Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Secondary Education
Summer 2003
Higher Tier

ASSESSMENT and QUALIFICATIONS ALLIANCE

DESIGN AND TECHNOLOGY (ELECTRONIC PRODUCTS) (SHORT COURSE)

3551/H

H

Monday 23 June 2003 1.30 pm to 3.00 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: 1 hour 30 minutes

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 100.
- Mark allocations are shown in brackets.
- A list of formulae and other information is given on pages 2 and 3 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	
TOTAL	
Examiner's initials	

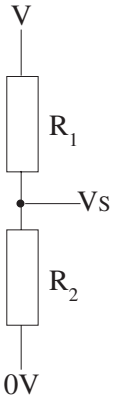
You may need to use one or more of the following formulae when answering questions which include calculations.

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

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

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

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

Astable Frequency for 555

$$f = \frac{1.44}{(R_1 + 2R_2) \times C}$$

Pulse duration

$$= \frac{1}{\text{frequency}}$$

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

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 a resistor placed in a breadboard (protoboard).

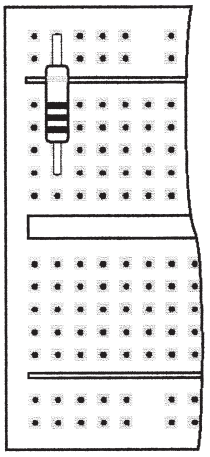


Figure 1

(a) The resistor has four colour bands – Brown Grey Orange Gold.

(i) State the value of the resistor.

.....

(3 marks)

(ii) Explain the meaning of the Gold band.

.....

.....

.....

(2 marks)

(b) Calculate the maximum and minimum values for the resistor shown in **Figure 1**.

(i) Maximum value.

Working

Answer and units .....

(3 marks)

(ii) Minimum value.

Working

Answer and units .....

(2 marks)

(c) (i) Show, by adding another resistor to **Figure 1**, how a series combination would be set up.

(1 mark)

(ii) Explain the advantages of using a breadboard for modelling circuits.

.....

.....

.....

(2 marks)

(iii) Calculate the total resistance of the series resistor combination shown in **Figure 2**.

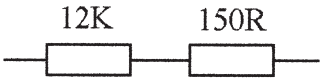


Figure 2

Formula .....

Working

Answer and units .....

(3 marks)

16

2 A student has been investigating the design for a circuit to be used as an alarm for a garden shed.

(a) Explain **three** advantages of using computer simulation software to develop and test circuit designs.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

(b) **Figure 3** shows a pulse generator outputting through a loudspeaker.

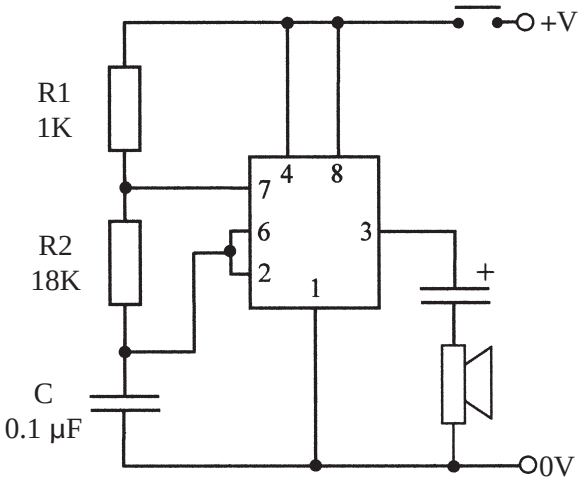


Figure 3

Calculate the frequency of the circuit.

Formula .....

Working

Answer with units .....

(5 marks)

(c) The PCB of the chosen circuit was drawn using CAD software.

Explain **two** advantages of using CAD to draw the PCB.

1 .....

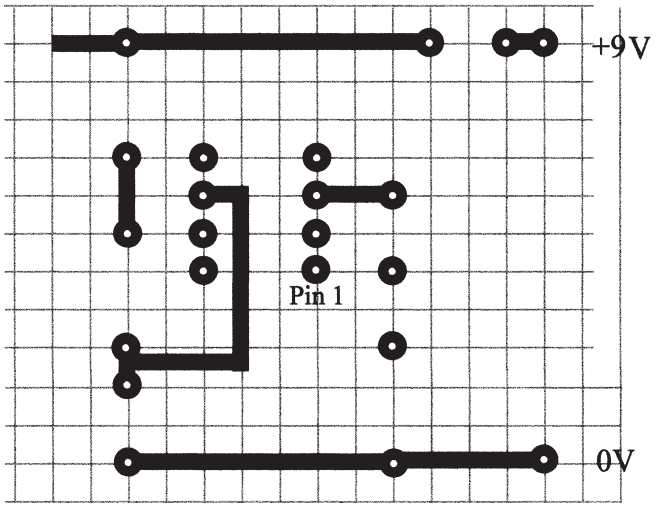
.....

2 .....

.....

(4 marks)

(d) **Figure 4** shows the incomplete printed circuit design.



(viewed from the component side)

Figure 4

Complete **Figure 4** by adding the **six** tracks needed for the circuit to work as intended.

(6 marks)

QUESTION 2 CONTINUES ON THE NEXT PAGE

(e) The student realises that the alarm will only sound when the push to make switch is pressed and decides to add a monostable timer to control the length of time the loudspeaker sounds.

Figure 5 shows the modified system.

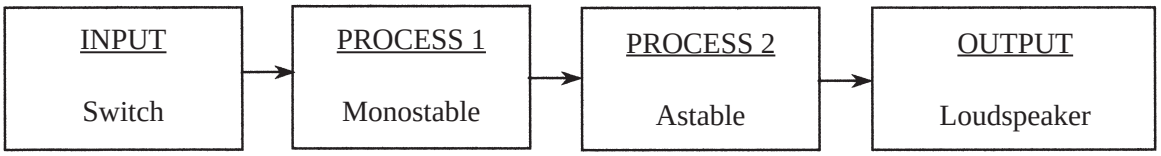


Figure 5

Figure 6 shows the incomplete circuit diagram for the modified system.

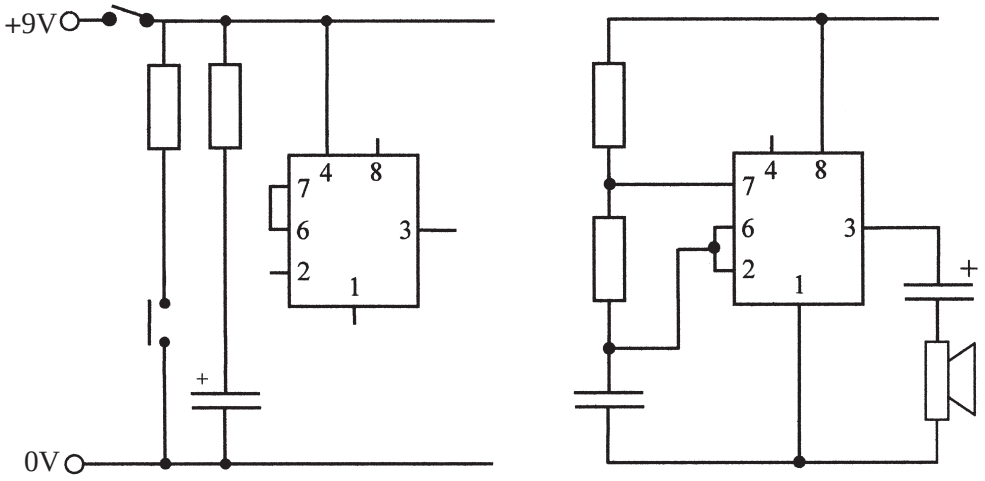


Figure 6

Complete **Figure 6** by adding:

(i) the connections on the monostable circuit; *(4 marks)*

(ii) the connection between the two circuits. *(4 marks)*

Quality of drawing *(2 marks)*

(f) An alternative to using the circuit shown as **Figure 6** would be to use a Peripheral Interface Controller (PIC).

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

1 .....

.....

2 .....

.....

(2 marks)

(g) 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 7**, using the letters **A**, **B**, **C** and **D** to give the correct order of operations when using PIC microprocessors.

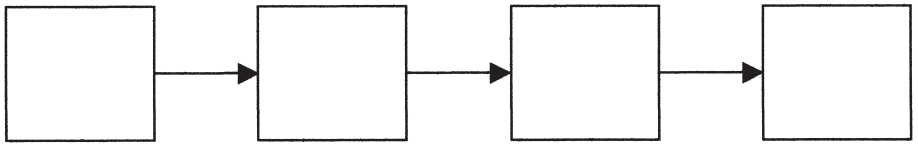


Figure 7

(3 marks)

33

TURN OVER FOR THE NEXT QUESTION

3 A student has been designing and developing a model of an automatic heating system for a greenhouse.

Some testing was carried out using the circuit shown in **Figure 8**.

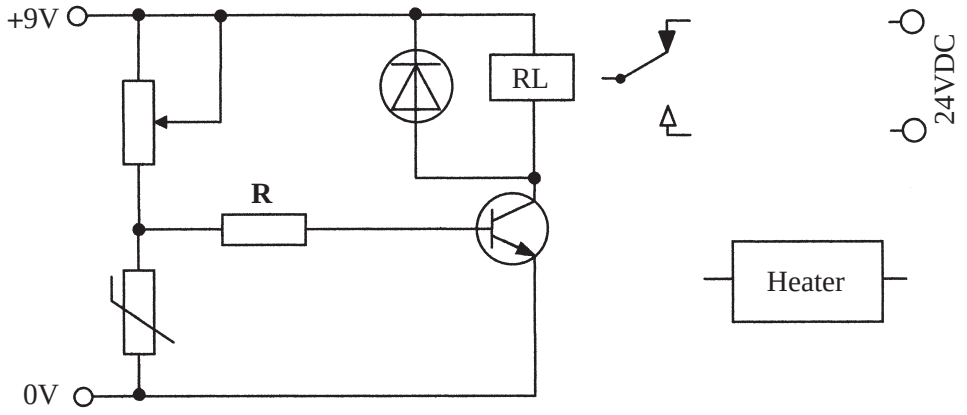


Figure 8

(a) Show, by completing **Figure 8**, 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.

(3 marks)

(b) Explain the function of the following components in the circuit.

(i) Resistor R.

.....

.....

(2 marks)

(ii) The diode.

.....

.....

(2 marks)

(c) Explain how the circuit operates as the temperature lowers.

.....

.....

.....

.....

.....

.....

(4 marks)

11

TURN OVER FOR THE NEXT QUESTION

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

Figure 9 shows the basic outline for the toy.

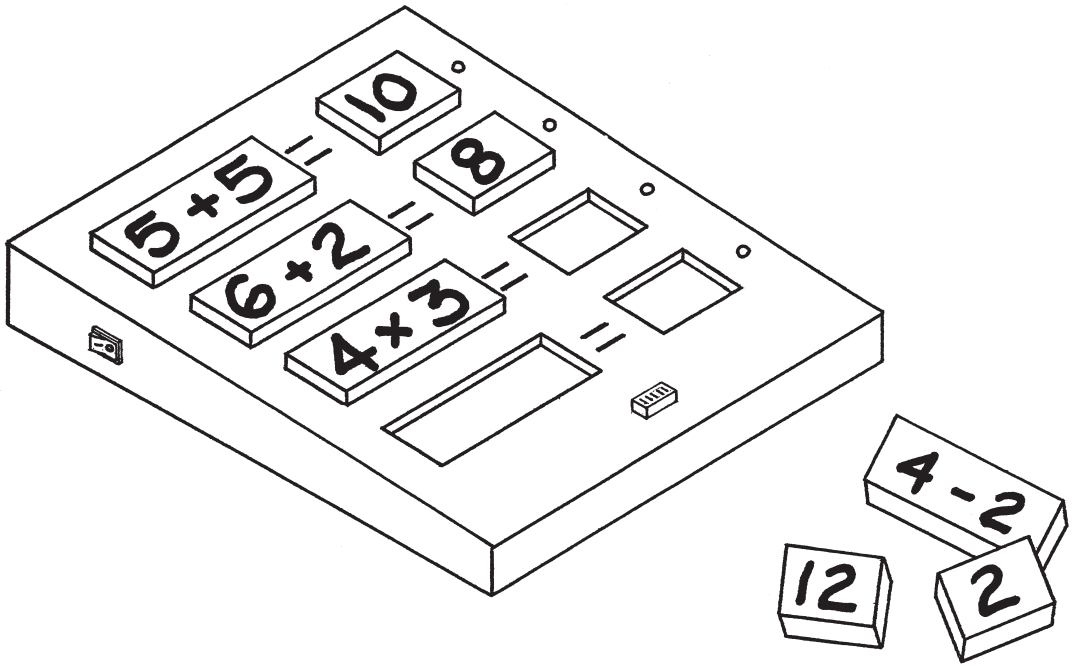


Figure 9

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) Complete **Figure 10**, to show a range of research needs and what you would expect to find out as part of your investigation.

Information that I need	Where I might find the information
	Nursery or Primary schools
	Local Suppliers materials catalogue
A range of toys already on the market	
The smallest sizes that can be safely used so as not to risk a child choking if they were to place it in their mouths	
	Anthropometric Data

Figure 10

(5 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)

QUESTION 4 CONTINUES ON THE NEXT PAGE

(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)*

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

1 .....

2 .....

(2 marks)

(ii) Use notes and drawings to show how **one** of the sensor or switching methods you have chosen in (i) would be located in the case.

(2 marks)

(iii) Use notes and drawings to show how you would position the sensors or switching methods on the blocks to enable only the correct combinations of question and answer blocks to turn on an LED.

(4 marks)

33

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

Complete **Figure 11**, by adding environmental issues that the manufacturer should consider at each stage in the life span of a product.

Stage	Environmental Considerations
Selection of raw materials for product	1 *When raw materials are removed, habitats, eco systems might be damaged.*
	2
During manufacture	1
	2
Final product when in use	1
	2
End of use	1
	2

Figure 11

(7 marks)

END OF QUESTIONS