Surname		Other Names	
Centre Number						Candidate Number				
Candidate Signature										

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General Certificate of Secondary Education
June 2005

DESIGN AND TECHNOLOGY (ELECTRONIC PRODUCTS) Higher Tier

3541/H

H

Thursday 16 June 2005 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 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	
6	
7	
TOTAL	
Examiner's initials	

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

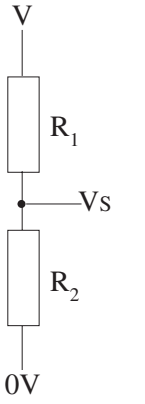
Potential Difference — Potential Difference = Current × Resistance ($V = I \times R$)

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 — $= \frac{Th}{Tl}$

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

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

1 **Figure 1** shows a block diagram of a fire alarm.

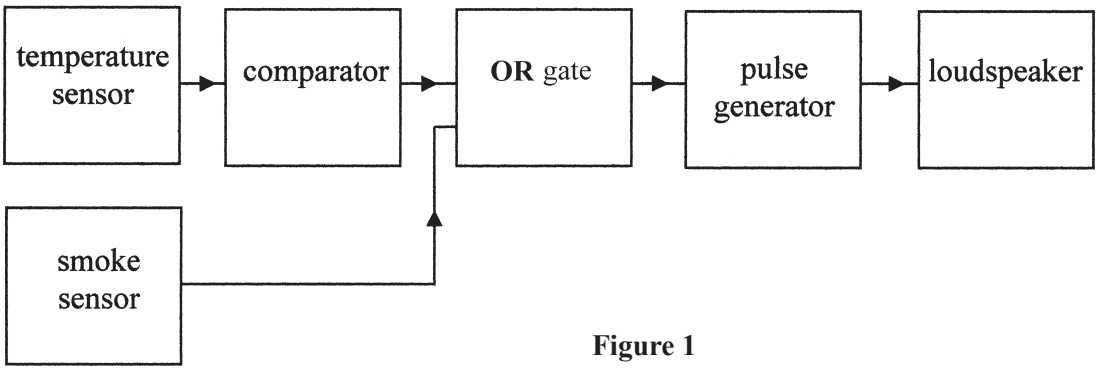


Figure 1

(a) State which block represents

(i) the final output stage .....
(1 mark)

(ii) an input stage .....
(1 mark)

(iii) an astable. .....
(1 mark)

(b) State the block in which you would find

(i) an op-amp .....
(1 mark)

(ii) a thermistor .....
(1 mark)

(iii) the control of the frequency of the sound. .....
(1 mark)

(c) **Figure 2** shows a pulse generator circuit used as part of the system.

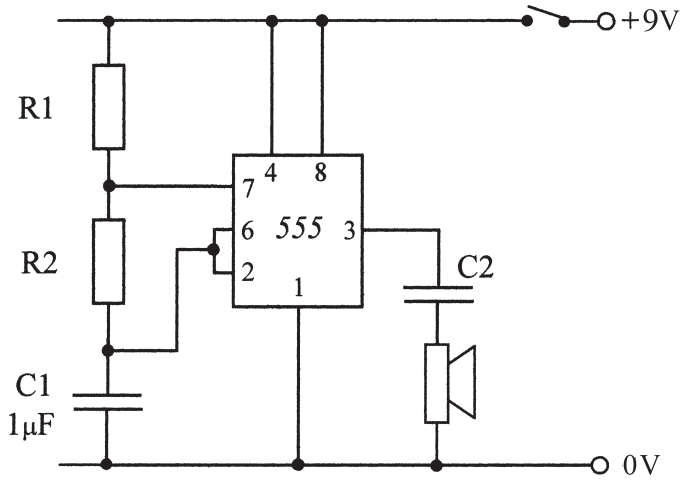


Figure 2

Component **C1** helps to control the frequency of the circuit.

(i) Circle the **two** components, other than **C1** in **Figure 2**, that control the frequency of the circuit. *(2 marks)*

(ii) Explain the effect on the sound from the loudspeaker if the value of **C1** was increased.

.....

.....

(2 marks)

(d) The final circuit could be constructed using either veroboard (stripboard) or on a PCB.

(i) Compare the use of veroboard as opposed to a PCB for producing the circuit.

.....

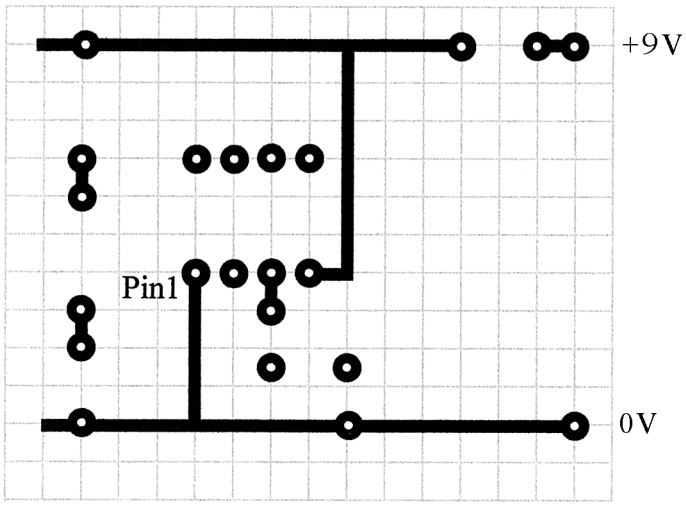
.....

(2 marks)

(ii) It is decided that the PCB method will be used.

Figure 3 shows the incomplete PCB design of the **pulse generator** stage of the circuit.

The pulse generator circuit is shown in **Figure 2**.



Viewed from the component side

Figure 3

Complete **Figure 3** by adding **five tracks** to the PCB so that:

- pin 8 is joined to the +V rail;
- pin 7 is joined between R1 and R2;
- pin 6 is joined to pin 2;
- pins 6 and 2 are joined between R2 and C1;
- C2 is joined to the loudspeaker.

(5 marks)

Quality of drawing *(2 marks)*

Turn over ►

2 You have been asked to design an electronic dice to be used by children when playing games.

Analysis

(a) List **two** things that you should think about when designing the electronic dice. An example has been given.

The likely cost of the whole project including both components and materials.

1 .....

2 .....

(4 marks)

Research

The layout of a research plan for the electronic dice is shown in **Figure 4**.

(b) Complete **Figure 4** by adding suitable research sources and stating the information that you would hope to find. *(7 marks)*

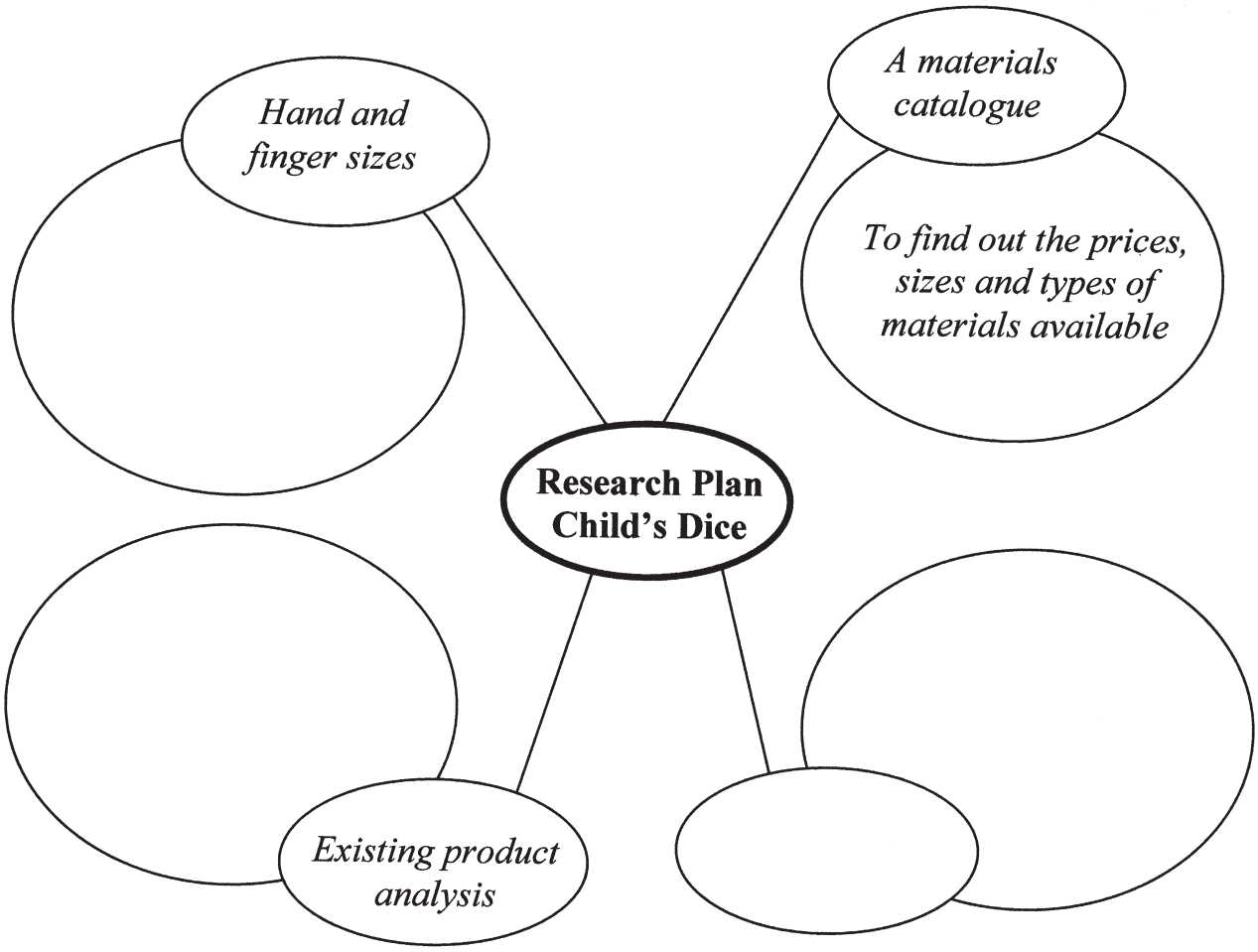


Figure 4

(c) Describe how the information from analysis and research may affect the final design.

.....

.....

.....

.....

(2 marks)

(d) Give **four** specification points for the electronic dice. **Two** of the points should be about the casing and **two** about the electronics. Examples have been given.

(i) Casing specifications

Not too heavy – so that it can be used by young children.

1 .....

2 .....

(4 marks)

(ii) Electronic specifications

The numbers will be made up from arrangements of 5 mm LEDs.

1 .....

2 .....

(4 marks)

21

TURN OVER FOR THE NEXT QUESTION

3 This question is about designing, making and evaluating the electronic dice.

(a) (i) Use notes and sketches to show:

- a design for the casing of the dice; *(4 marks)*
- how the dice is switched on and activated. *(2 marks)*

Quality of communication *(2 marks)*

(ii) Give the name of a suitable material from which the casing could be made.

Material .....

(1 mark)

(iii) Use notes and sketches to show:

- a suitable method of fitting an LED into the case; *(2 marks)*
- how the circuit is securely held in place in the casing. *(3 marks)*

(b) List **two** situations when health and safety hazards might be an issue whilst making the casing and give the precaution that you would need to take.

Situation 1 .....

Precaution .....

.....

Situation 2 .....

Precaution .....

.....

(4 marks)

(c) Explain **two** methods of evaluating the finished dice.

1 .....

.....

2 .....

.....

(4 marks)

(d) Give **two** reasons why quality checks need to be made during the making of electronic products.

1 .....

.....

2 .....

.....

(4 marks)

26

TURN OVER FOR THE NEXT QUESTION

4 The lift in a department store is controlled using logic gates.

The lift will only operate if

- a person has requested the lift from another floor
- a floor has been chosen by a person in the lift
- the doorway is not obstructed.

Figure 5 shows the logic diagram for the system.

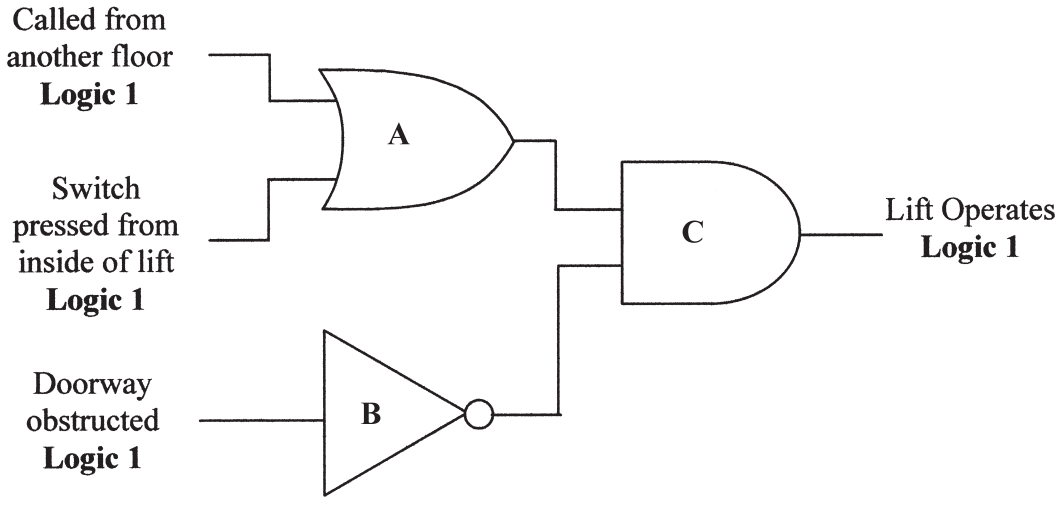


Figure 5

(a) Name the **three** logic gates shown in **Figure 5**.

A .....

B .....

C .....

(3 marks)

(b) When designing a logic circuit it is possible to use a single IC which contains a number of identical logic gates.

Give **two** advantages of using this type of IC.

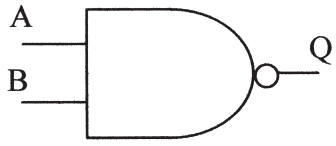
1 .....

2 .....

(2 marks)

(c) **Figure 6** shows a NAND gate and its incomplete truth table.

(i) Complete **Figure 6** by adding the output states of the truth table. *(4 marks)*



A	B	Q
0	0	
0	1	
1	0	
1	1	

Figure 6

(ii) Complete **Figure 7** to show how the logic diagram in **Figure 5** can be constructed using **six** NAND gates. *(6 marks)*

Quality of drawing *(2 marks)*

Called from another floor — **Logic 1**

Switch pressed from inside of lift — **Logic 1**

— Lift Operates **Logic 1**

Doorway obstructed — **Logic 1**

Figure 7

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5 The owner of the company who manufactures the lift in **Question 4** is considering replacing the logic system of lift control with a PIC microprocessor control system.

(a) Explain **one** advantage and **one** disadvantage of installing a PIC system compared to the present system which uses a number of logic gates.

Advantage .....

.....

(2 marks)

Disadvantage .....

.....

(2 marks)

Figure 8 shows a drawing of a lift with its doors open at the ground floor.

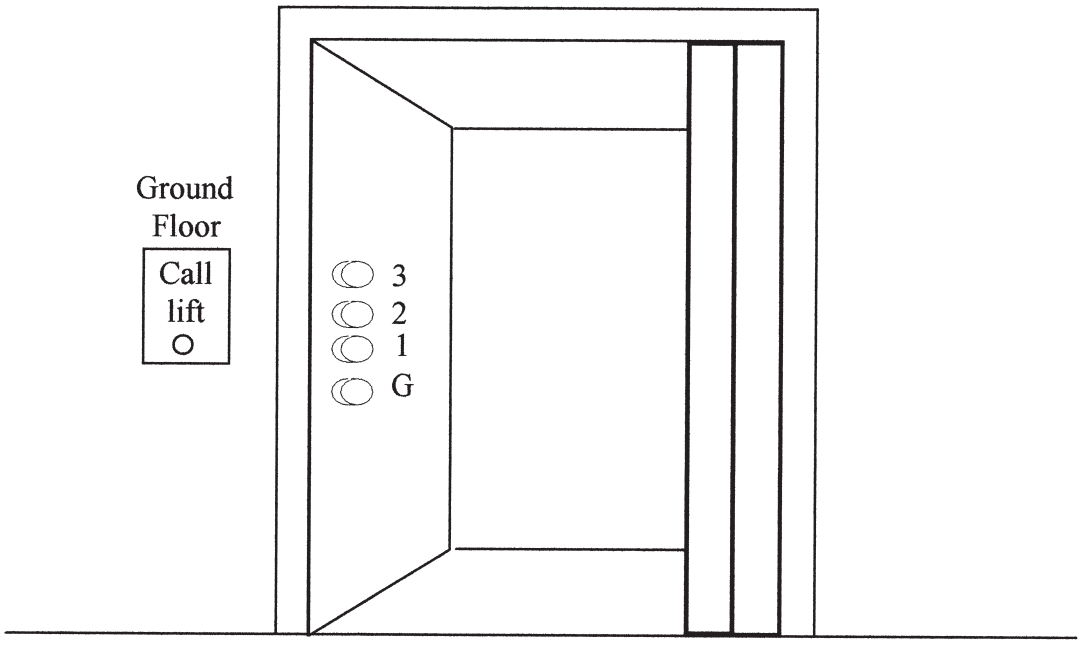

Figure 8

The lift will only operate when a person has requested the lift from another floor **or** a floor has been chosen by a person in the lift **and** the doorway is not obstructed.

(b) Complete **Figure 9** by designing a flow chart to illustrate the lift operating sequence from when the lift starts at the ground floor with its doors open and is called to the first floor where its doors open. *(10 marks)*

Quality of drawing *(2 marks)*

Figure 9

6 **Figure 10** shows an incomplete circuit that is to switch on the 24 V cooling fan when the temperature gets warm.

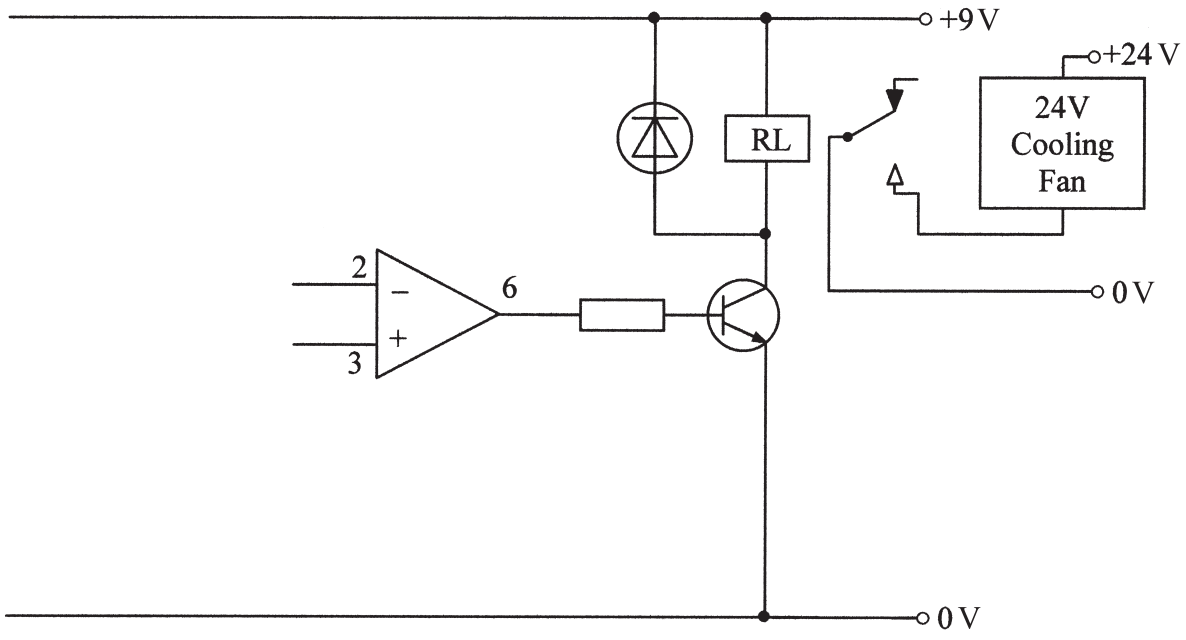

Figure 10

(a) (i) Give the name of the type of relay shown in **Figure 10**.

.....

(2 marks)

(ii) Explain the reason for the need to include the relay in the circuit.

.....

.....

(2 marks)

(b) (i) Complete **Figure 10** by adding

- a method of producing a reference voltage of 4.5 V at pin 2 including the value of any components used; *(2 marks)*
- a potential divider that includes a thermistor and a means of adjusting the voltage connected on Pin 3 of the op amp that will cause pin 6 to go high when the temperature rises. *(4 marks)*

Quality of drawing *(2 marks)*

(ii) Suggest a suitable voltage at pin 3 which will cause pin 6 to go high.

.....

(2 marks)

(iii) Explain the reason for the voltage that you suggested.

.....

.....

(2 marks)

(c) The thermistor has a value of 10K at 25°C.

Calculate the voltage of pin 3 when the room temperature reaches 25°C and the means of adjusting the voltage is set at 5K.

Formula .....

Working

Answer with units .....

(4 marks)

20

TURN OVER FOR THE NEXT QUESTION

7 During the past twenty years the use of ICT and electronic control systems have revolutionised manufacturing.

Explain **one** advantage and **one** disadvantage that these developments have had for the environment.

Advantage .....

.....

.....

(3 marks)

Disadvantage .....

.....

.....

(3 marks)

6

END OF QUESTIONS