

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	
TOTAL	



General Certificate of Secondary Education  
June 2012

# Design and Technology: 45401 Electronic Products

Unit 1 Written Paper

Thursday 21 June 2012 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.

**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 7 (a).



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H/Jun12/45401

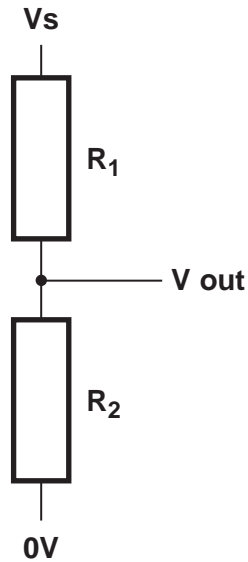
**45401**

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 ( $V = I \times R$ )

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

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

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 Gain =  $\frac{-R_f}{R_{\text{in}}}$  Where  $R_f$  = feedback resistor value  
 Where  $R_{\text{in}}$  = 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 table-top games.

You have been asked to design a device to count and display the number of balls rolling through a hole.

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

- it is visually attractive
- it is battery powered
- the device can be switched on and off
- it must be able to be fixed to a table-top or flat playing surface
- the balls are not affected or stopped by the device
- the system can count up to 9
- the system can be reset to zero
- each time a ball rolls through a gate there is a visual display and an audible output.

**1 (a)** Complete the table below by suggesting **two** suitable alternative inputs, processes and outputs for the ball counter.

	<b>INPUT</b> (sensing)	<b>PROCESS</b>	<b>OUTPUT</b> (visual/audible)
Alternative 1			
Alternative 2			

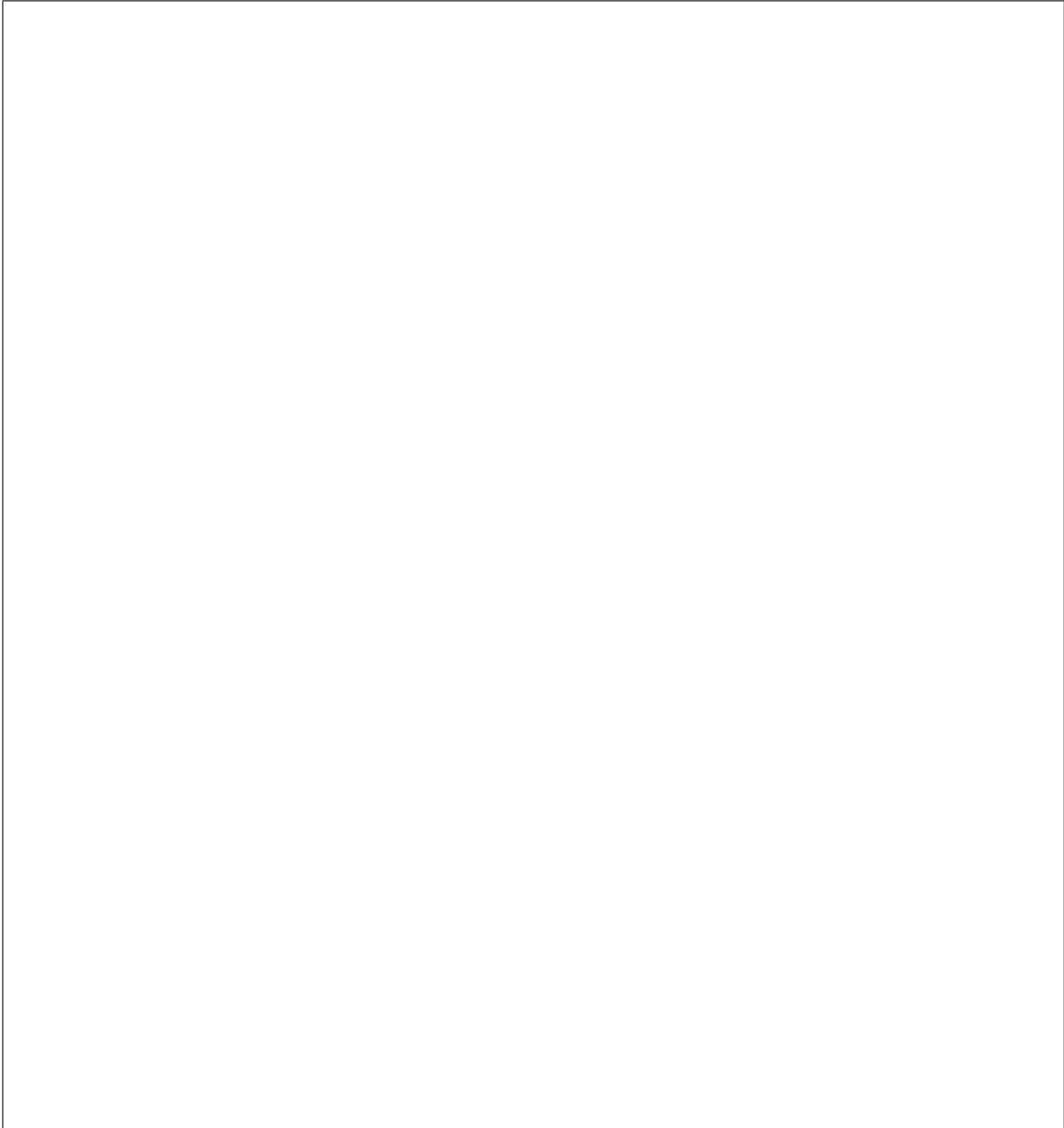
(6 marks)



**1 (b)** Using notes and sketches, produce an initial idea for the design of the *product casing* only.

Your design must meet the following specification points:

- it is visually attractive
- it is battery powered
- the device can be switched on and off
- it must be able to be fixed to a table-top or flat playing surface
- the balls are not affected or stopped by the device.



(6 marks)

Question 1 continues on the next page

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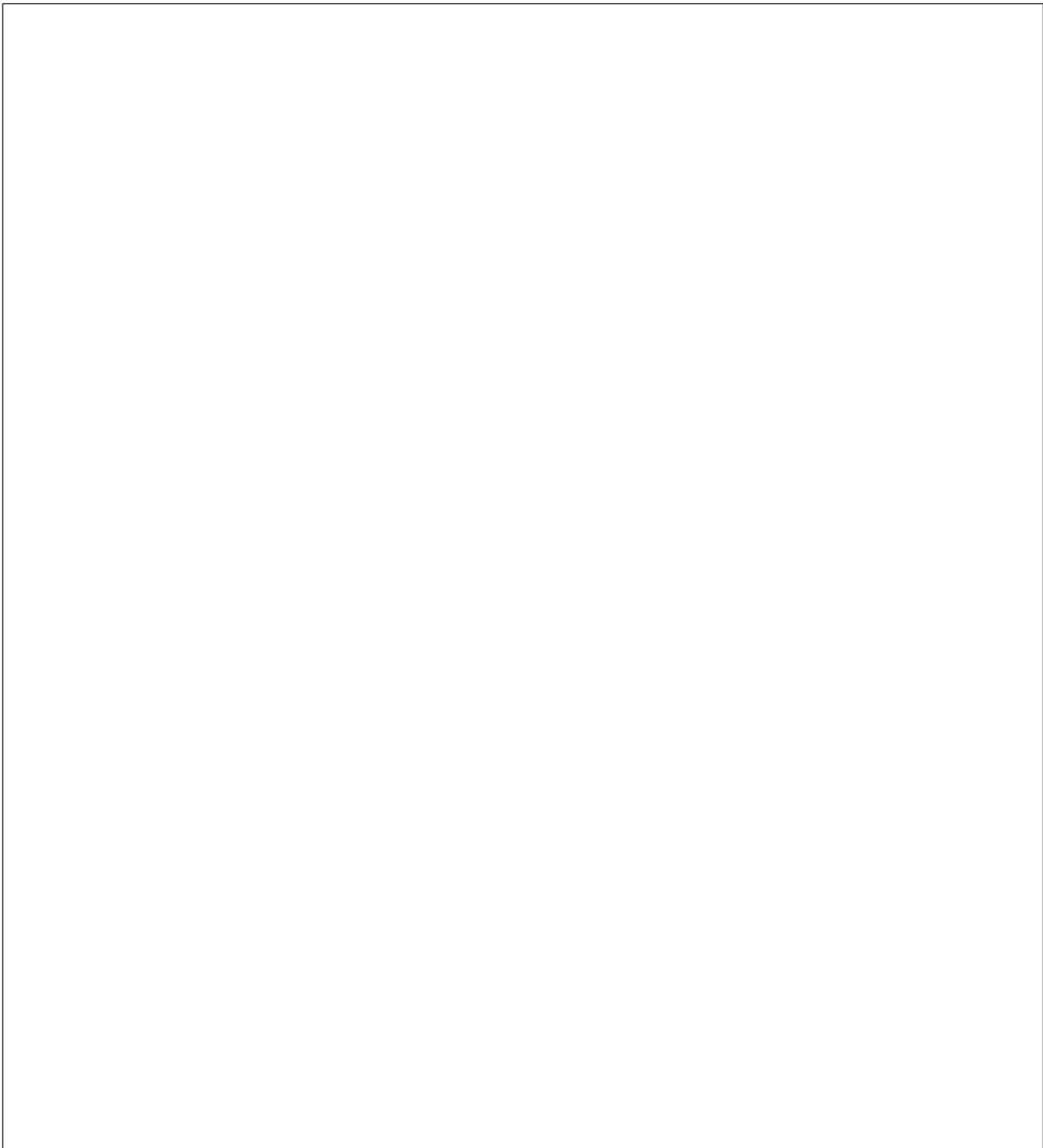


**1 (c)** Using notes and sketches, produce an initial idea for the *electronic design* of your product.

You may wish to use a system block diagram to help explain your idea.

Your design must meet the following specification points:

- the system can count up to 9 (2 marks)
- the system can be reset to zero (2 marks)
- each time a ball rolls through a gate there is a visual display and an audible output. (2 marks)

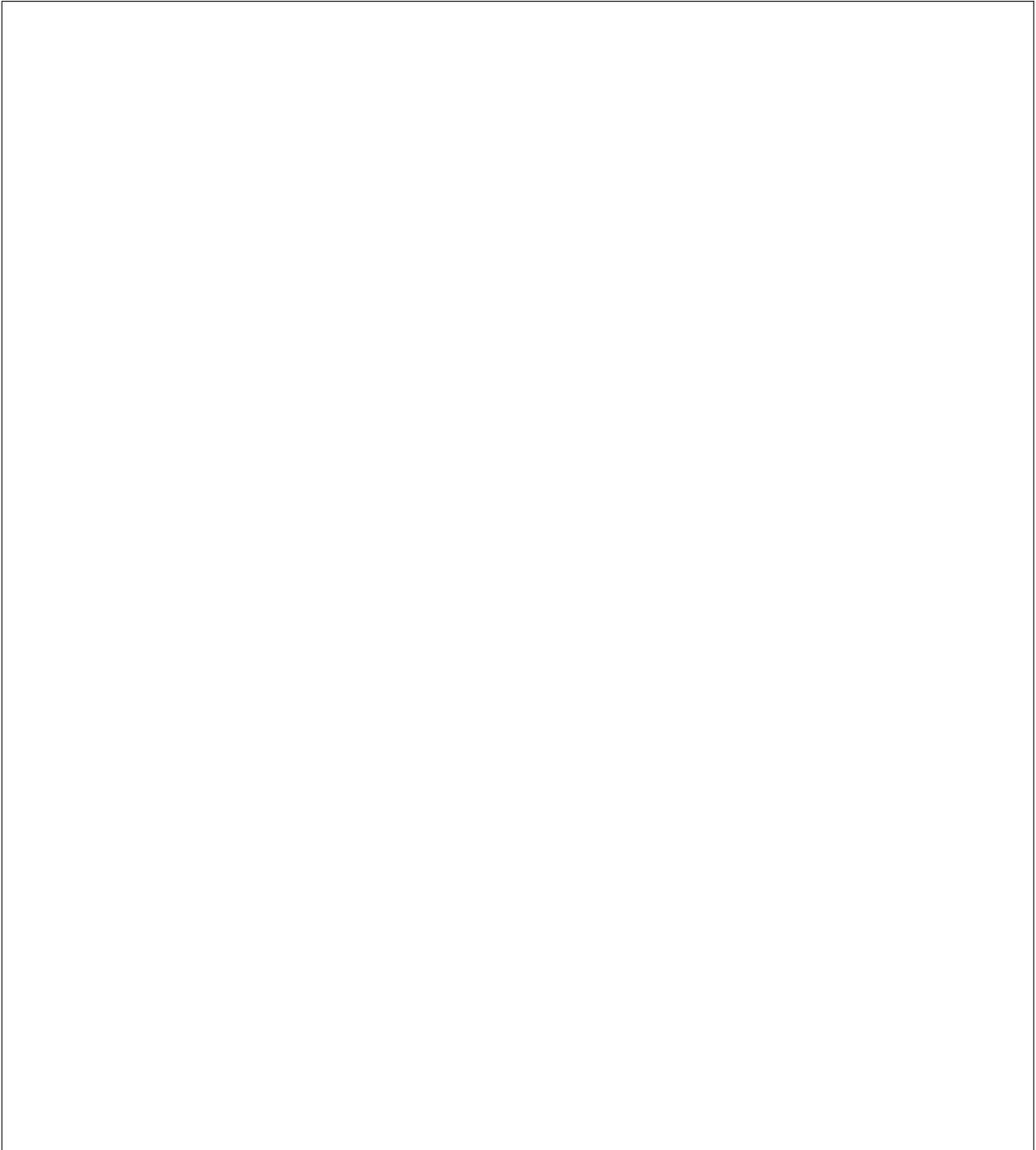


**1 (d)**

In the box below use notes and sketches to produce a fully detailed design of your product that shows clearly how the specification points on page 4 have been met.

Marks will be awarded for:

- constructional details showing how the product is made (6 marks)
- operational details showing how the circuit works (6 marks)
- communication of the design (quality of graphic presentation). (3 marks)



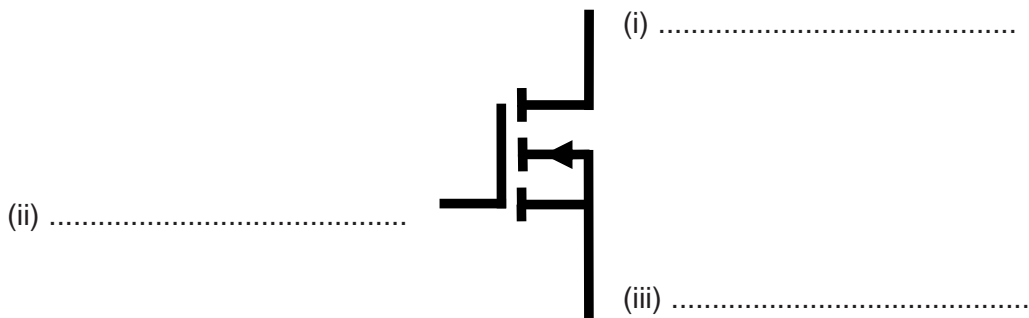
**Section B**

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

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

**2** This question is about interfacing and outputs.

**2 (a)** One type of interface device is the Field Effect Transistor (FET) shown below. Label the **three** leads on the diagram.



*(3 marks)*

**2 (b)** Explain why a digital output from an integrated circuit (IC) needs an interface to drive a solenoid or relay.

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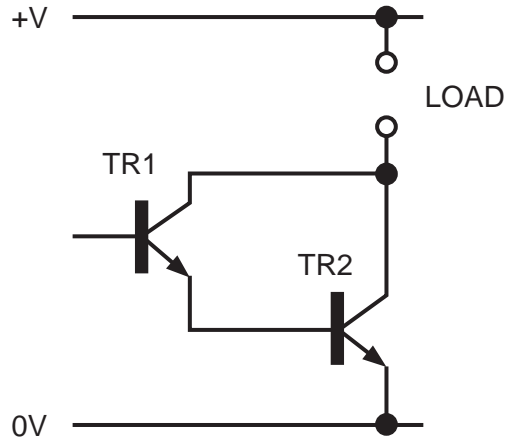
*(2 marks)*





**2 (c)** A possible interface for a solenoid or relay load is shown in the diagram below.

**2 (c) (i)** A diode is often used with this type of interface. On the diagram below draw and correctly connect a suitable diode.



(2 marks)

**2 (c) (ii)** Give a reason for using a relay in a circuit.

.....  
 .....  
 .....  
 .....

(2 marks)

**2 (c) (iii)** Explain the reason for using the two transistors TR1 and TR2 shown in the diagram above.

.....  
 .....  
 .....  
 .....

(2 marks)



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

**3** This question is about Printed Circuit Board (PCB) design and manufacture.

Prototype circuits might be produced by breadboarding or using a Computer-Aided Design (CAD) package.

**3 (a) (i)** Explain why a breadboard is used when designing circuits.

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*(2 marks)*

**3 (a) (ii)** Explain why CAD is used as an alternative to breadboarding.

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*(2 marks)*

**3 (b)** Explain why surface mounting is replacing through-hole mounting of components.

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.....  
.....  
.....

*(2 marks)*

**3 (c)** Describe how surface mount components might be placed and attached to a PCB.

Placed .....

Attached .....

*(2 marks)*



**3 (d)** Give **two** reasons why the use of surface mounted components might be difficult when prototyping.

Reason 1 .....

.....

Reason 2 .....

.....

(2 marks)

**3 (e)** Complete the table below to show six stages in the design and production of **either** a photo etched **or** a machined PCB.

State method .....

Stage	Description
1	
2	
3	
4	
5	
6	

(6 marks)



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

**4** This question is about materials.

**4 (a)** Smart materials are now increasingly being used in electronic products.

What is meant by the term 'smart material'?

.....

.....

.....

.....

(2 marks)

**4 (b)** Describe the application and property of the following materials. An example has been completed for you.

	<b>Application</b>	<b>Property</b>
Fibre optic cable	<i>To conduct modulated light signals</i>	<i>Thin, transparent, flexible signal cable</i>
Quantum tunnelling composite (QTC)		
Electro-luminescent (EL) material		
Photovoltaic cells (PV)		

(6 marks)



**4 (c)** New developments make many products obsolete quickly.  
Mobile phones are a good example.

**4 (c) (i)** What is meant by *planned obsolescence*?

.....  
.....  
.....  
.....

(2 marks)

**4 (c) (ii)** Describe what can be done by a user of an electronic product to reduce the impact of obsolescence.

.....  
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(2 marks)

12

**Turn over for the next question**

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

**5** This question is about creating electronic pulses.

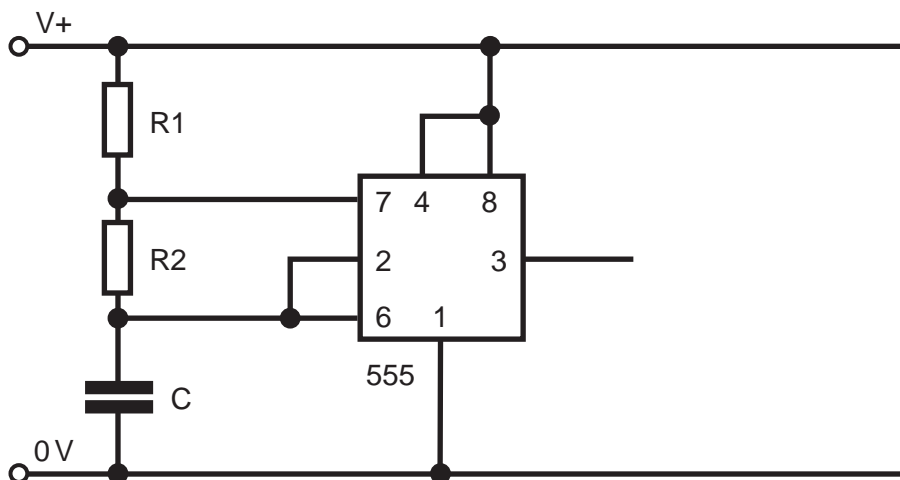
**5 (a)** Complete the table below by inserting the correct term from the following list:

- astable
- an electronic device with two stable states
- monostable
- an electronic timer
- tri-state device

	Sub system	Description of output
(i)		Produces a continuous stream of pulses, high and low
(ii)	Bistable	
(iii)		Has a fixed period output, either high or low

(4 marks)

**5 (b) (i)** Complete the diagram below to create an alternate flashing output with two LEDs (light emitting diodes) and two resistors.



(5 marks)



**5 (b) (ii)** In the graph space below, draw a typical output signal at pin 3 shown on the circuit diagram in Question **5 (b) (i)**.

Label the mark, the space and the period or cycle.



(4 marks)

**5 (b) (iii)** Using the correct formula from the information on page 2, calculate the value of the Time Low for the pulse stream if the capacitor value used is 10 uF and the resistor value 100 K.

State formula used .....  
.....  
(1 mark)

Show calculation and units used .....  
.....  
.....  
.....  
(2 marks)

Calculated Time Low .....  
(1 mark)



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ANSWER IN THE SPACES PROVIDED**





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

**6** This question is about microcontrollers.

For a point of sale display, a manufacturer is keen to attract the attention of consumers by using a flashing LED (light emitting diode) display.

Having prototyped a version using a timer integrated circuit (IC), it was decided to use a microcontroller (PIC) instead.

**6 (a)** Suggest **three** advantages of selecting a microcontroller instead of a timer integrated circuit to drive the display.

Advantage 1 .....

.....

Advantage 2 .....

.....

Advantage 3 .....

.....

*(3 marks)*

**6 (b)** Explain why, when the circuit prototype was developed, an IC socket was used to hold the microcontroller chip.

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*(2 marks)*

**6 (c) (i)** State a typical voltage for powering microcontrollers.

.....

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*(1 mark)*

**Question 6 continues on the next page**

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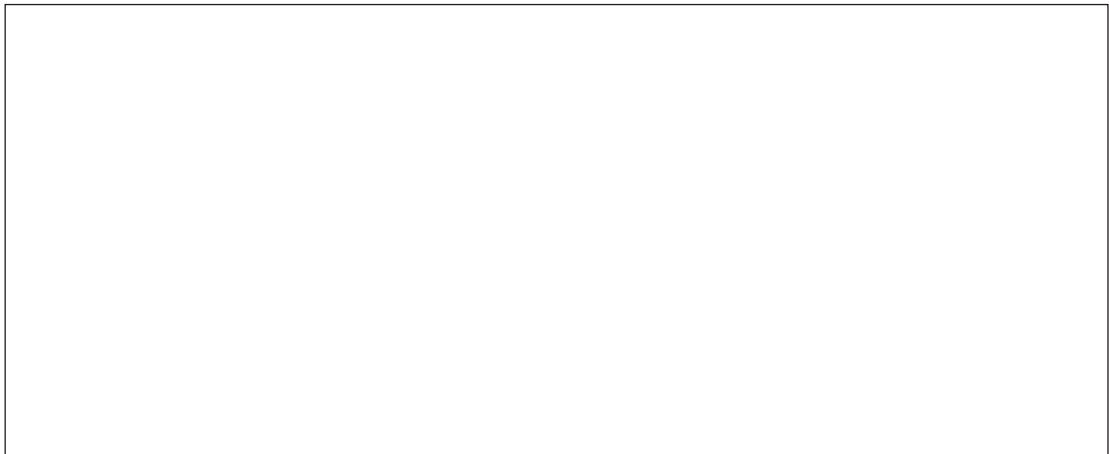
- 6 (c) (ii)** Suggest a suitable additional component that could be used if the only supply available is 12 volts.

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*(1 mark)*

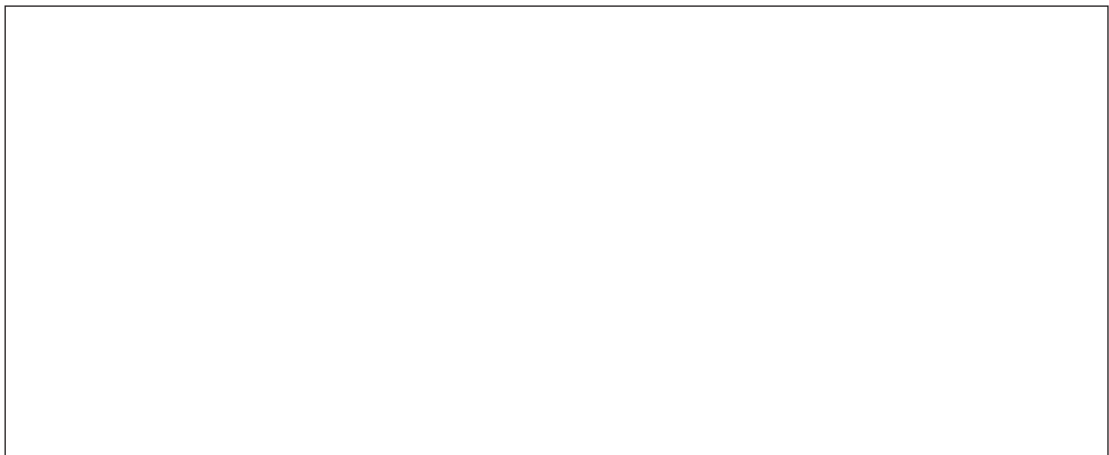
- 6 (d)** Using a programming method you are familiar with, design a short microcontroller programme for each of the following:

- 6 (d) (i)** Program to switch on when a push to make switch is pressed.



*(3 marks)*

- 6 (d) (ii)** Program to run for 60 seconds before automatically switching off.



*(3 marks)*



**6 (d) (iii)** Program to drive two sets of LEDs on and then off at 1 second intervals.



(4 marks)

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**Turn over for the next question**

**Turn over ►**



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

**7** This question is about testing circuits.

You will be marked on your quality of written communication in this question.

**7 (a)** Describe methods you would use to test a printed circuit board (PCB).

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*(8 marks)*



7 (b) Complete the table of the test equipment shown that you might use.

Equipment	Name	Purpose
		
		

(4 marks)

7 (c) Explain what is meant by the term *Quality Control*.

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(2 marks)

**END OF QUESTIONS**



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