Surname

Other Names

Candidate Signature

AQA

General Certificate of Secondary Education
June 2013

Design and Technology: Electronic Products   45401

Unit 1   Written Paper

Wednesday 22 May 2013   1.30 pm to 3.30 pm

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

You may use a calculator.

Time allowed
- 2 hours

Instructions
- Use black ink or black ball-point pen.
- 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 answer 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.
- The question in Section A relates to the context referred to in the preliminary material that was previously issued.
- 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.

You may need to use one or more of the following formulae when answering questions which include calculations.

Potential Difference   Potential Difference = Current x Resistance   (V = I x R)

Series Resistors R_{total} = $R_1 + R_2 + R_3$ etc

Potential Divider

Vs

R_1

V out

$$V\ out\ =\ \frac{R_2}{R_1 + R_2}\ x\ Vs$$

where   V out = signal value
Vs = supply voltage
R_1 and R_2 are resistance values

R_2

0V

Time Constant   Time Constant $\simeq$ Resistance x Capacitance   (T $\simeq$ R x C)

Astable Frequency for 555 $f\ =\ \dfrac{1.44}{(R_1 + 2R_2)\ x\ C}$

Mark Space Ratio $=\ \dfrac{Time\ high}{Time\ low}$

Time High $=\ 0.693\ x\ (R_1 + R_2)\ x\ C$

Time Low $=\ 0.693\ x\ R_2\ x\ C$

Inverting Op. Amps   Gain $=\ \dfrac{-\ Rf}{Rin}$ Where Rf = feedback resistor value
Where Rin = input resistor value

You may need to use the following information when answering some of the questions.

The figures shown below and their decade multiples or submultiples are the series of preferred values in accordance with BS:2488.

E12 Resistor series   10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82

E24 Resistor series   10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91

Capacitor series   10, 22, 47

Resistor Colour Code

Colour	Band 1	Band 2	Band 3 (No. of 0s)	Band 4 (Tolerance)
Black	0	0	None	
Brown	1	1	0	
Red	2	2	00	
Orange	3	3	000	
Yellow	4	4	0000	
Green	5	5	00000	
Blue	6	6	000000	
Violet	7	7	–	
Grey	8	8	–	
White	9	9	–	
				Gold = 5%
				Silver = 10%

Turn over for the first question

Turn over ▶

Section A

Answer **all** questions in the spaces provided.

You are advised to spend about 35 minutes on this question.

1   This question is about designing an electronic location device.

Model aircraft can easily be lost from sight and can be hard to locate if they land some distance from the user.

You have been asked to design a suitable electronic product to attach to a model aircraft to help locate it.

You are to design a product that meets the following specification:

- the product needs to attach securely to a model aircraft
- it must alert the owner to the aircraft location
- it must be able to be switched on and off easily
- it is battery powered
- it is waterproof, shockproof and lightweight
- the design is visually appealing.

1 (a) You may consider using different components as output devices.

Draw the circuit symbol for each component in the boxes below.

Component	Image	Circuit Symbol
Lamp		
Buzzer		

(2 marks)

1 (b) State **two** advantages for each component.

Lamp

Advantage 1 ....

....

Advantage 2..

....

Buzzer

Advantage 1..

....

Advantage 2..

....

(4 marks)

Turn over ▶
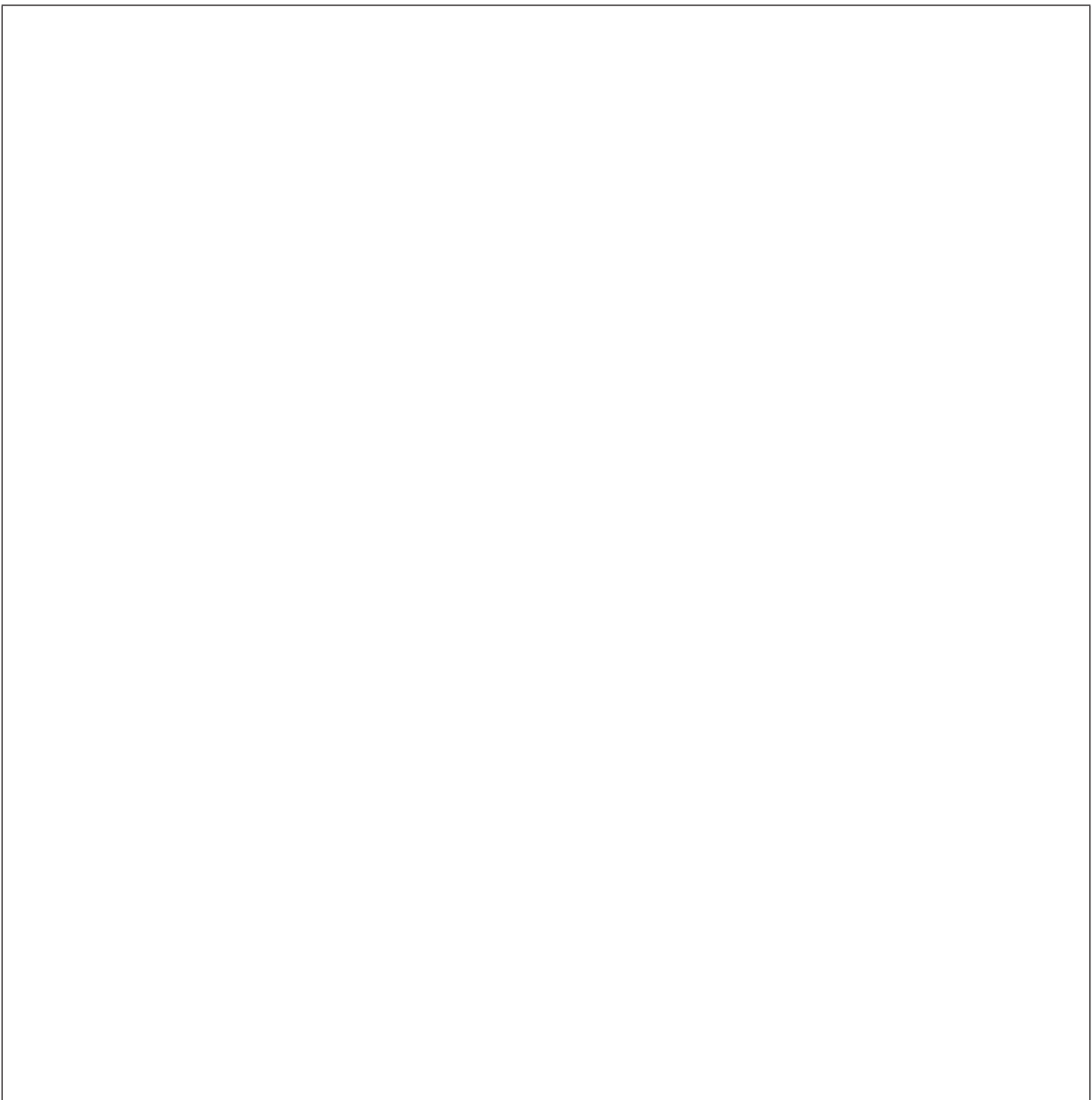
1 (c) The manufacturer has decided that the product will have a flashing light output.

Use notes and sketches to produce an idea for the design of the **outside** of the product casing.

Marks will be awarded for the following:
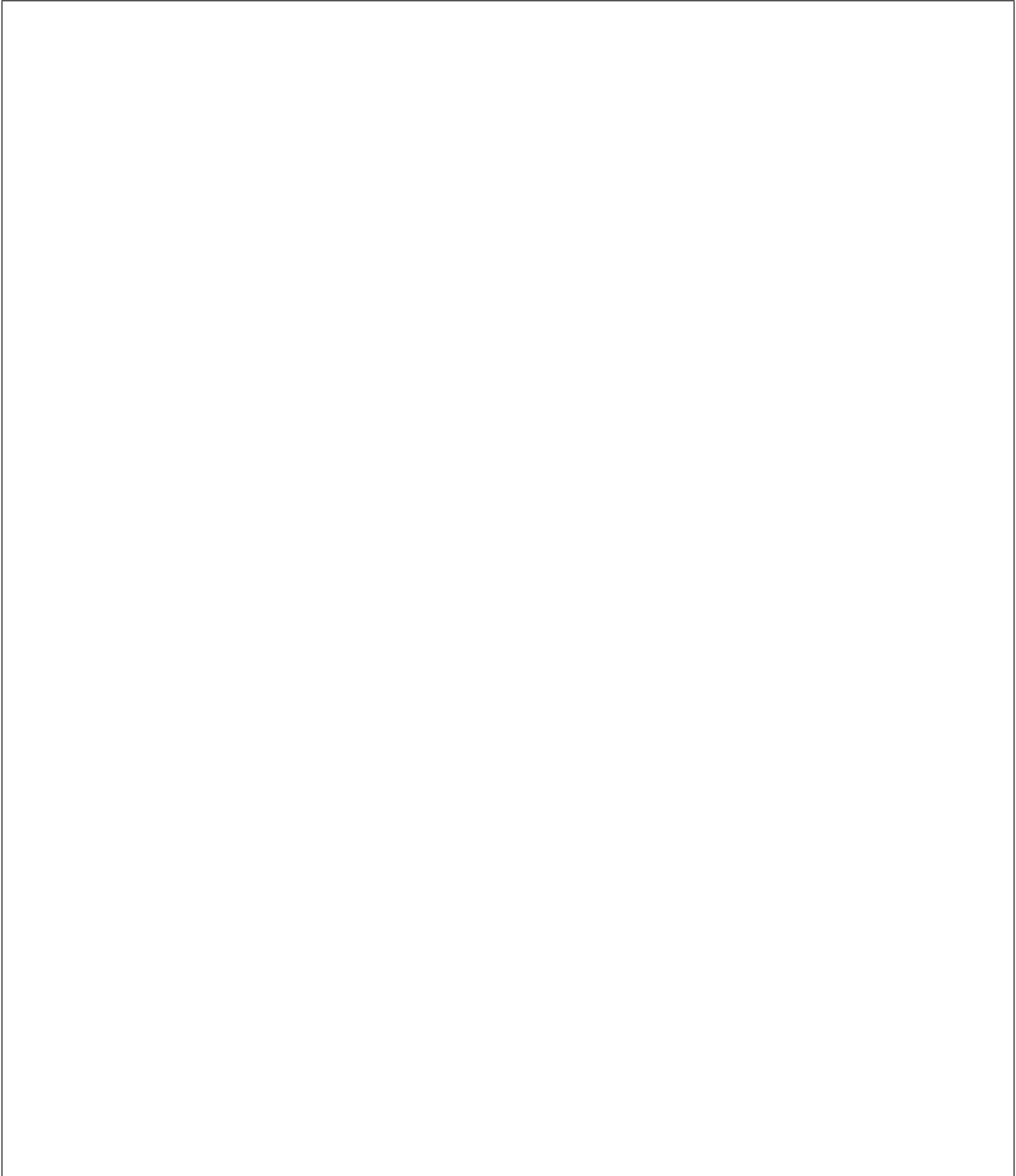
- casing construction and materials *(3 marks)*

- control and light positions *(2 marks)*

- means of attachment to a model aircraft *(2 marks)*

- visual appeal. *(2 marks)*

1 (d)   Using notes and sketches show your ideas for the **inside** of the product casing.

Marks are awarded for:

- a means of fixing controls and lights   *(3 marks)*

- battery fixing and access   *(3 marks)*

- circuit fixing and wiring.   *(3 marks)*

Turn over ▶

1 (e) (i)   Complete the diagram below showing how the flashing light output is controlled.

INPUT	PROCESS	OUTPUT
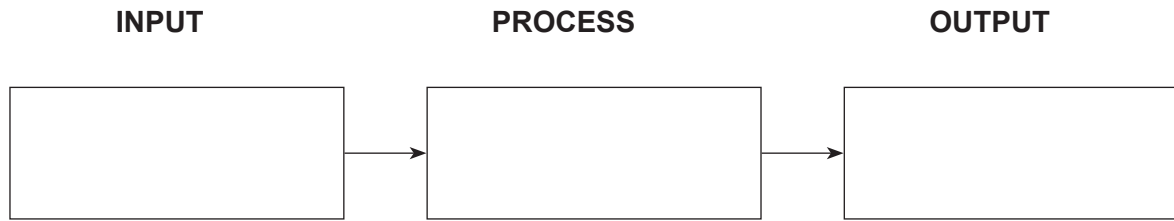
(3 marks)

1 (e) (ii)   Describe using notes and sketches how the process block controls the flashing light.

(5 marks)

32

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Turn over ▶

Section B

Answer **all** questions in the spaces provided.

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

2　　This question is about output devices.

　　Light emitting diodes (LEDs) need to be correctly connected when they are used.

2 (a)　　Clearly identify **two** physical features on the LED shown below that indicate the negative leg (cathode).
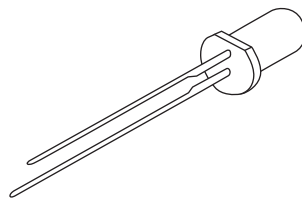
(2 marks)

2 (b)　　Shown below is a seven segment display.
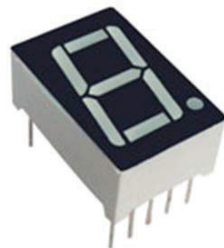
　　Give the advantages and disadvantages of using a seven segment display in a counting display instead of using separate light emitting diodes (LEDs).

　　Advantages ....

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　　..

　　..

　　..

Disadvantages ....

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(6 marks)

2 (c) Calculate a suitable value for the resistor R1 in the diagram below.

The input voltage is 6 volts, the voltage drop for each LED is 2 volts and the maximum LED current is 20 mA.
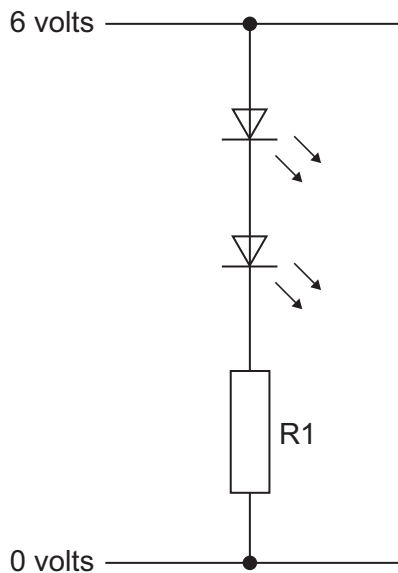
State formula used...

Calculation ....

....

....

....

Value of R1 ....

(4 marks)

Turn over ▶

2 (d)   One student has connected components as shown below.

Input
6 volts
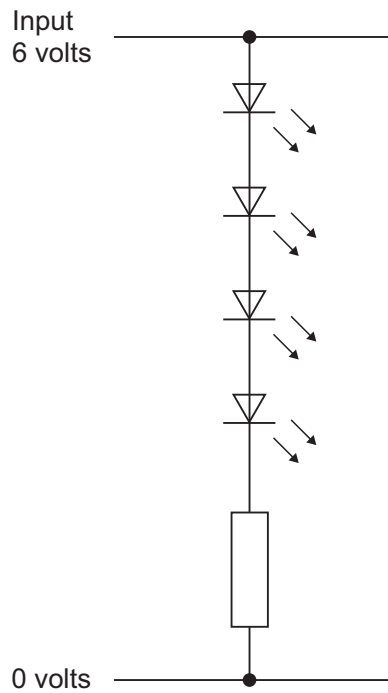
0 volts

Explain the reason why this connection may not work as expected by the student when connected to 6 volts.

....

....

(2 marks)

2 (e)   An LED connected to a 9 volt supply requires a limiting resistor.
On the diagram below identify the colour of each band shown for a 680 Ω resistor.

Band 1 Colour ....

Band 2 Colour……………..

Band 3 Colour……………..
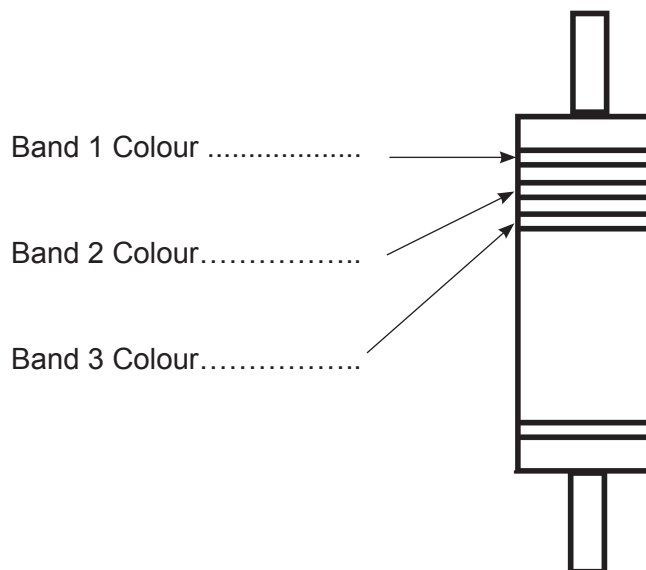
(3 marks)

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

3   This question is about 555 ICs (integrated circuits).

3 (a)   Which **two** of the following components used together create a time delay?

Circle **two** components only.

Transistor   Diode   Capacitor   Resistor   Thyristor

(2 marks)

3 (b)   Shown below is a 555 IC circuit.
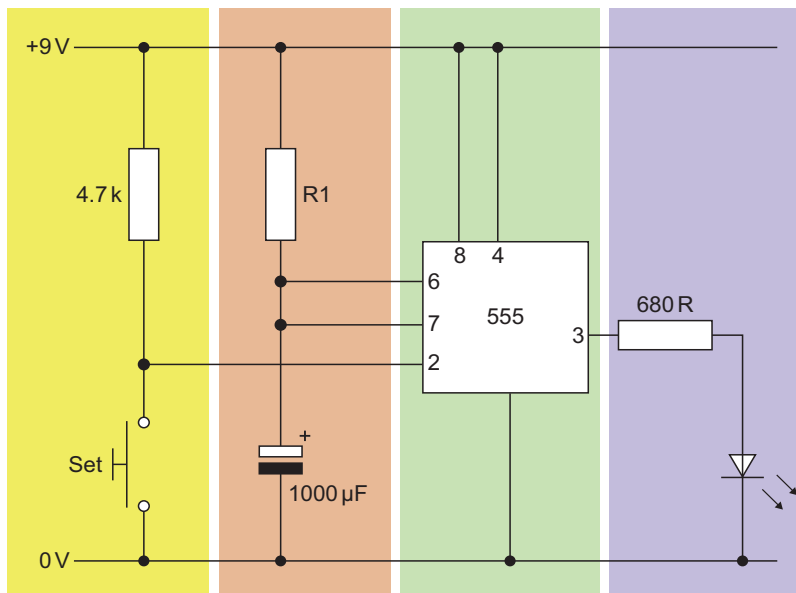
Sections   **A**   **B**   **C**

3   (b) (i)   Which of the following is the correct function of this circuit?
Circle your choice.

astable   monostable   bistable   *(1 mark)*

3 (b) (ii)   Explain the function of the sections of the circuit labelled **A**, **B** and **C**.

A ....

....

B ....

....

C ....

....

(6 marks)

Turn over ▶

3 (b) (iii) Calculate the time delay in seconds when R1 is set to 100 KΩ and the capacitor value is 1000 uF.

Formula used ....

Calculation showing units ....

....

....

....

Time Delay ....

(4 marks)

13

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

4   This question is about soldering.

Describe in detail the processes involved and the risks to safety when soldering components to a printed circuit board (PCB).
You will be tested for quality of written communication in this question.

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(10 marks)

10

Turn over ▶

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

5   This question is about microcontrollers.

5 (a)   Give **two** reasons why microcontrollers are used for controlling products.

Reason 1 ....

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Reason 2 ....

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(4 marks)

5 (b)   A notch is clearly moulded as shown at one end of a microcontroller IC.
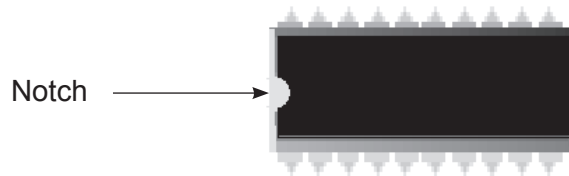
Notch

Explain the purpose of the notch and why it is important.

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(2 marks)

5 (c) A point of sale display for a charity collection box is controlled by a microcontroller (PIC).

A push to make (PTM) switch is used as the input.

Complete the circuit schematic below by drawing a PTM switch and a pull down resistor in the correct positions.
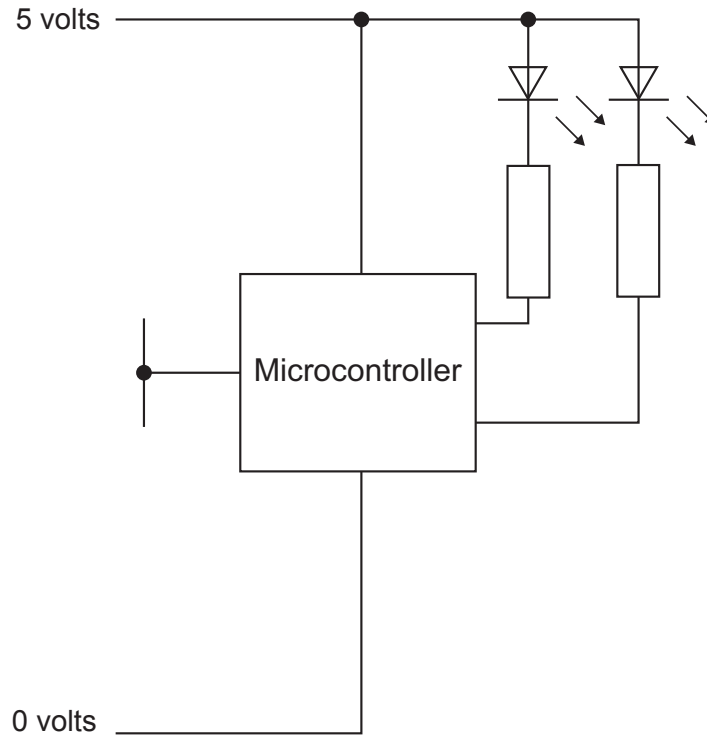
(3 marks)

Question 5 continues on the next page
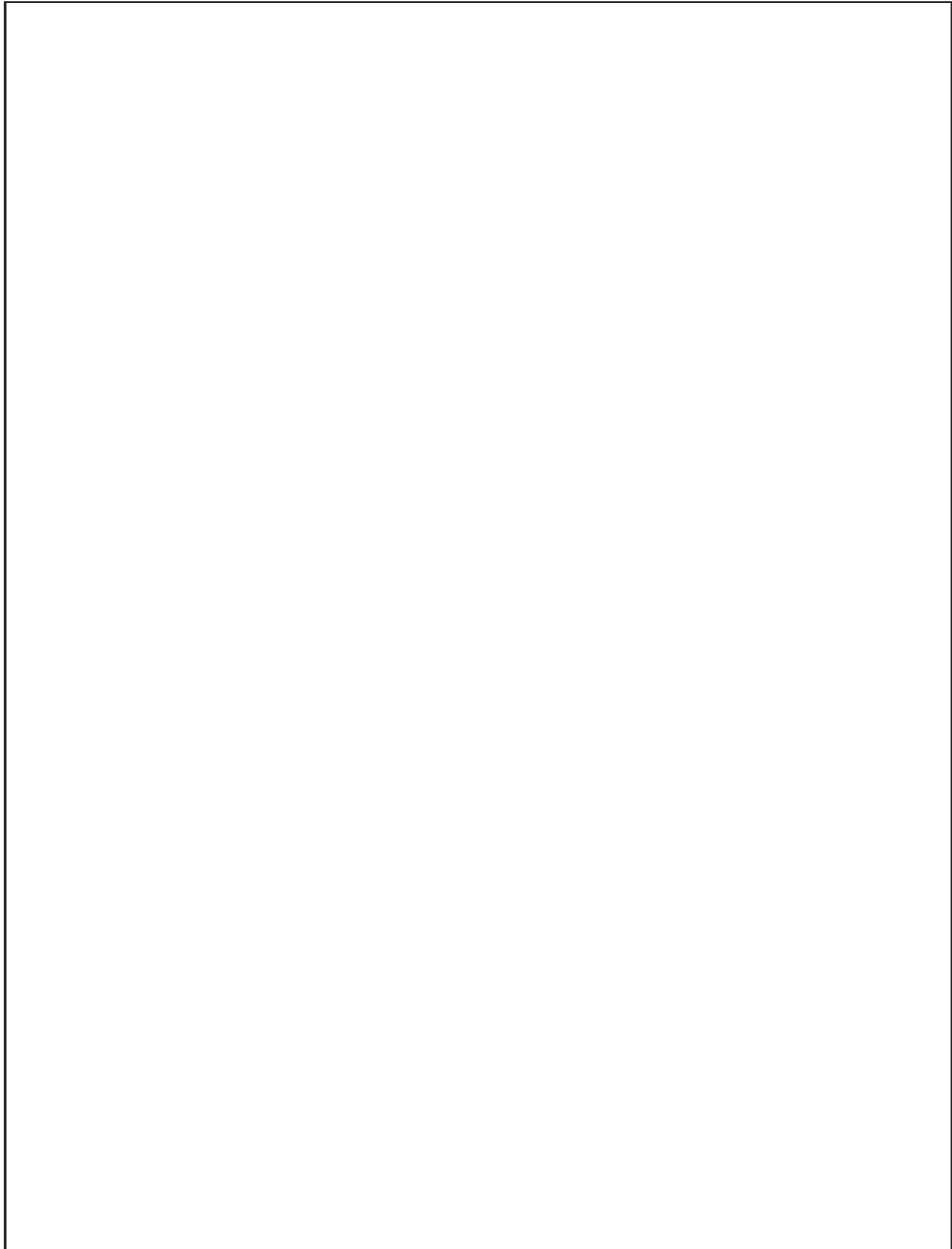
Turn over ▶

5 (d) When a coin is inserted in the charity collection box, the coin activates the switch.

Write a program using text or a flowchart to program the microcontroller to flash two light emitting diodes (LEDs) together at 1 Hz for 5 seconds.

Show your text-based or graphical (flowchart) method in the box below.

(10 marks)

19

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

6 This question is about energy sources.

Many electronic products use batteries.

Give **three** reasons why non-rechargeable batteries can be considered to be harmful to the environment.

Reason 1 ....

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Reason 2 ....

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Reason 3 ....

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(6 marks)

6

Turn over for the next question

Turn over ▶

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

7 This question is about circuit protection.

7 (a) On the diagram below, add a diode to protect the circuit from incorrect polarity when connected to a battery.

+ Volts ─────────────┐
                     │
            ┌────────────────┐
            │   │
            │   Circuit   │
            │   │
            └────────────────┘
                     │
0 Volts ─────────────┘
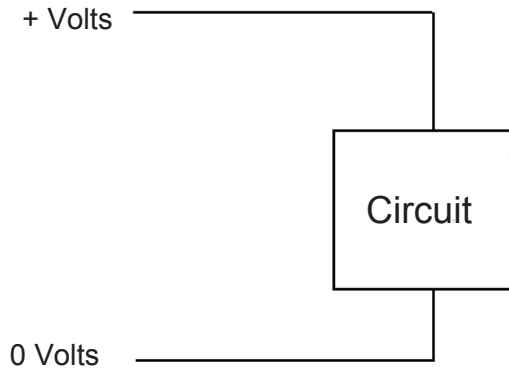
(2 marks)

7 (b) Explain how a diode protects the circuit.

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(2 marks)

4

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

8 This question is about logic gates.

8 (a) Name the logic gate symbol shown below.

A ─┐
   │   ⊃── Z
B ─┘

....
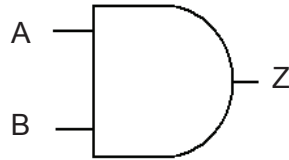
(1 mark)

8 (b) Complete the truth table for the gate symbol shown above.

B	A	Z
0	0	
0	1	0
1	0	
1	1	

(3 marks)

4

Turn over for the next question

Turn over ▶

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

9 This question is about manufacturing and designing.

9 (a) A company has invested in Computer-Aided Design (CAD).

Describe **three** ways the company could use CAD in the design and manufacture of electronic products.

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2 ....

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3 ....

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(6 marks)

9 (b) A manufacturer is producing product casings using a vacuum former.

Explain why the manufacturer has chosen this process.

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(3 marks)

9 (c) Scale of production affects the way products are made.

Describe the differences between one-off and high volume production of products.

Include examples in your answer.

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(6 marks)

15

END OF QUESTIONS

There are no questions printed on this page

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