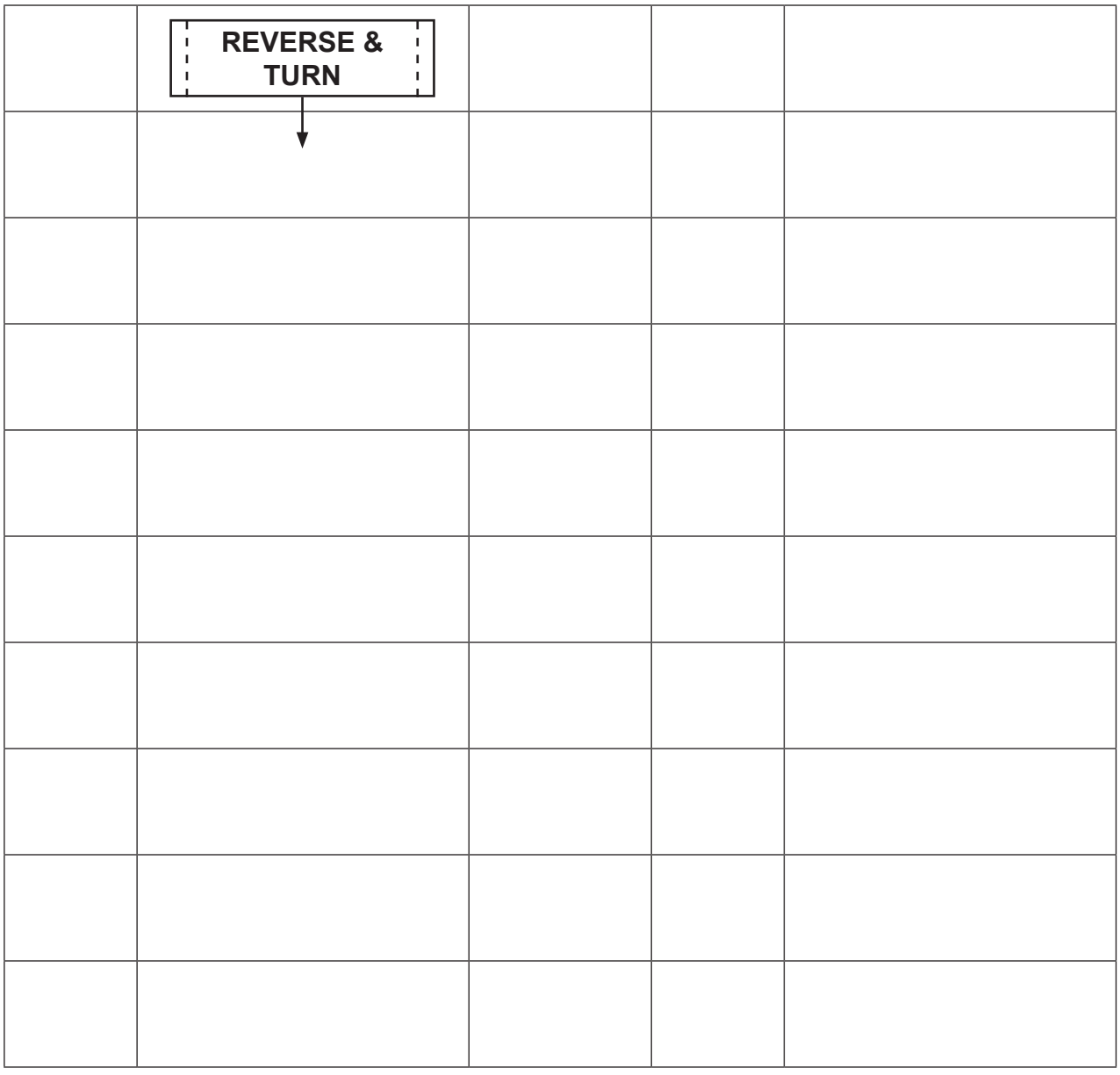


[9]

Fig. 11

(iii) Complete the flow chart in **Fig. 12** to represent the **REVERSE & TURN** macro as follows:

The **WARNING** macro will operate. The two motors **A** and **B** will turn on for four seconds, reversing the buggy before stopping. Motor **A** will switch on after a one second delay to turn the buggy to the right through 90°. This motor operates for three seconds, before switching off to end the macro.



[9]

Fig. 12

[Turn over

(iv) Complete the flow chart in **Fig. 13** to show the full operation of the buggy.

When the slide switch is operated, the power LED is turned on and the **FORWARD** and **REVERSE & TURN** macros will operate. There is then a two second delay. This process will repeat until the slide switch is turned off.

	START			
	↓			

[10]

Fig. 13

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Question Number	**Marks**
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Total Marks	

Examiner Number