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Candidate Numb

General Certificate of Secondary Education
2014

Technology and Design

Unit 2:
Systems and Control

Element 1: Electronic and
Microelectronic Control Systems

MV18

[GTD21]

TUESDAY 3 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.
Questions which require drawing or sketching should be completed using an HB pencil. All other questions must be completed in blue or black ink.
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.

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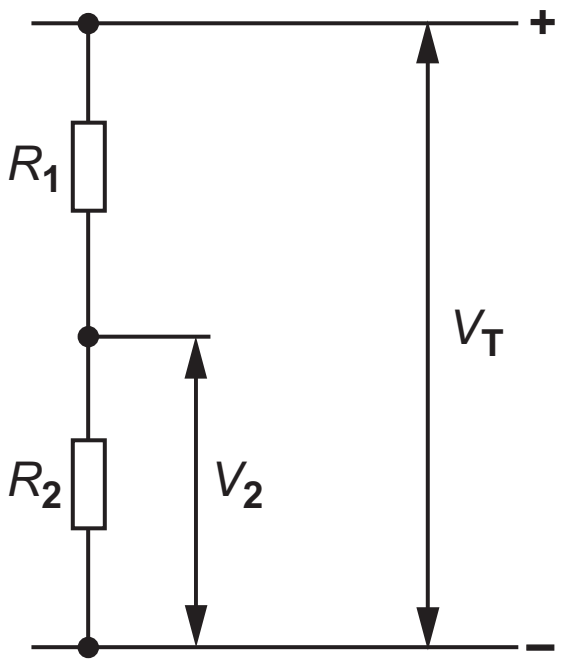
Formulae for GCSE Technology and Design

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) With reference to integrated circuits what does DIL mean? Explain with the aid of a sketch how pin one can be identified.

DIL [1 mark] _____

Sketch

Identity of pin one [2 marks] _____

_____

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(b) (i) Calculate the value of the single resistor which could replace the three resistors shown in **Fig. 1** below. [2 marks]

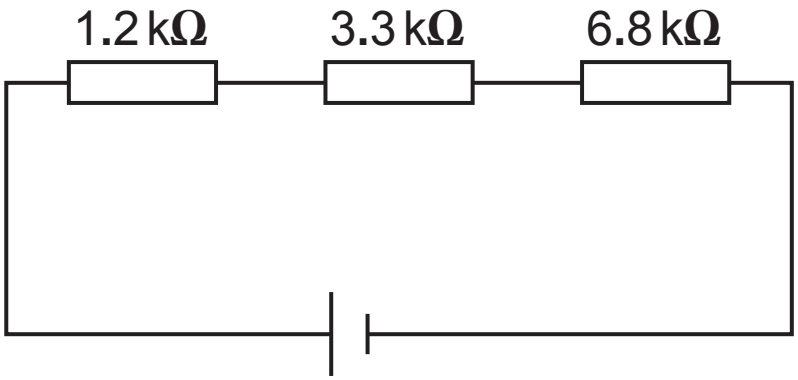

Fig. 1

Calculation

(ii) Using the colour code below identify the colour of the first three bands of the 6.8 kΩ resistor shown in **Fig. 1**. [3 marks]

0 = Black 1 = Brown 2 = Red 3 = Orange 4 = Yellow
5 = Green 6 = Blue 7 = Violet 8 = Grey 9 = White

Colour of Band 1 _____

Colour of Band 2 _____

Colour of Band 3 _____

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(iii) Calculate the combined value of the two resistors shown in **Fig. 2** below. Each resistor has a value of 6.8 kΩ. [3 marks]

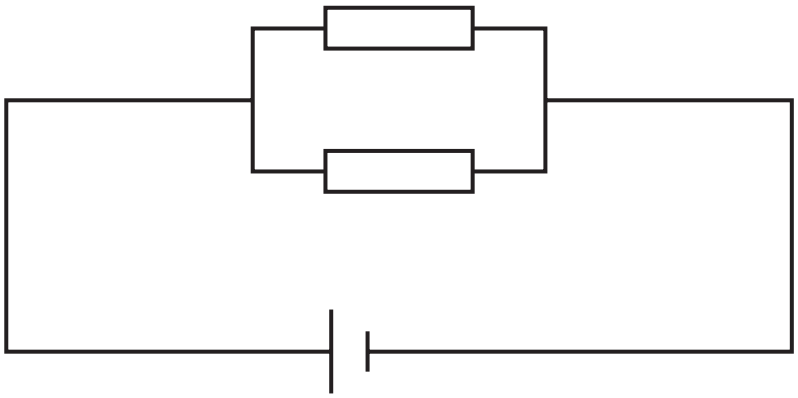

Fig. 2

Calculation

(iv) Calculate the maximum and minimum values that the 6.8 kΩ resistor may have if it has a 5% tolerance. [3 marks]

Calculation

(v) Complete the sentence below by inserting the missing words. [2 marks]

The resistors in **Fig. 1** on page 5 are said to be connected in _____ while the resistors in **Fig. 2** are said to be connected in _____.

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(c) The potential divider circuit in **Fig. 3** is often used in preference to the potential divider circuit shown in **Fig. 4**.

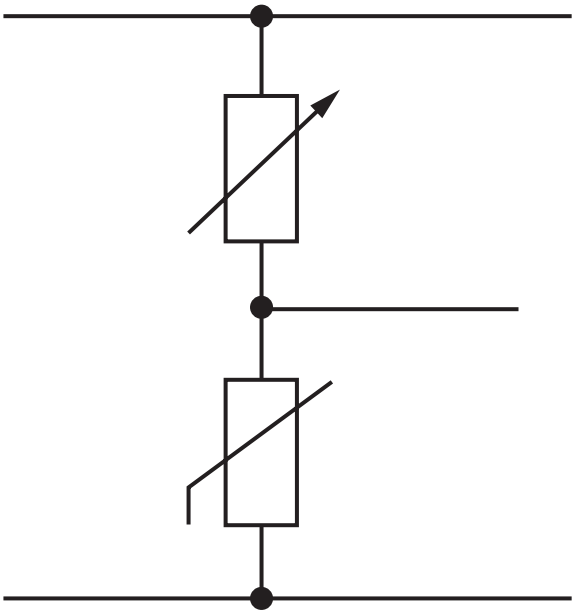

Fig. 3

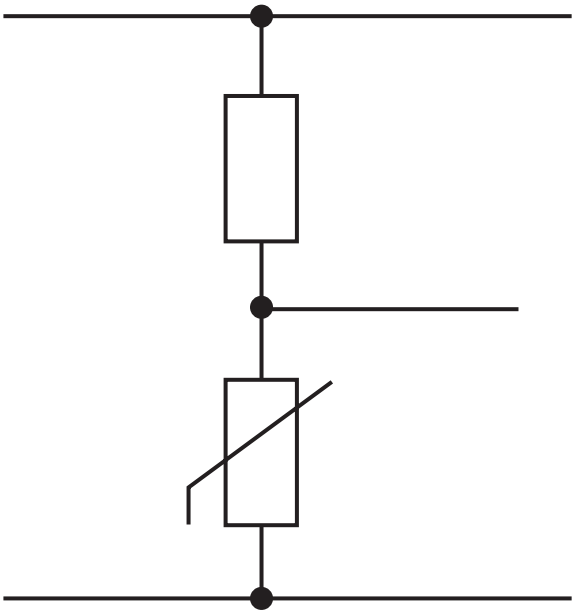

Fig. 4

State the difference between the two potential divider circuits shown and explain why the potential divider circuit shown in **Fig. 3** would be used in preference to the potential divider circuit shown in **Fig. 4**.

Difference [1 mark] _____

Explanation [2 marks] _____

_____

_____

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(d) Potential divider circuits form part of timing circuits as shown in **Fig. 5**. A timing circuit produces either an astable or monostable output.

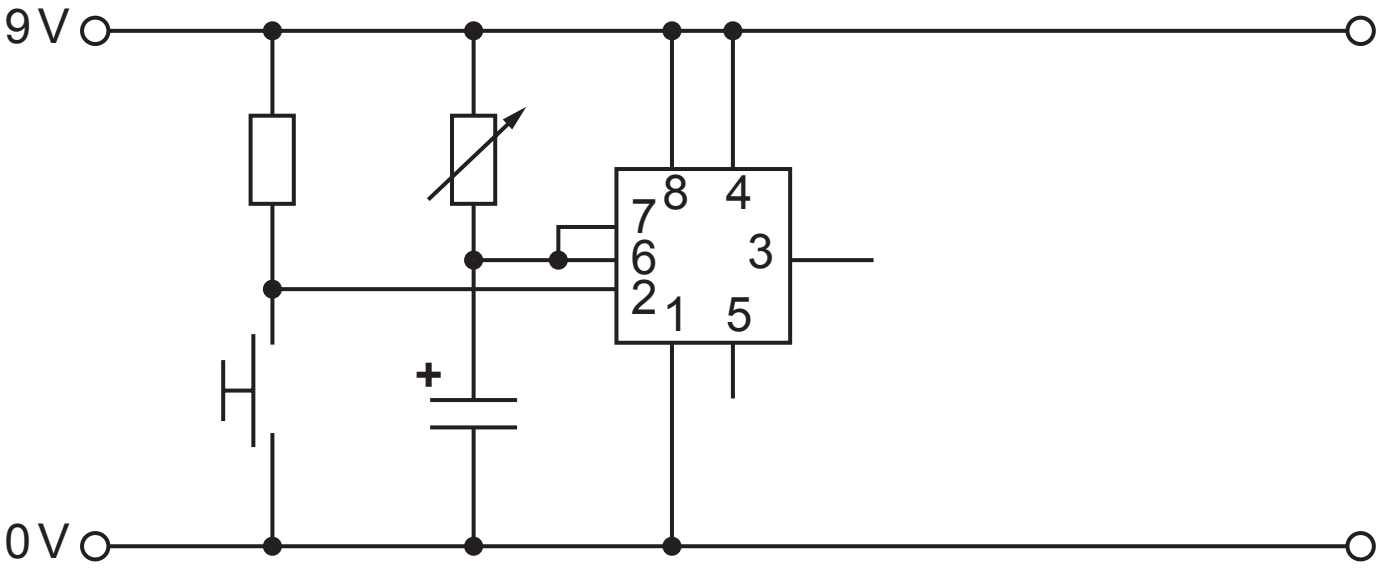

Fig. 5

(i) Explain what an astable output is and what a monostable output is.

Astable output [2 marks] _____

_____

_____

_____

Monostable output [2 marks] _____

_____

_____

_____

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(ii) Does the circuit in **Fig. 5** produce a monostable or an astable output? [2 marks]

_____

(iii) Name the integrated circuit (IC) component used in the circuit to provide the output. [1 mark]

_____

(iv) Outline what is meant by the term time constant. [2 marks]

_____

_____

_____

(v) Use the capital letters **A** and **B** to clearly mark on **Fig. 5** the two components used to provide the time constant. [2 marks]

(vi) Name the **two** components used in the circuit to provide the time constant. [2 marks]

_____

_____

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(vii) Outline how the time constant in this circuit can be changed. [2 marks]

_____

_____

_____

(viii) An LED is to be fitted in the circuit to indicate when the output is high. Complete the circuit in **Fig. 5** on page 8 so that the LED will operate as described. [6 marks]

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2 The incomplete circuit diagram in **Fig. 6** shows part of a primary PIC circuit and a secondary circuit. The secondary circuit requires a 12 volt supply and a 12 volt motor.

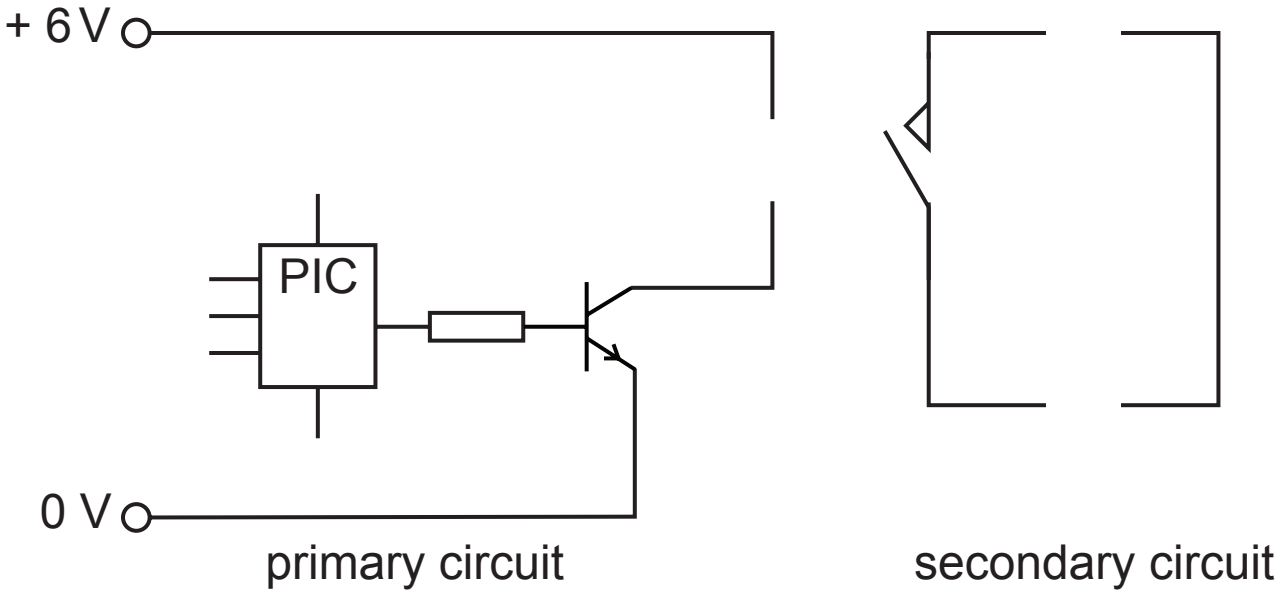

Fig. 6

(a) (i) Complete **Fig. 6** by inserting symbols for a relay coil, a diode, a 12 volt supply and a motor in the correct locations. [4 marks]

(ii) What is the purpose of the diode in the circuit? [1 mark]

_____

_____

(iii) Suggest a reason for the use of a secondary circuit. [1 mark]

_____

_____

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(b) An outline sketch of a steady hand game is shown in **Fig. 7**. The circuit to operate the steady hand game contains a PIC. The PIC flowchart includes 3 macros called, **DISPLAY**, **ATTEMPTS** and **SOUND**. Each macro will have a specific function:

- **DISPLAY** – to activate the 3 LEDs
- **ATTEMPTS** – to count the number of failed attempts
- **SOUND** – to activate a buzzer after the third failed attempt

To start the game the **DISPLAY** macro must first be turned on.

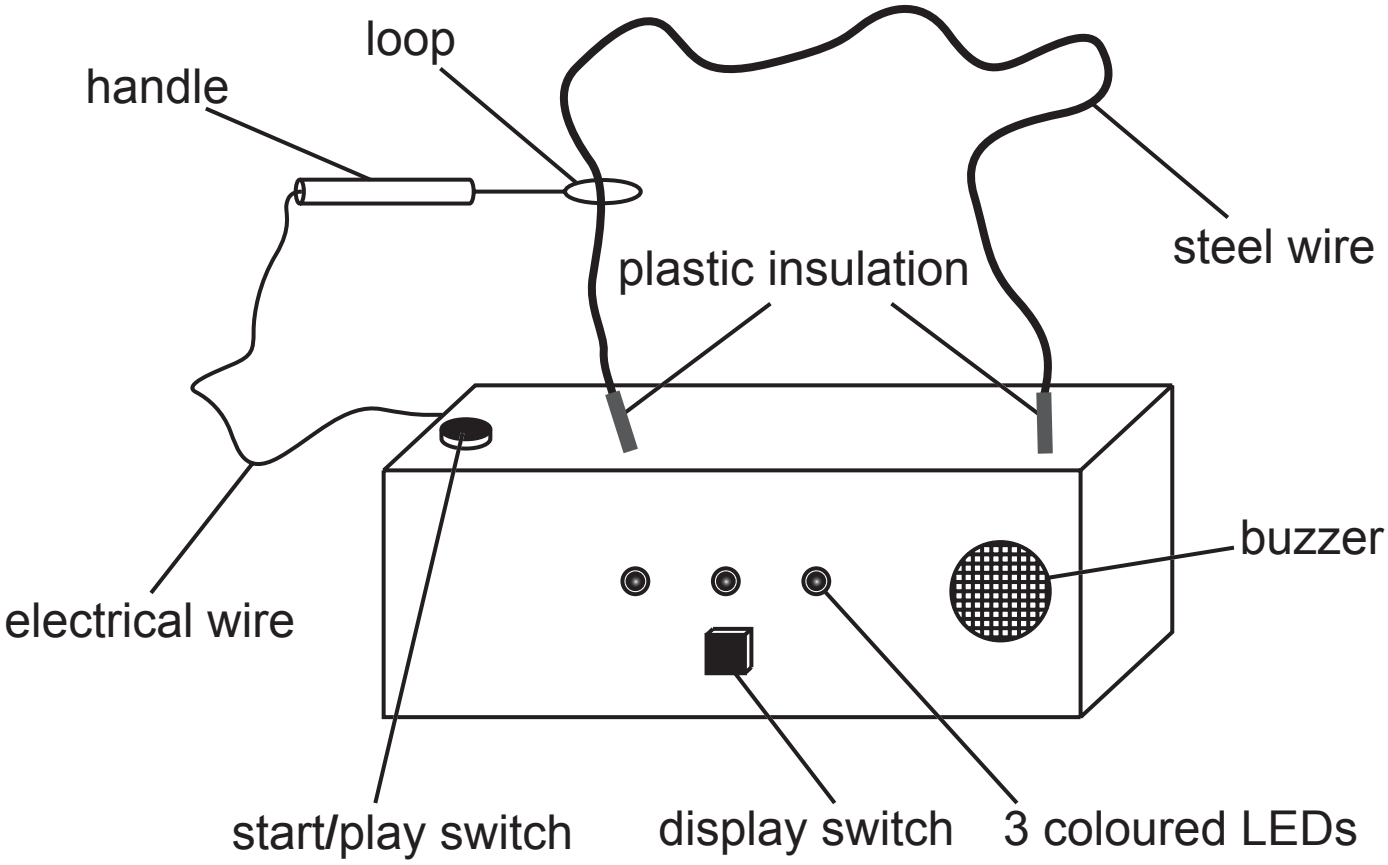

Fig. 7

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Tables 1 and **2** show the inputs and outputs which are used in the PIC circuit.

Table 1

PIC Inputs	Not used	Not used	Start/Play Switch	Display Switch	Loop Contacts Steel Wire
BIT	4	3	2	1	0

Table 2

PIC Outputs	Not used	Not used	Not used	Buzzer	Not used	Green LED	Yellow LED	Red LED
BIT	7	6	5	4	3	2	1	0

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(i) Macro 1 DISPLAY

A display showing 3 different coloured LEDs will operate when the display switch is turned on.

Complete the **DISPLAY** macro in **Fig. 8**. When the display switch is turned on a red LED will turn on. Then after 0.5 seconds a yellow LED will turn on and after another 0.5 seconds a green LED will turn on. When all the LEDs are on the macro ends.

Beside each input and output cell, indicate the relevant bit pattern. [10 marks]

	DISPLAY			BIT PATTERN

Fig. 8

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(ii) Macro 2 ATTEMPTS

Complete the **ATTEMPTS** macro in **Fig. 9** as follows:

During the game the player will have 3 chances. Each time the loop touches the steel wire an LED will turn off. The green LED will turn off first, then the yellow LED and finally the red LED will turn off. When all the LEDs are off the macro ends.

Show the relevant bit pattern opposite each input and output cell. [10 marks]

	ATTEMPTS			BIT PATTERN

Fig. 9

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(iii) Macro 3 SOUND

When all the LEDs are turned off a buzzer will switch on and off five times.

Complete the **SOUND** macro in **Fig. 10** to enable the buzzer to switch on and off five times before ending. The buzzer should remain on for 2 seconds and switch off for 1 second each time.

Bit patterns are not required. [7 marks]

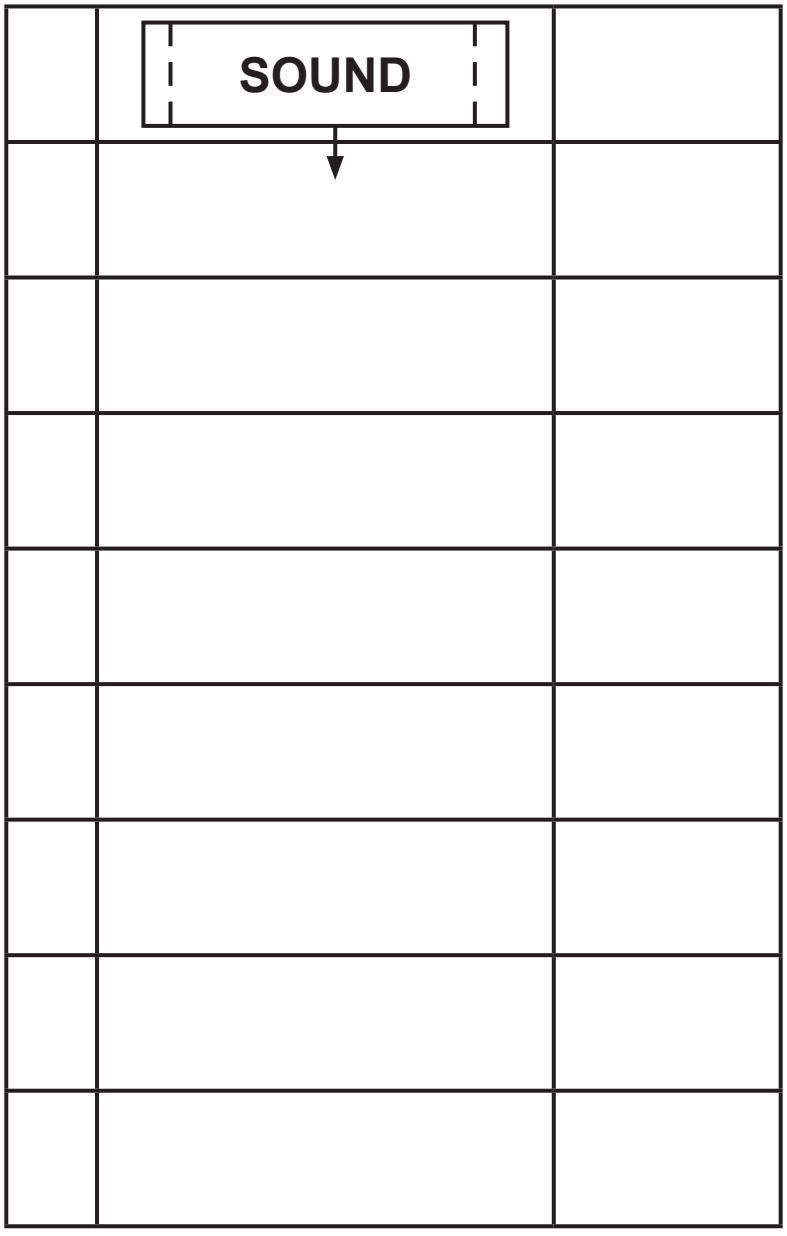

Fig. 10

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(c) Complete the flow chart in **Fig. 11** to represent the steady hand game program as follows:

To start the game the **DISPLAY** macro must operate first. The start/play switch is then turned on.

This is then followed by the **ATTEMPTS** macro.
After 1 second delay the **SOUND** macro then operates.

The game is now over.

Bit patterns are not required. [7 marks]

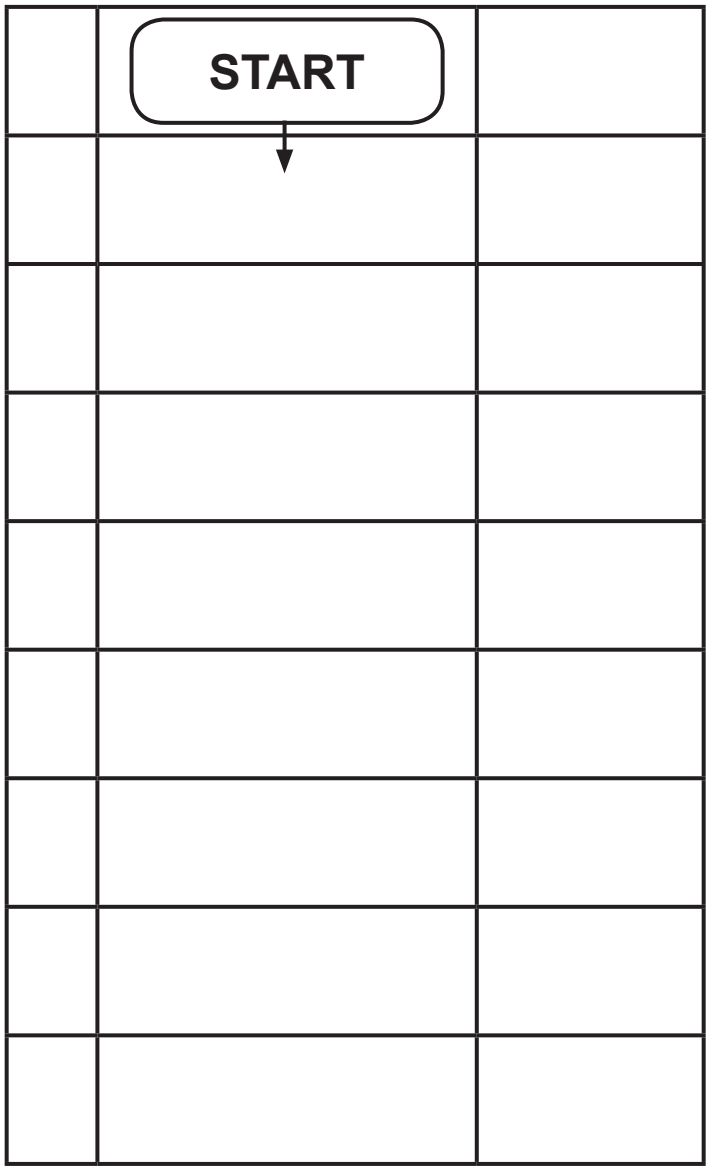

Fig. 11

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THIS IS THE END OF THE QUESTION PAPER

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Question Number	Marks
1	
2	
Total Marks	

Examiner Number

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