Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

AQA

General Certificate of Secondary Education
June 2014

Design and Technology: Electronic Products

45401

Unit 1 Written Paper

Friday 23 May 2014 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.

A

Time allowed
- 2 hours

Instructions
- Use black ink or black ball-point pen. Use pencil only for drawing.
- 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.

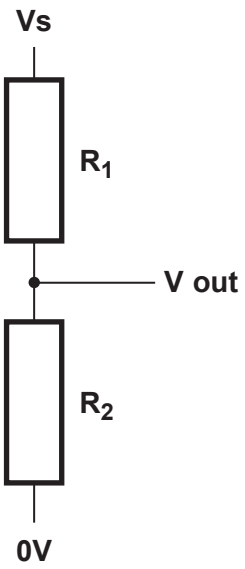
Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 120.
- The question in Section A relates to the context referred to in the preliminary material that was previously issued.
- You are reminded of the need for good English and clear presentation in your answers. Quality of Written Communication will be assessed in Question 8.

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



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

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

Time Constant — Time Constant $\triangleq$ Resistance x Capacitance ($T \triangleq R \times C$)

Astable Frequency for 555 — $f = \frac{1.44}{(R_1 + 2R_2) \times C}$

Mark Space Ratio — $= \frac{\text{Time high}}{\text{Time low}}$

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

Time Low — $= 0.693 \times R_2 \times C$

Inverting Op. Amps — $Gain = \frac{-Rf}{Rin}$ 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

Section A

Answer this question in the spaces provided.

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

1 This question is about designing a temperature warning product for use in a shop.
In shops, many perishable food items must be stored in a fridge at a temperature below 5°C.

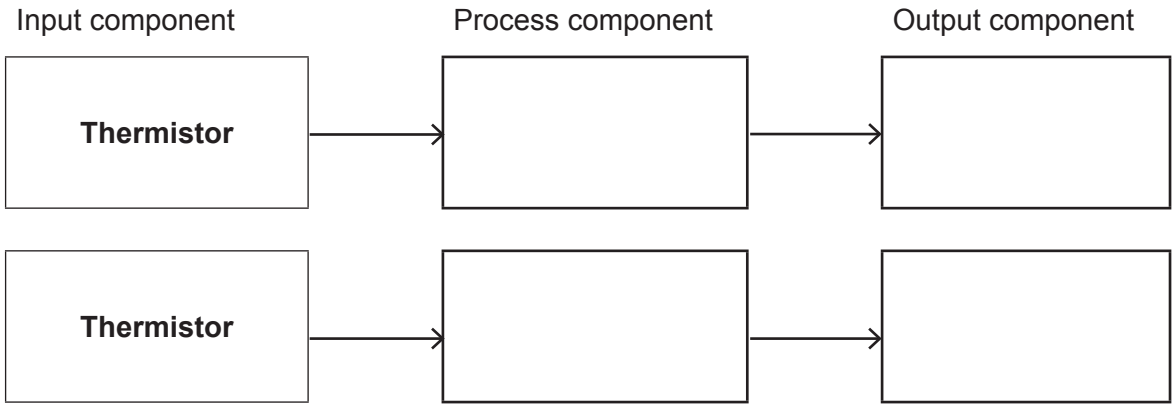
You have been asked to design a product which will warn the user if the temperature of the fridge is 5°C or above.

The product must meet the following specification points.

- It must clearly warn the user if the temperature is 5°C or above.
- It must be powered by a re-chargeable battery.
- The battery can be re-charged without removing it from the product.
- It must be easy to clean for hygiene reasons.
- It must have a visually appealing design.

1 (a) Complete the system diagram below by naming **two** different process components and **two** different output components for the temperature warning product.

[4 marks]



1 (b) Choose one of the output components you have named in **1(a)** and evaluate its suitability for a temperature warning product.

[3 marks]

Output chosen .....

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Question 1 continues on the next page

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1 (c) Use notes and sketches to produce a design for the **case** of the product to meet the specification on page 4**.**

Marks will be awarded for:

- case construction details
- location of input and output components
- visual appeal
- features to make sure the product is hygienic
- showing how the battery can be re-charged
- quality of communication.

[11 marks]

1 (d) Choose **one** of your systems from question **1(a)**.

Use notes and a circuit diagram to explain how the system you have chosen works.

Marks will be awarded for:

- details of how the input, process and output components function
- quality of communication.

[8 marks]

1 (e) Describe methods of testing and evaluating the product for effectiveness and reliability.

[5 marks]

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1 (f) Describe methods of how the temperature warning product should be disposed of when it is no longer needed.

[4 marks]

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35

Section B

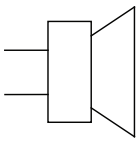
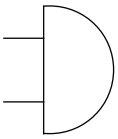
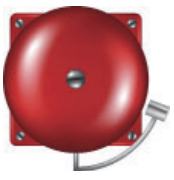
Answer **all** questions in the spaces provided.

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

2 This question is about components.

2 (a) Complete the table below by adding the name of each component and drawing the correct circuit symbols in the blank spaces provided.

[6 marks]

Component	Symbol	
Push to make switch		
Resistor		
Potentiometer		
Flashing Light Emitting Diode (LED)		
		
		

2 (b) Insert a tick in the correct box to show whether each component is polarised or non-polarised.

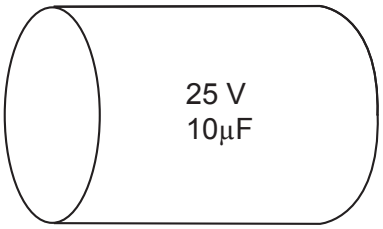
[4 marks]

Component	Polarised	Non-polarised
Buzzer	☐	☐
NPN transistor	☐	☐
PTM switch	☐	☐
Thermistor	☐	☐

2 (c) The drawing below shows an incomplete diagram of an electrolytic capacitor.

Complete the drawing to show **two** features of the capacitor which ensure it is correctly connected in a circuit.

[2 marks]



2 (d) Give **two** reasons why many mass-produced electronic products include surface mount components instead of through-hole components.

[2 marks]

1 .....

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2 .....

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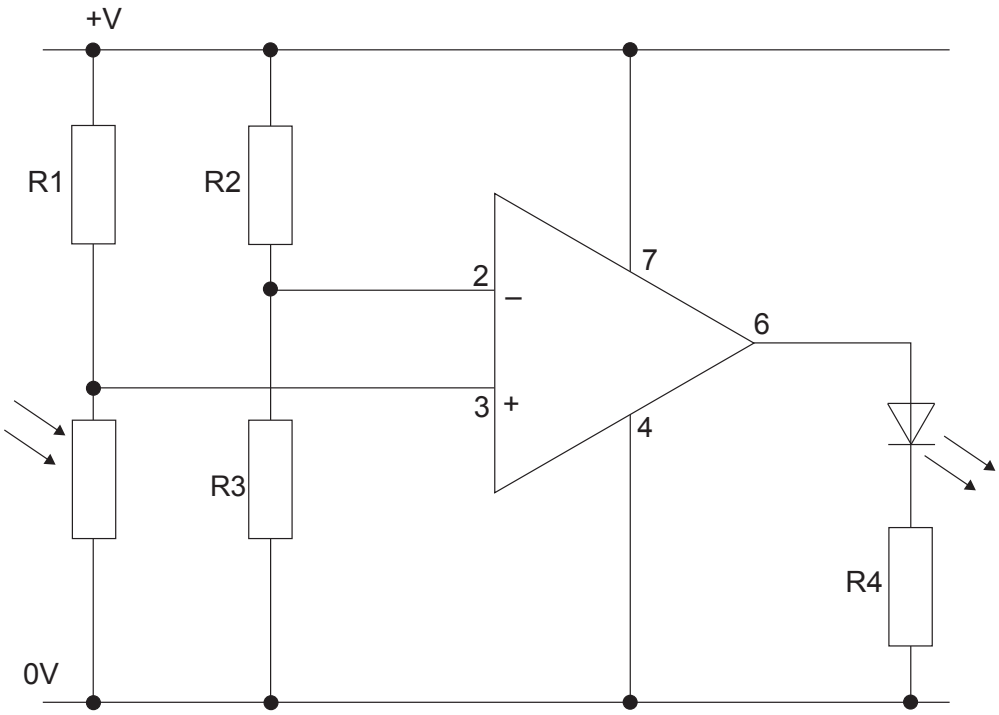
14

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

3 This question is about circuit designing and circuit testing.

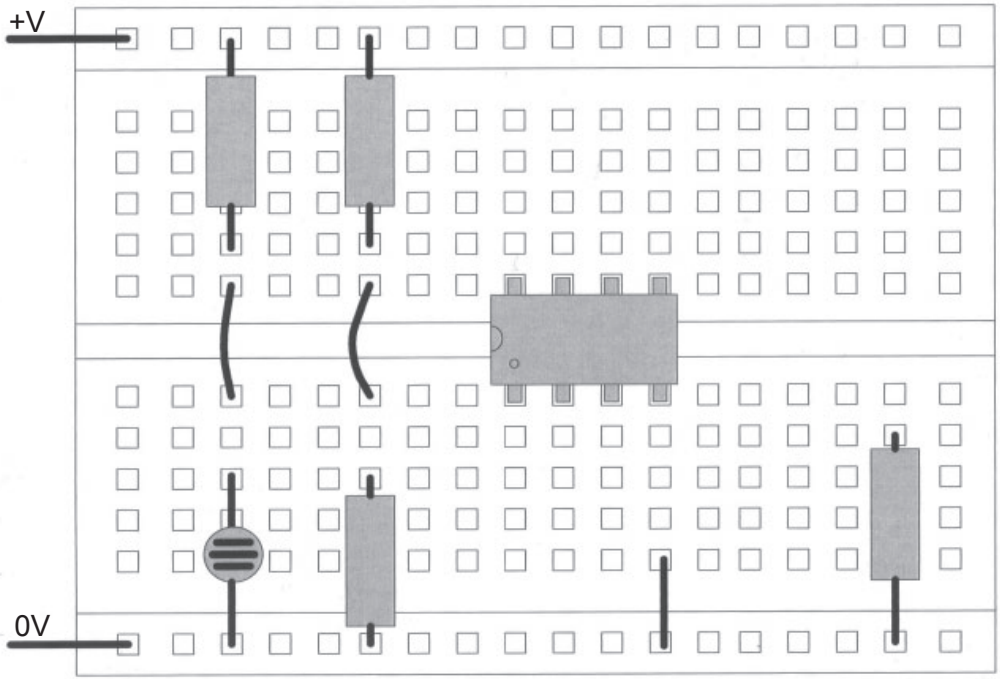
A student wants to prototype the circuit idea shown below.



3 (a) The circuit is to be tested using a breadboard.

Complete the breadboard diagram below by adding an LED and wire connections so that the circuit works.

[6 marks]



3 (b) When the breadboard was completed and tested, the circuit did not work. Suggest **three different** reasons why the circuit may not have worked.

[3 marks]

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2 .....

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3 (c) A multimeter can be used to test parts of a circuit.

Explain in detail how you would use the multimeter to measure the voltage drop across the LED on the breadboard.

[4 marks]

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3 (d) Explain what is meant by the term 'prototype'.

[2 marks]

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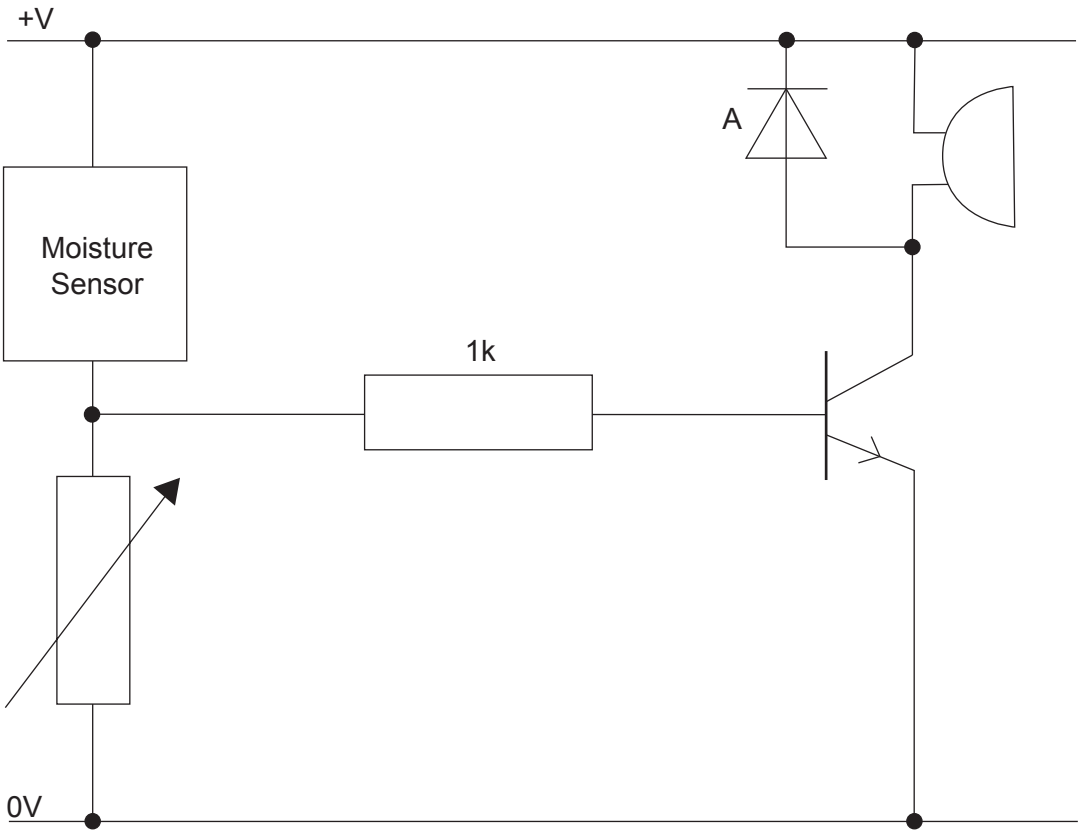
15

Turn over for the next question

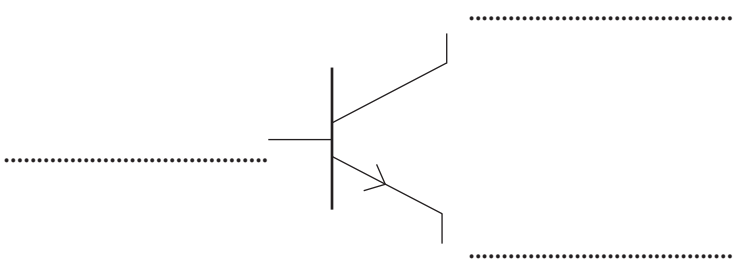
You are advised to spend about 10 minutes on this question.

4 This question is about transistors.
A circuit idea for a moisture sensor is shown below.



4 (a) Name the **three** connections of a NPN transistor.

[3 marks]



4 (b) State the purpose of the 1k resistor in the circuit.

[1 mark]

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4 (c) Explain why component A is needed in the circuit on page 14.

[2 marks]

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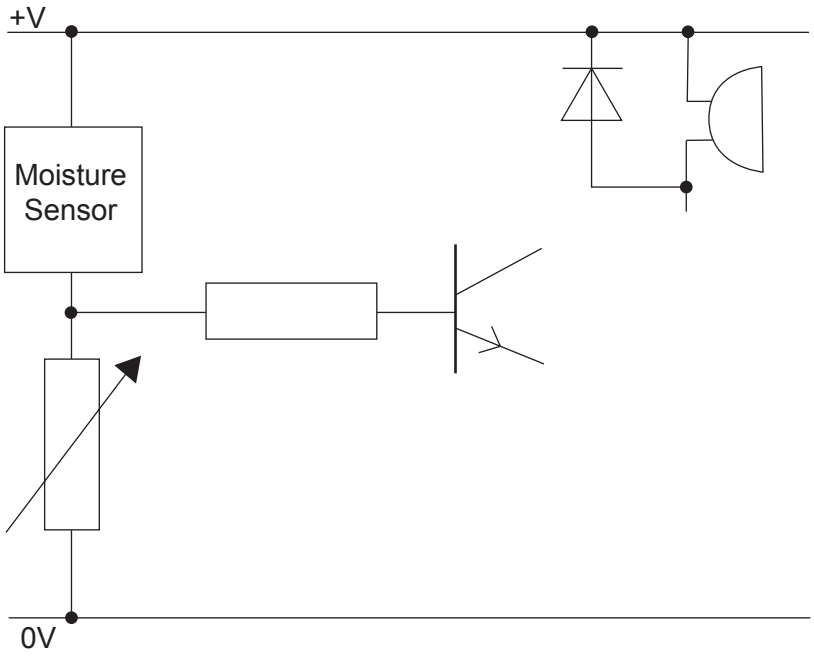
4 (d) A second transistor can be added to the circuit to create a Darlington pair.

On the diagram below, complete the circuit so that the Darlington pair switches the buzzer on.

[4 marks]



4 (e) A Darlington pair can be packaged as a single transistor, for example, a BCX38. Suggest **two** benefits of using this single component.

[2 marks]

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2 .....

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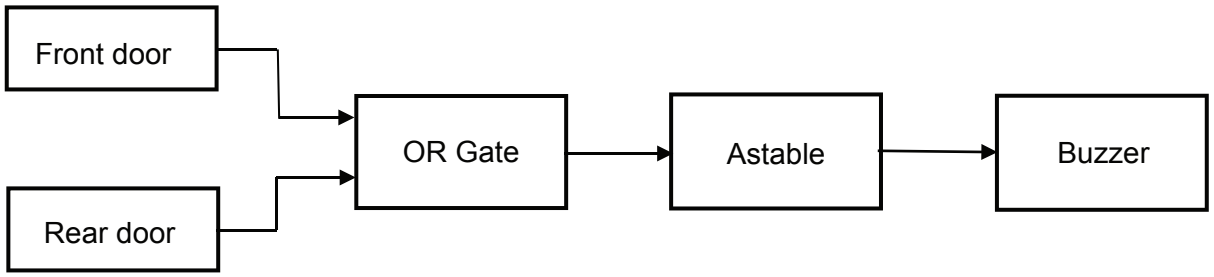
12

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

5 This question is about logic.

A system diagram for a door alarm is given below.



5 (a) (i) Name the output stage of the door alarm system.

[1 mark]

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5 (a) (ii) Suggest a suitable component to detect that a door has been opened.

[1 mark]

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5 (b) In the box below, draw the circuit symbol for a two input OR gate.

[2 marks]

5 (c) Complete the truth table for an OR gate.

[3 marks]

B	A	Q
0	0	
0	1	
1	0	1
1	1	

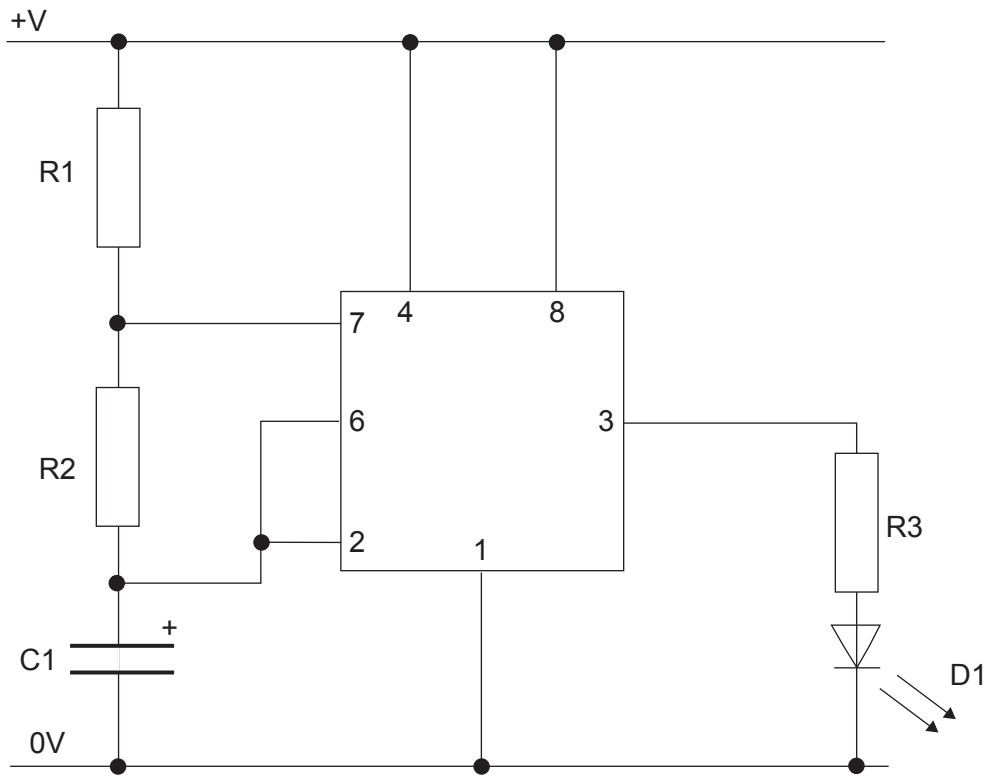
7

Turn over for the next question

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

6 This question is about a 555 astable circuit.

A circuit diagram for a 555 astable is shown below.



6 (a) Describe the function of a 555 astable.

[2 marks]

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6 (b) Calculate the frequency of the output pin 3 if R1 is 1k, R2 is 100k, and C1 is 10μF.

[5 marks]

Formula .....

Working .....

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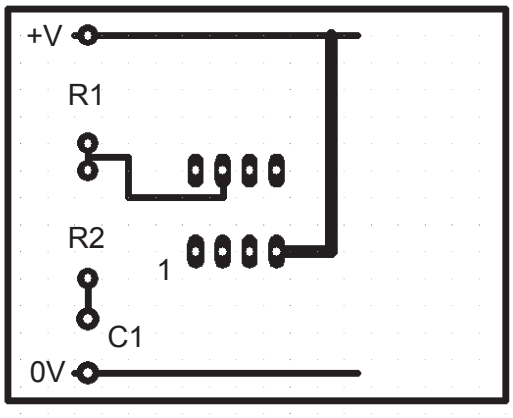
Answer with units .....

6 (c) The diagram below shows an incomplete printed circuit board (PCB) design for the astable circuit shown on page 18.

Complete the PCB layout by adding pads for R3, D1 and tracks so that the circuit works as intended.

Pin 1 has been identified and the PCB layout is viewed from the component side.

[6 marks]



6 (d) Suggest **two** modifications to the PCB design in 6(c) which could improve the quality and ease of manufacture of the circuit.

[2 marks]

1 .....

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2 .....

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15

Turn over ▶

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

7 This question is about microcontrollers (PICs).

A manufacturer of bicycle lights uses a microcontroller circuit to control a bicycle rear light.

7 (a) State **two** disadvantages of using microcontrollers in circuits.

[2 marks]

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2 .....

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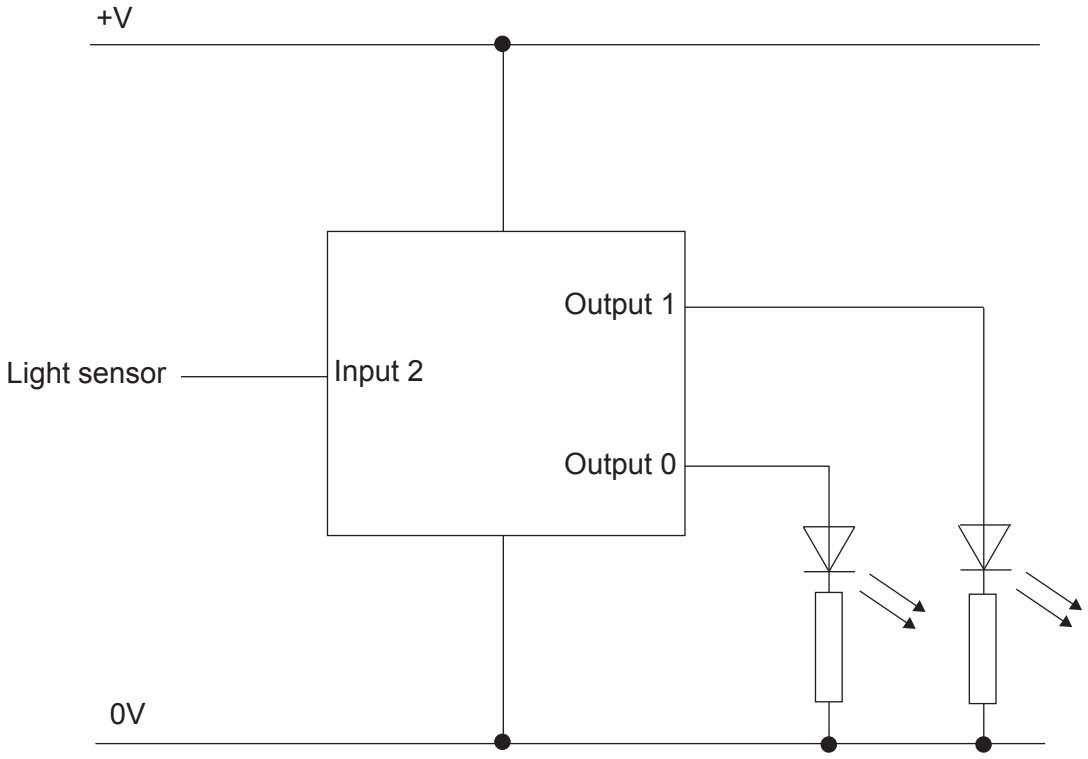
7 (b) The diagram below shows an 8 pin microcontroller circuit for the bicycle light.

The light sensor has an analogue value of 100 in daylight and this value falls as it gets darker.



Describe the difference between an analogue signal and a digital signal.

[2 marks]

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7 (c) In the space below, use a programming system you are familiar with to write a program so that both LEDs continuously flash together. The LEDs should be on for one second and off for one second.

[5 marks]

7 (d) In the space below write a new program so that;

- the LEDs switch on automatically **only** when the value of the light sensor is 50 or less
- the LEDs flash alternately on for one second and off for one second.

[5 marks]

14

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

8 This question is about manufacturing products safely.

Making cases for electronic products in the school workshop involves many processes such as:

- drilling
- sawing
- sanding
- heating and forming plastics.

Discuss the health and safety issues for **two** of these processes:

- describing any hazards identified
- stating any precautions you can take to reduce the risk.

You will be tested on the Quality of Written Communication in this question.

[8 marks]

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8

END OF QUESTIONS

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