Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Secondary Education
Summer 2003
Foundation Tier

ASSESSMENT and QUALIFICATIONS ALLIANCE

DESIGN AND TECHNOLOGY (ELECTRONIC PRODUCTS)

3541/F

F

Monday 23 June 2003 1.30 pm to 3.30 pm

In addition to this paper you will require:
- blue or black pen, pencil, coloured pencils and ruler.

You may use a calculator.

Time allowed: 2 hours

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 125.
- Mark allocations are shown in brackets.
- A list of formulae and other information is given on pages 3 and 4 which you may need to use when answering certain questions.
- Wherever calculations are needed you should show your working.
- You are reminded of the need for good English and clear presentation.

For Examiner's Use	
Number	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	
Examiner's initials	

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

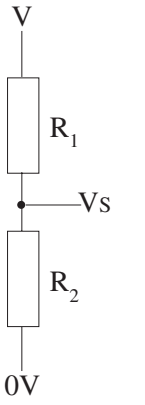
Potential Difference — Potential Difference = Current × Resistance ($V = I \times R$)

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

Parallel Resistors — $\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

Electrical Power — Electrical Power = Current × Potential Difference ($P = I \times V$)

Potential Divider



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

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

Inverting Op-Amps — $Gain = \frac{-Rf}{Rin}$ Where Rf = feedback resistor value, Rin = input resistor value

Time Constant — Time Constant ≃ Resistance × Capacitance ($T \simeq R \times C$)

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

Pulse duration — $= \frac{1}{\text{frequency}}$

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

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

Mark Space Ratio — $= \frac{Th}{Tl}$

Turn over ►

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%

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

1 **Figure 1** shows two resistors.

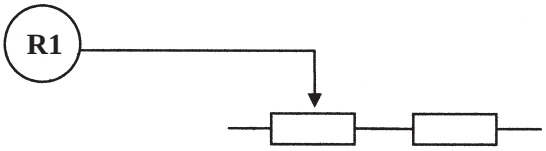


Figure 1

(a) Circle **one** of the words below which best describes the resistor combination shown in **Figure 1**.

Parallel **Series**

(1 mark)

(b) R1 has four colour bands – Brown Black Red Gold.

(i) State the value of R1.

.....

(3 marks)

(ii) The total resistance of the combination shown is 2K.
Calculate the value of the second resistor.

Formula .....

Working

Answer and units .....

(3 marks)

(c) The gold band indicates the level of ‘‘tolerance’’ of the resistor value. Explain the meaning of ‘‘tolerance’’.

.....

.....

.....

(2 marks)

9

2 A student has been looking at possible systems and circuits for an automatic bath water temperature control.

(a) **Figure 2** shows a block diagram for a control system.

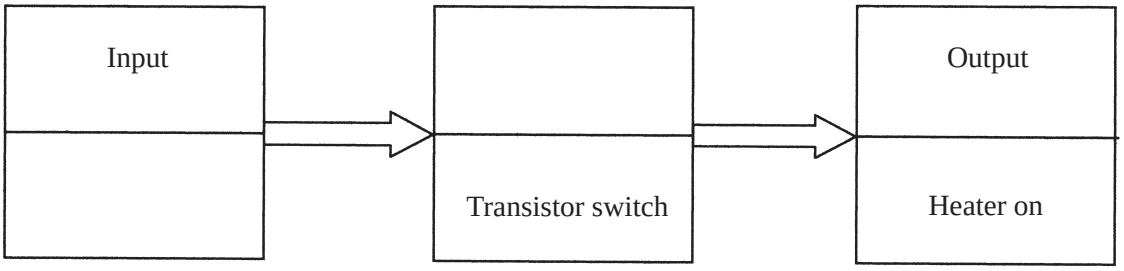


Figure 2

(i) Complete **Figure 2** for a heating control system.

(2 marks)

(ii) Name the type of control system shown.

.....

(1 mark)

(b) Some testing was carried out using the circuit shown in **Figure 3**.

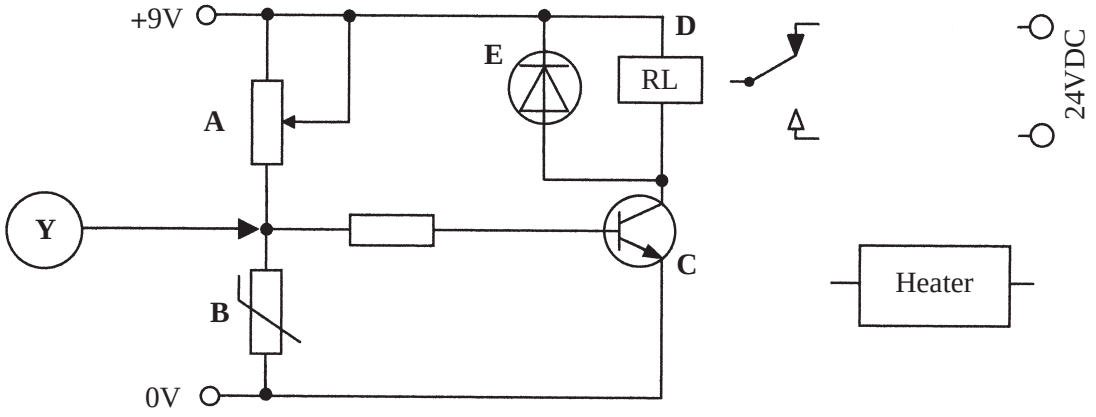


Figure 3

Name the components in **Figure 3** which are labelled:

(i) **A** .....

(1 mark)

(ii) **B** .....

(1 mark)

(iii) **C** .....

(1 mark)

(iv) **D** .....

(1 mark)

(v) **E** .....

(1 mark)

(c) With reference to **Figure 3**.

(i) State which **two** components make up the potential divider part of the circuit.

..... and .....

(2 marks)

(ii) State what happens to the resistance of component **B** when it gets warm.

.....

(1 mark)

(iii) State the reason for including component **A** in the circuit.

.....

(2 marks)

(iv) State what happens to the voltage at **Y** when it gets warm.

.....

(1 mark)

(v) Give the voltage required at the base of a transistor in order to ''switch'' it on.

.....

(1 mark)

(d) Show, by completing **Figure 4**, how the heater, the 24VDC power supply and the relay would be connected so that the heater is switched on when the relay is energised.

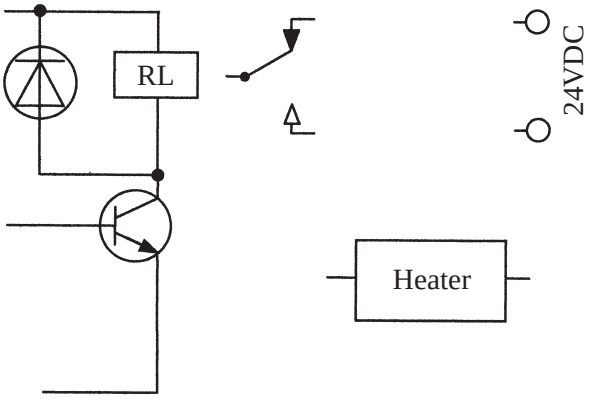


Figure 4

(3 marks)

18

3 **Figure 5** shows a pulse generator that controls the flash rate of an LED.

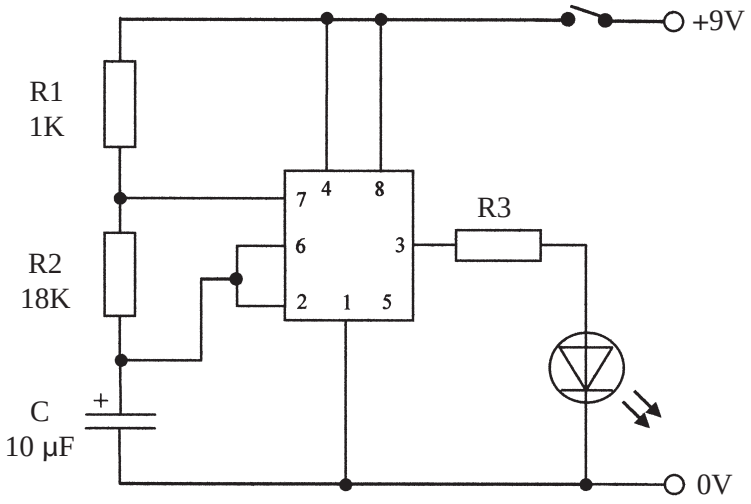


Figure 5

(a) Circle **one** of the words below which best describes the circuit shown in **Figure 5**.

Astable **Monostable**

(1 mark)

(b) Number pin 3 on the IC shown in **Figure 6**.

(1 mark)

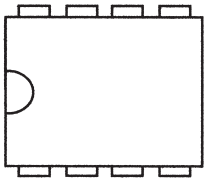


Figure 6

(c) R1 and R2 help to control the frequency of the circuit. Name the other component that controls the frequency of the circuit.

.....

(1 mark)

(d) (i) Explain the reason for including R3 in the circuit.

.....

.....

(2 marks)

(ii) Calculate the value of R3 when the output from pin 3 is 7V, the LED uses 2V and draws a current of 20mA.

Formula .....

Working

Answer and units .....

(4 marks)

(e) The pulse generator circuit is to be modelled and tested on breadboard (protoboard). Complete **Figure 7** by adding **six** wire connections to make the circuit work as intended.

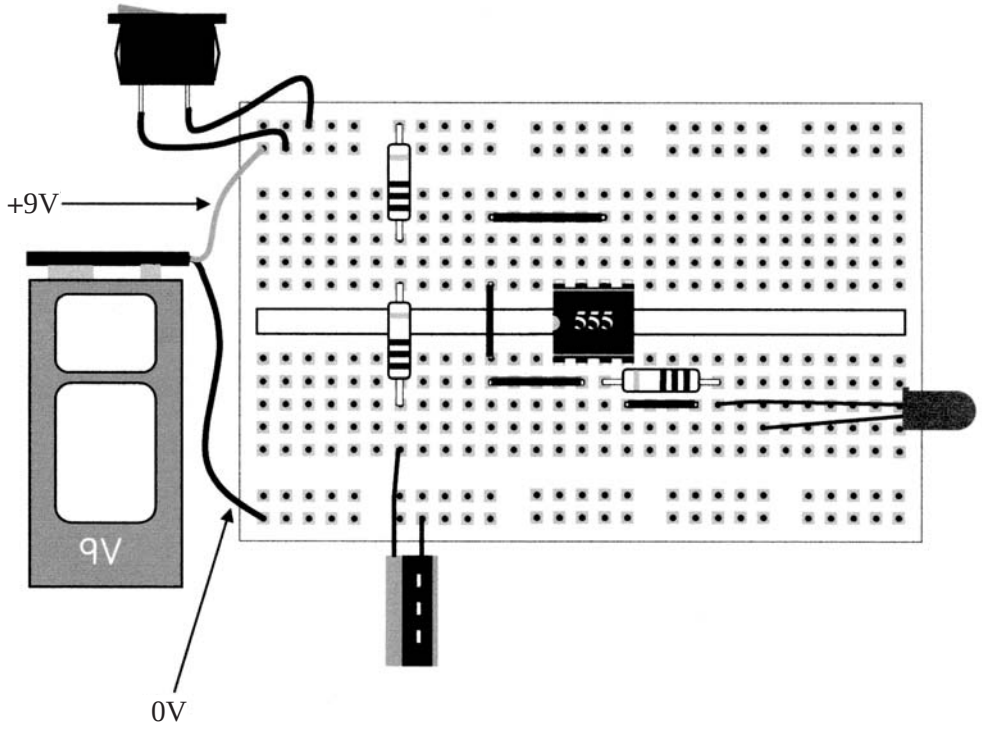


Figure 7

(6 marks)

15

4 An automatic plant watering system has been designed using logic gates.

Figure 8 shows the symbols for the two logic gates to be used and their incomplete truth tables.

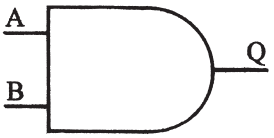
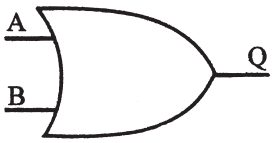
Symbol	Name	Truth Tables
		A B Q 0 0 0 0 1 1 0 1 1 1
		A B Q 0 0 0 0 1 1 0 1 1 1

Figure 8

(a) Complete **Figure 8** by

(i) stating the name for each type of gate; *(2 marks)*

(ii) adding the omitted logic outputs (Q). *(4 marks)*

(b) A water pump will only switch on when it is either cool **or** dark **and** the soil is dry **and** there is water in the tank.

Complete **Figure 9** so that the pump only operates when required.

Quality of drawing *(1 mark)*
Quality of answer *(5 marks)*

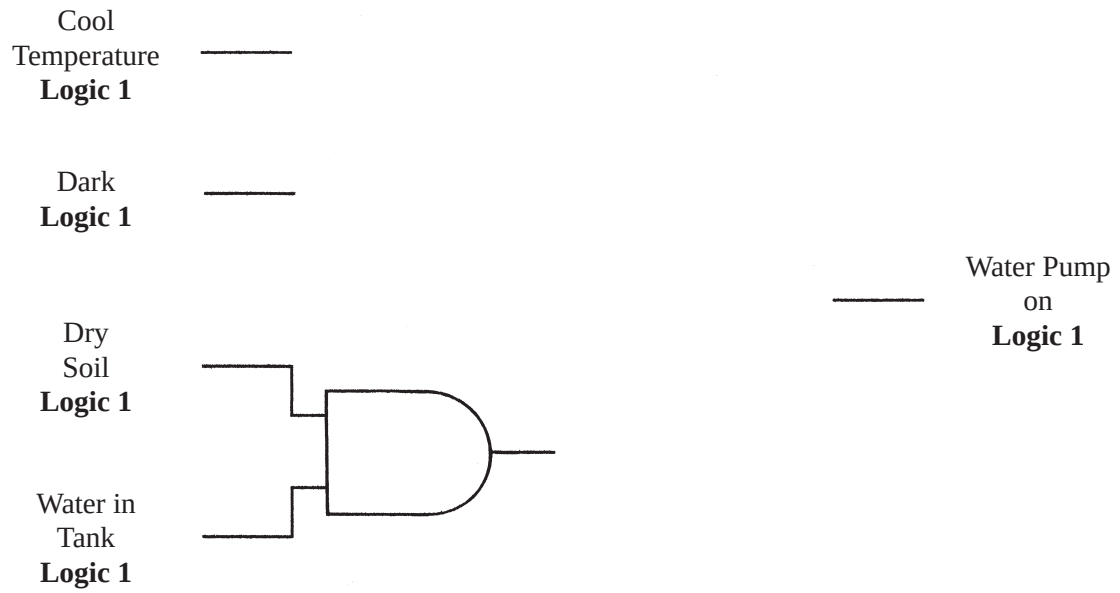


Figure 9

(c) An alternative to using logic gates would be to use a Peripheral Interface Controller (PIC).

Give **two** advantages of using a PIC in place of a logic system made up of individual ICs.

1 .....

.....

2 .....

.....

(2 marks)

(d) A list of the operations when using a PIC is shown below, they are not in the correct order.

A – Download onto PIC.

B – Insert chip into final working circuit/output module.

C – Design flow chart/procedure/program using a PC.

D – Test the procedure on screen.

Complete the block diagram shown as **Figure 10**, using the letters **A**, **B**, **C** and **D** to give the correct order of operations when using PIC microprocessors.

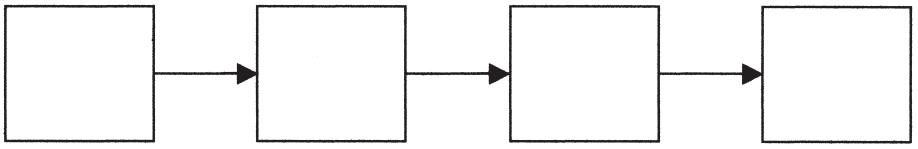


Figure 10

(3 marks)

17

TURN OVER FOR THE NEXT QUESTION

5 **Figure 11** shows part of an automatic lighting circuit.

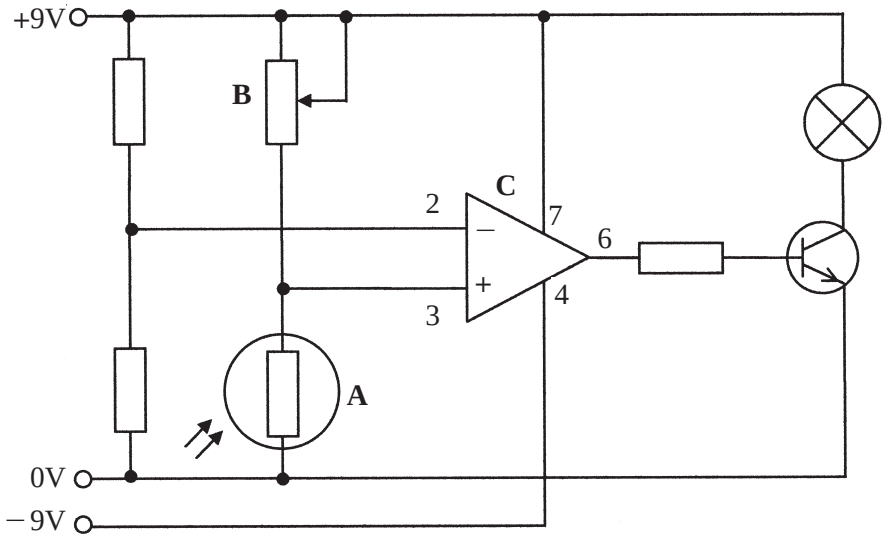


Figure 11

(a) Name the labelled components and give the reason for them being in the circuit.

(i) **A** .....

Reason .....

.....

(3 marks)

(ii) **B** .....

Reason .....

.....

(3 marks)

(iii) **C** .....

Reason .....

.....

(3 marks)

(b) (i) Explain an advantage of using computer simulation software to develop and test circuit designs.

.....

.....

(1 mark)

(ii) The PCB of the chosen circuit was designed using Computer Aided Design (CAD) software.

Give **two** advantages of using CAD to design the PCB.

1 .....

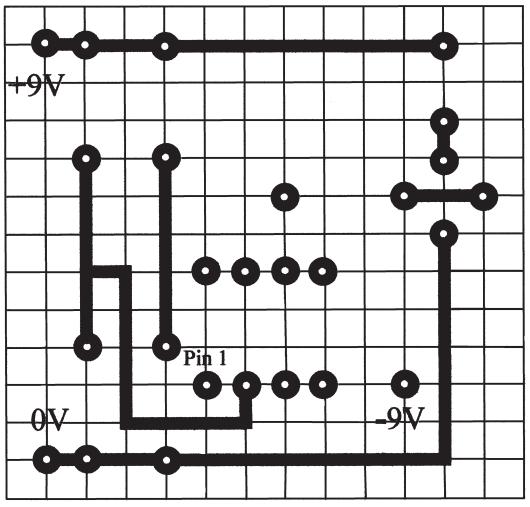
.....

2 .....

.....

(2 marks)

(c) **Figure 12** shows the incomplete printed circuit design.



viewed from the component side

Figure 12

Complete **Figure 12** by adding **four** tracks to the PCB so that

(i) the +9V rail is connected to the IC; *(1 mark)*

(ii) the output from the IC is connected to the resistor; *(1 mark)*

(iii) the non inverting input is connected to the LDR potential divider; *(1 mark)*

(iv) the −9V supply is connected to the IC. *(1 mark)*

QUESTION 5 CONTINUES ON THE NEXT PAGE

(d) Describe **two** procedures that need to be followed in order to achieve quality soldering.

1 .....

.....

2 .....

.....

(2 marks)

(e) List **two** safety hazards to consider when soldering and give the precautions you would need to take.

Hazard 1 .....

Precaution .....

.....

Hazard 2 .....

Precaution .....

.....

(4 marks)

22

6 A student has decided to design and make an educational toy that will help to encourage young children to improve their maths.

Figure 13 shows the basic outline for the toy.

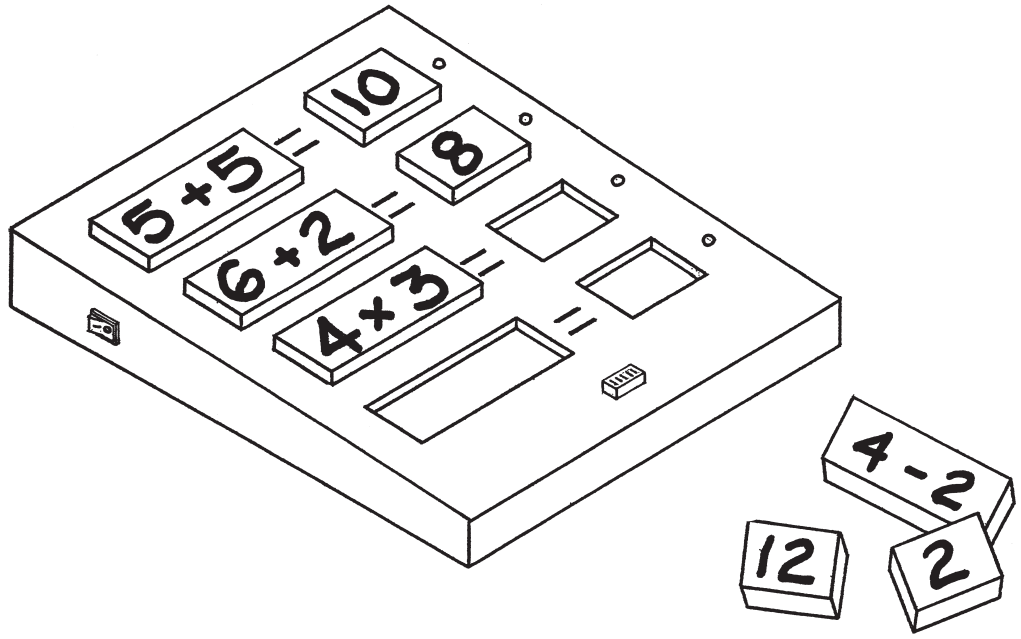


Figure 13

Various question blocks can be placed in the spaces on the left, the child then needs to place the correct answer blocks in the spaces on the right.

(a) List **three** more important design considerations that you should consider when designing for young children.

1 *Must be colourful – so it is attractive for children to use.*

2 .....

3 .....

4 .....

(6 marks)

(b) List **three** more useful areas for research when designing children's toys.

1 *Different materials – to find out prices, availability and properties.*

2 .....

3 .....

4 .....

(6 marks)

(c) (i) Give the name of a specific material from which the case could be made and explain the reason for your choice.

Material .....

(1 mark)

Reason .....

.....

(2 marks)

(ii) Use notes and drawings to show clearly how the casing would be constructed in order to provide suitable housings for the blocks and components.

Quality of solution *(5 marks)*
Quality of drawing *(2 marks)*

(iii) Use notes and drawings to show clearly how the circuit is securely held in place.

Quality of solution *(2 marks)*
Quality of drawing *(2 marks)*

QUESTION 6 CONTINUES ON THE NEXT PAGE

(d) **Figure 14** shows the incomplete circuit for the toy.

When a correct answer is given an LED will turn on and the next question can be used. The toy will only work if the questions are answered in the correct order.

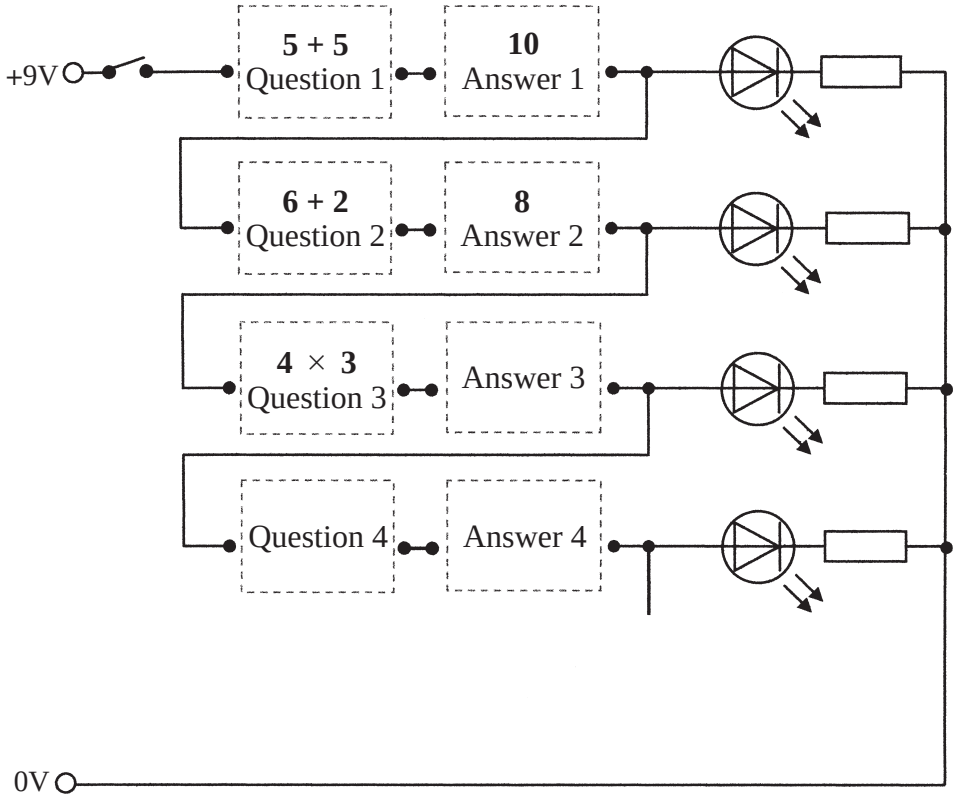


Figure 14

(i) Complete **Figure 14** by adding a buzzer that will sound when **all four** questions have been answered correctly. *(2 marks)*

(ii) Give the names of **two** different sensors or switching devices that could be used to detect when a question block is placed in the toy.

1 .....

2 .....

(2 marks)

(e) A local manufacturing company has shown an interest in the idea and has produced a batch of 100 of the toys.

Explain **two** advantages for the company by producing the batch rather than going into full scale mass production.

1 .....

.....

2 .....

.....

(2 marks)

(f) Modern manufacturing methods using Computer Aided Manufacture (CAM) can provide many advantages.

List **two** advantages that the use of CAM has for:

(i) manufacturers;

1 .....

.....

2 .....

.....

(2 marks)

(ii) consumers.

1 .....

.....

2 .....

.....

(2 marks)

(g) Explain **one** method of testing the toy as part of a final evaluation.

.....

.....

.....

.....

(2 marks)

38

Turn over ►

7 Manufacturers have always had to balance the cost of developing and making a product against environmental considerations.

Shown below are key words that may be used when writing about environmental issues.

Energy	**Ecosystems**	**Availability**	**Waste**
Pollution	**Sustainable**	**Resources**	**Extraction**
Workers' Conditions	**Public Health**	**Waste Disposal**	**Recycling**

Complete the table, **Figure 15**, by adding the environmental considerations that the manufacturer should take at each of the stages of the production and life cycle of a product.

You may find some of the key words helpful.

Stage	Environmental Considerations
Selection of raw materials for product	1 *When raw materials are removed, habitats, eco systems might be damaged.*
	2 *If too much top soil/trees etc is removed soil erosion could occur.*
During manufacture	1
	2
Final product in use	1
	2
End of use	1
	2

Figure 15

(6 marks)

END OF QUESTIONS