



Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

GCSE

DESIGN AND TECHNOLOGY: ELECTRONIC PRODUCTS

Unit 1 Written Paper

Tuesday 24 May 2016

Morning

Time allowed: 2 hours

Materials

For this paper you must have:

- a black pen
- a pencil
- a ruler
- an eraser
- a pencil sharpener.

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.
- 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 6.
- You may use a calculator.



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

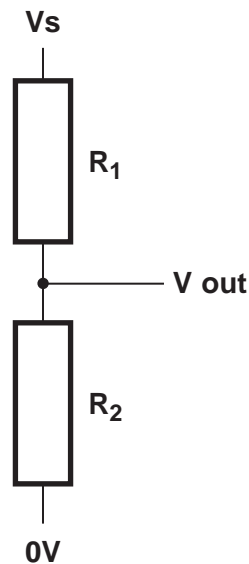
Potential Difference

$$\text{Potential Difference} = \text{Current} \times \text{Resistance} \quad (V = I \times R)$$

Series Resistors

$$R_{\text{total}} = R_1 + R_2 + R_3 \text{ etc}$$

Potential Divider



$$V_{\text{out}} = \frac{R_2}{R_1 + R_2} \times V_s$$

where V_{out} = signal value
 V_s = supply voltage
 R_1 and R_2 are resistance values

Time Constant

$$\text{Time Constant} \approx \text{Resistance} \times \text{Capacitance} \quad (T \approx R \times C)$$

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

$$\text{Gain} = \frac{-R_f}{R_{\text{in}}} \quad \begin{array}{l} \text{Where } R_f = \text{feedback resistor value} \\ \text{Where } R_{\text{in}} = \text{input resistor value} \end{array}$$



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 this question in the spaces provided.

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

- 1 This question is about designing a product to help improve hand and eye coordination.

Design Brief

You are asked to design an electronic target game to help children to improve their throwing skills.

When a child hits a target, a circuit switches on an output.

- 1 (a) Give **two** design requirements for the target game and explain your answers.

An example is given below.

Example: The game must weigh less than 2 kg so that it can be easily carried by children.

[4 marks]

Requirement 1 _____

Requirement 2 _____

- 1 (b) On the opposite page, sketch **two** different ideas for the target game.

Marks will be awarded for:

- visual appeal
- creativity
- showing how to adjust the level of difficulty
- the location of input and output components.

[8 marks]



Idea 1

Idea 2

Turn over ►



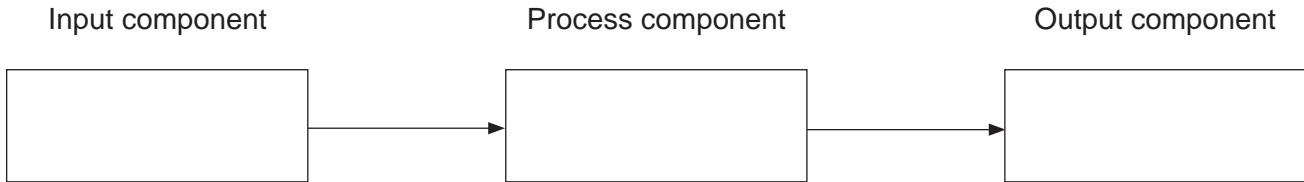
0 5

1 (c) Choose **one** of your ideas from part **1(b)**

State which idea from question **1(b)** you have chosen _____

Complete the system diagram below by naming an input, process and output component for your chosen idea.

[3 marks]



1 (d) 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]

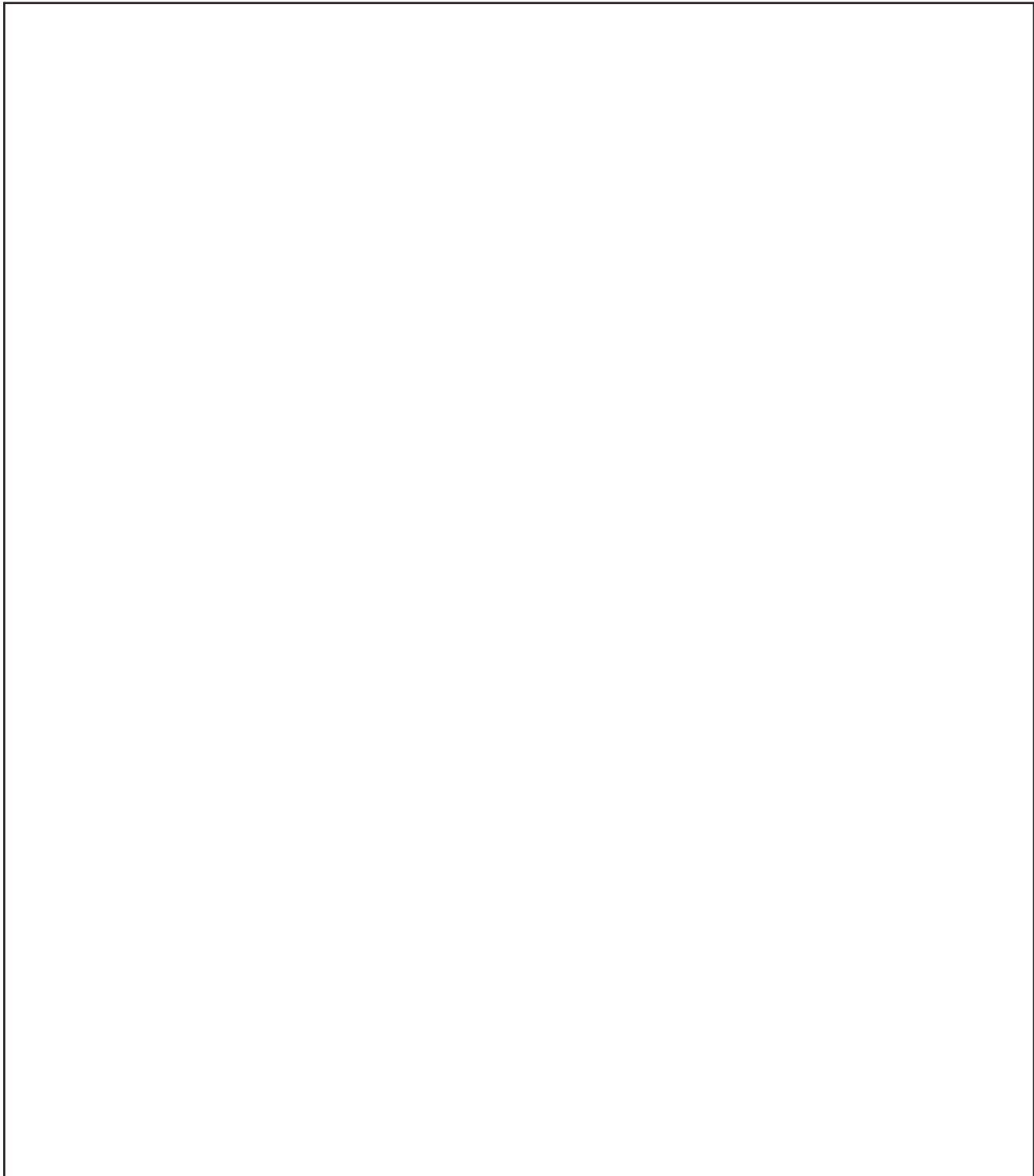


1 (e) Use notes and sketches to produce a detailed design for the **casing** of the circuit for the target game.

Marks will be awarded for:

- casing construction details
- materials to be used
- quality of communication.

[6 marks]



Turn over ►

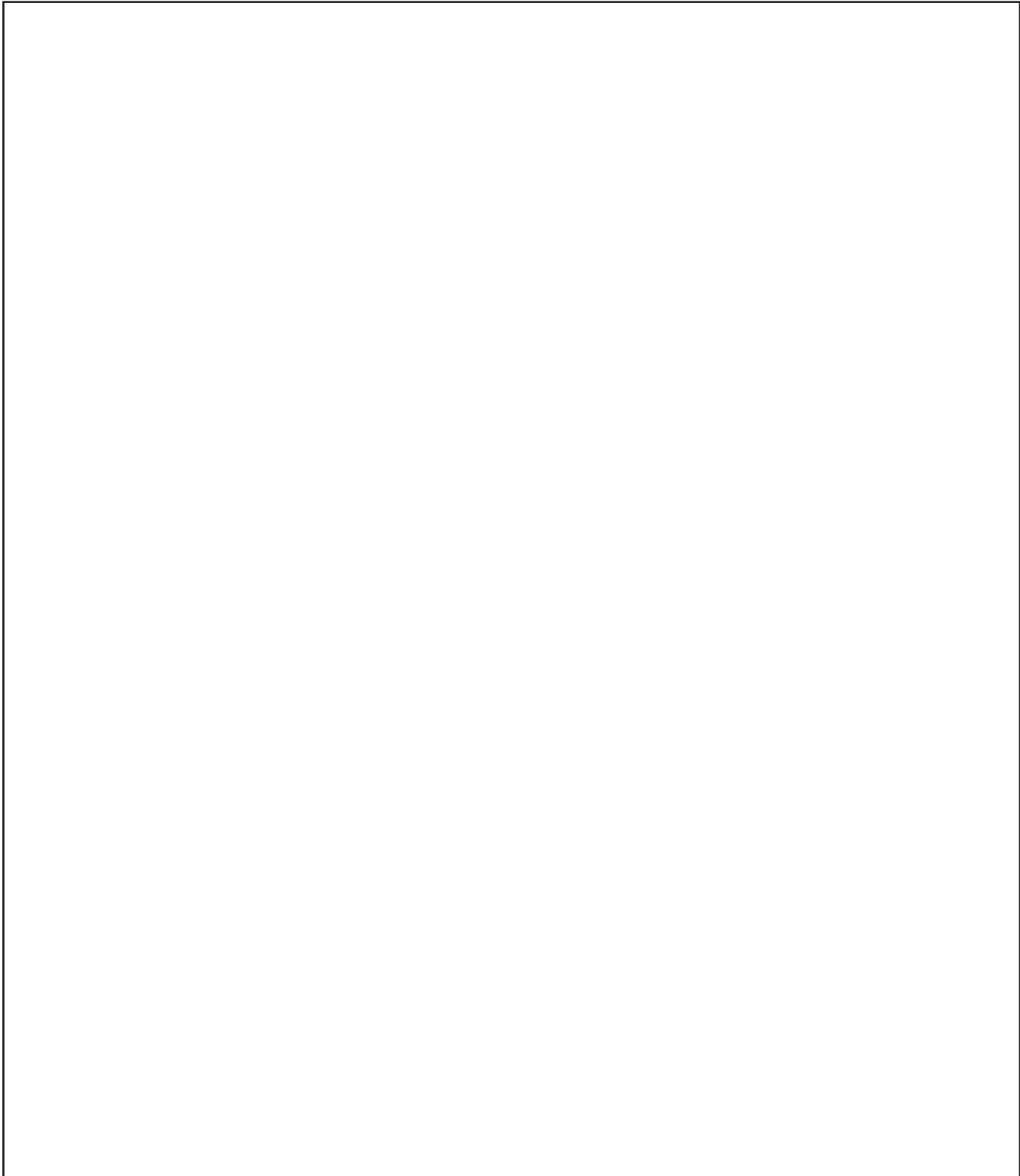


1 (f) Using notes and sketches, show ideas for the **inside** of the casing.

Marks will be awarded for showing:

- how the battery is secured and can be easily removed
- how the circuit and any wiring is secured
- how the output component(s) can be secured.

[5 marks]



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Section B

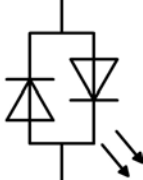
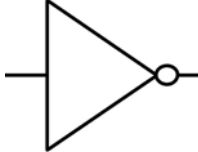
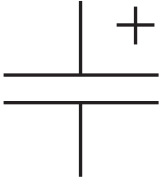
Answer **all** questions in the spaces provided.

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

2 This question is about components.

2 (a) Complete the table below by adding the name of the component or drawing the circuit symbol in the blank spaces provided.

[6 marks]

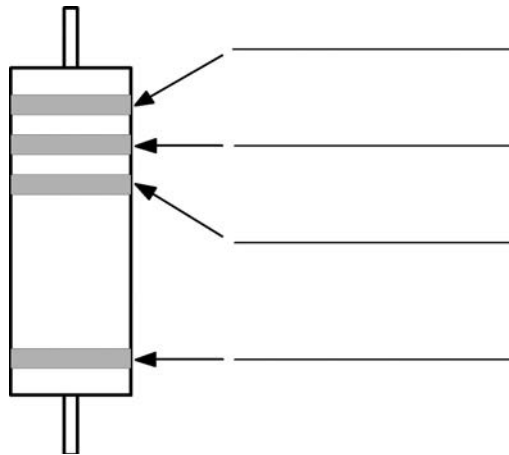
Component	Symbol
Cell	
Microphone	
Single pole double throw switch	
	
	
	

Turn over ►



2 (b) On the diagram below, state the colour of each band for a 56 k resistor with a tolerance of $\pm 5\%$.

[3 marks]

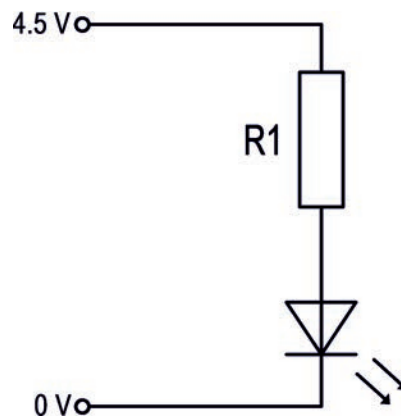


2 (c) (i) The diagram below shows a resistor R1 which limits the current that flows through a light emitting diode (LED).

The maximum LED current is 20 mA and the voltage drop across the LED is 2 volts.

Calculate the value of R1.

[5 marks]



Formula _____

Working _____

Answer with units _____

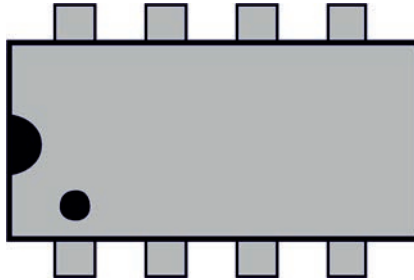


- 2 (c) (ii) Select a resistor from the E24 series that would be suitable for use with the LED shown in part (c)(i).

[2 marks]

- 2 (d) On the drawing of an integrated circuit (IC) shown below, clearly label the location of pins 2 and 5.

[2 marks]



- 2 (e) Suggest **three** reasons for using an IC socket in the construction of circuits.

[3 marks]

1 _____

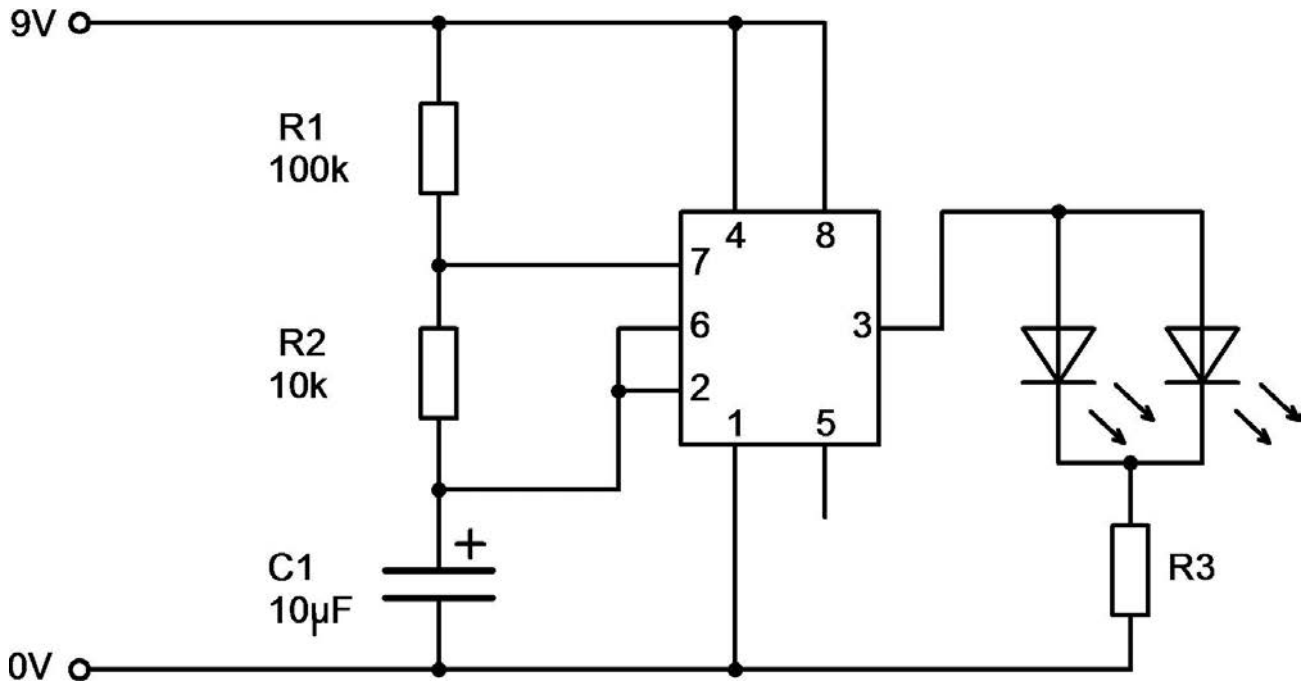
2 _____

3 _____



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

3 Study the circuit diagram below.



3 (a) Circle the word below which describes the function of the circuit.

[1 mark]

Bistable

Counter

Astable

3 (b) Explain how the circuit can be modified so that the frequency can be adjusted.

[2 marks]



3 (c) Calculate the Time High of pin 3 when R1 is 100 k, R2 is 10 k and C1 is 10 μ F.

[5 marks]

Formula _____

Working _____

Answer with units _____

3 (d) A circuit diagram for a warning light is shown below.

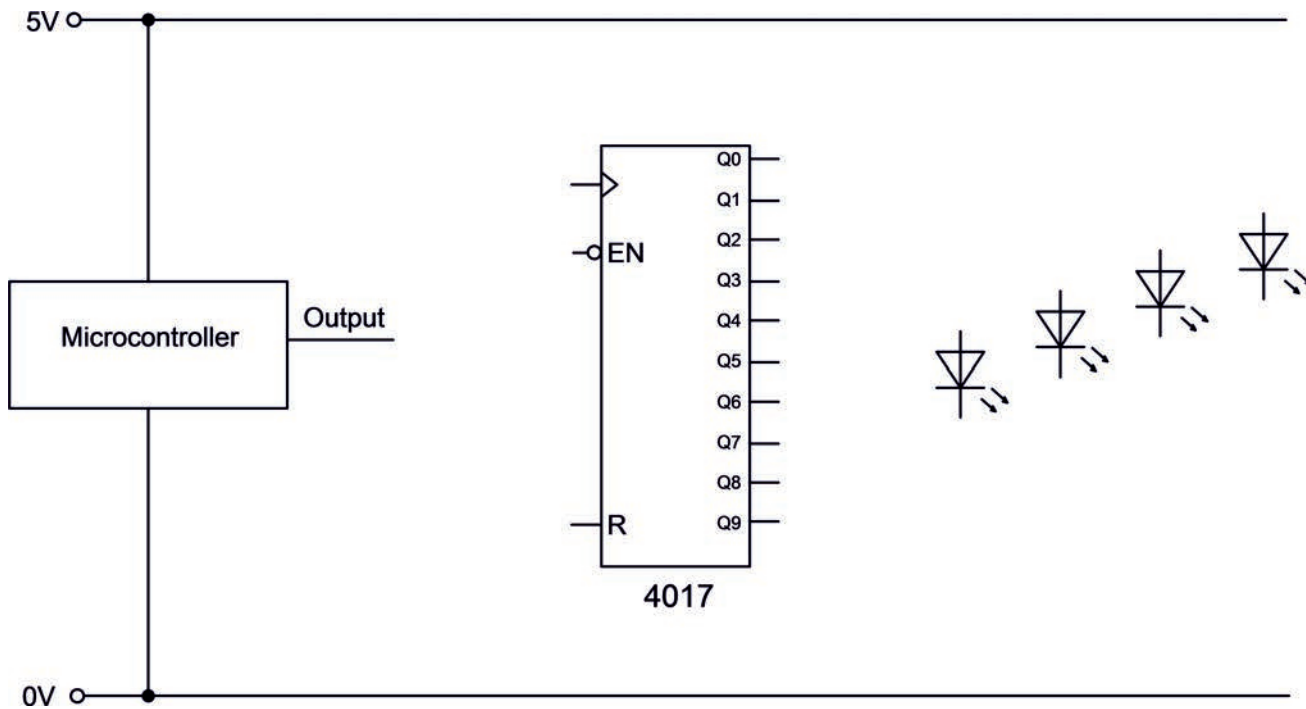
The microcontroller is generating a continuous pulsed output and a 4017 counter IC controls the LEDs.

The circuit must flash 4 LEDs one after another and the warning light must always display at least one LED.

Complete the diagram by:

- connecting the microcontroller output to the clock input of the counter
- connecting the 4 LEDs so that they flash as intended
- connecting the enable pin
- connecting the reset pin so that the LEDs are constantly flashing.

[5 marks]



Turn over ►



3 (e) Describe **three** ways a manufacturer could use Computer Aided Design (CAD) in the design and manufacture of a warning light.

[6 marks]

1 _____

2 _____

3 _____

19



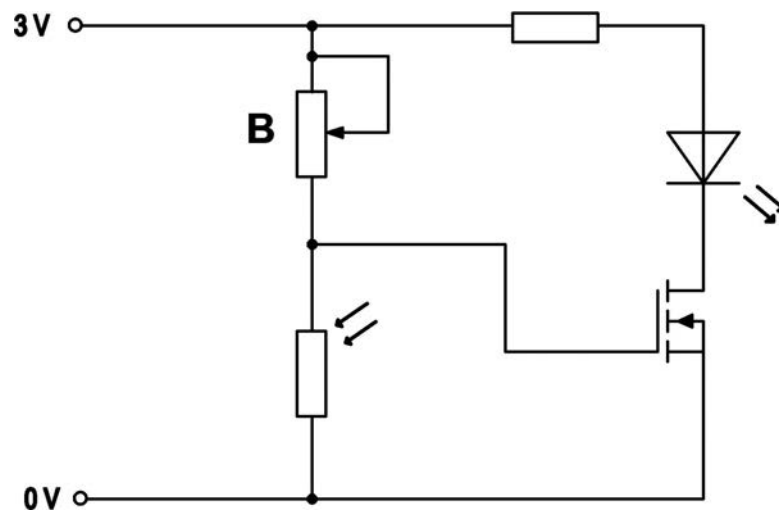
You are advised to spend about 15 minutes on this question.

4 This question is about the design and manufacture of a decorative garden light.

A manufacturer is developing a product which will automatically light up when in the dark.



A circuit idea for the product is shown below.



4 (a) Name and explain the function of the component labelled **B** in the circuit diagram above.

[2 marks]

Name _____

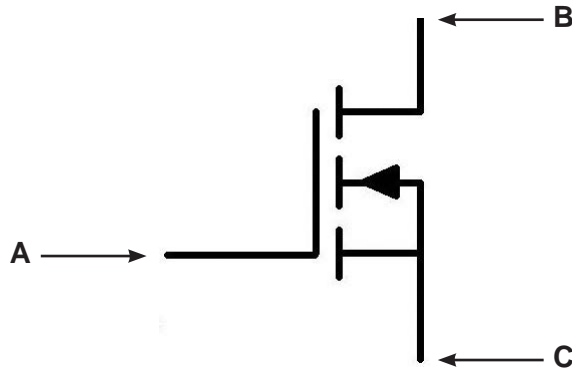
Function _____

Turn over ►



4 (b) Name the **three** connections of the Field Effect Transistor shown below.

[3 marks]



A _____
 B _____
 C _____

4 (c) A photovoltaic (PV) cell charges the battery of the garden light.

Discuss **one** advantage and **one** disadvantage of using a PV cell in the product.

[4 marks]

Advantage _____

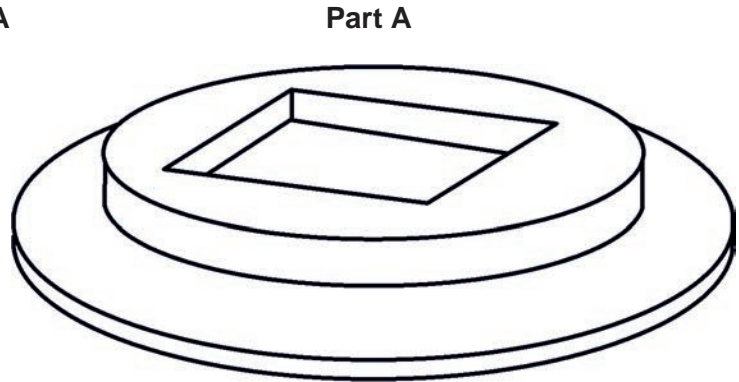
Disadvantage _____



4 (d) Part A of the garden light is to be manufactured.



Part A



Part A

4 (d) (i) Before manufacturing can start, a prototype of part A is produced to test the design.

Name a specific material and process that can be used to make the prototype, and explain your choice of process.

[4 marks]

Material _____

Process _____

Explanation _____

4 (d) (ii) Discuss the manufacturing processes that could be used for the high volume production of part A.

[4 marks]

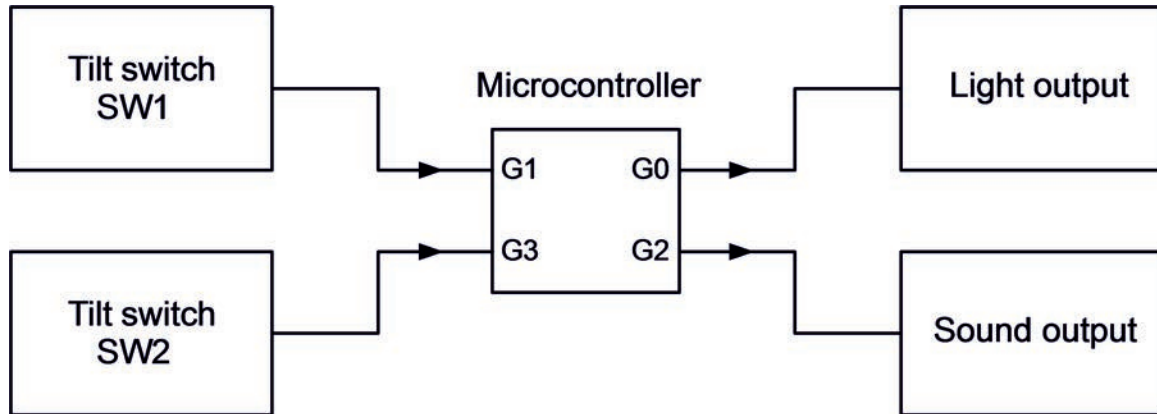


You are advised to spend about 10 minutes on this question.

5 This question is about a microcontroller circuit for a garage alarm.

A system diagram for the alarm is shown below.

SW1 and SW2 are tilt switches attached to the garage door and window.



5 (a) In the space below, use a programming system to write a program so that:

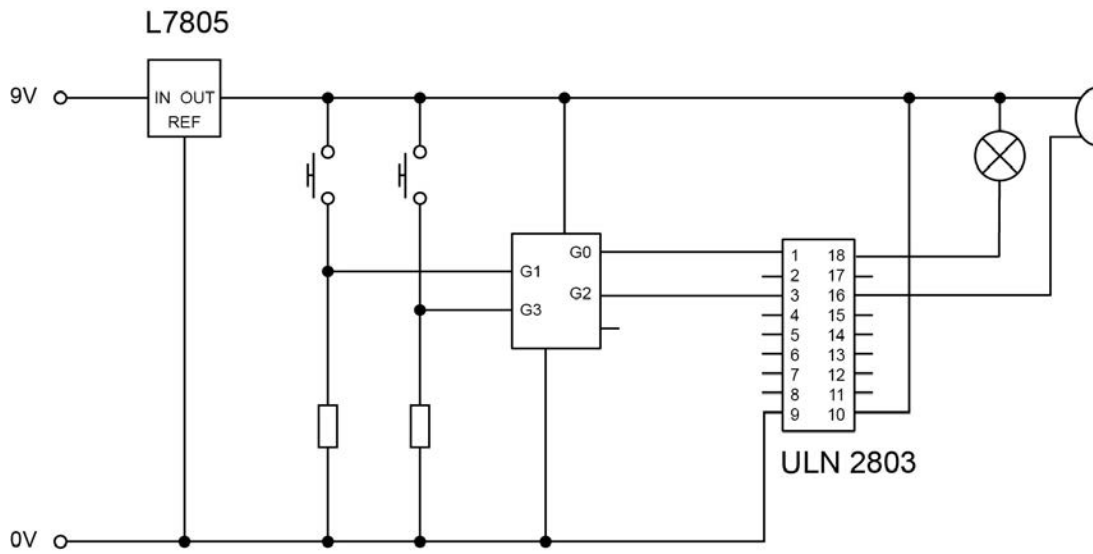
- when first switched on, there is a 3 second delay
- if either of the tilt switches senses movement, the light and sound outputs switch on for 60 seconds
- the sound then switches off, but the light stays on.

[7 marks]

Turn over ►



5 (b) Study the circuit diagram for the garage alarm.



5 (b) (i) The L7805 is a voltage regulator. Explain why it is used in the circuit.

[2 marks]

5 (b) (ii) A ULN 2803 Darlington driver transistor array has been added to the circuit.

Explain why this component is used in the circuit.

[2 marks]



- 5 (c)** Many modern house alarms are designed to switch the loud sound output off after a number of minutes.

Explain why the sound output is switched off.

[2 marks]

13

Turn over for the next question

Turn over ►



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

7 This question is about manufacturing electronic products.

A picture of a game console is shown below.



7 (a) Give **two** reasons why quality control is important during the manufacture of the console.

Explain your answer.

[4 marks]

Reason 1 _____

Reason 2 _____

Question 7 continues on the next page

Turn over ►



7 (b) Give **two** advantages of using a pick and place component machine during the manufacture of a printed circuit board for the console.

Explain your answer.

[4 marks]

Advantage 1 _____

Advantage 2 _____

8

END OF QUESTIONS

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