General Certificate of Secondary Education
June 2004

**DESIGN AND TECHNOLOGY
(ELECTRONIC PRODUCTS)
Higher Tier**

3541/H

H

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Friday 28 May 2004   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.

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

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

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

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

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

Potential Divider

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

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

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

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

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

Pulse duration $= \dfrac{1}{frequency}$

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 $= \dfrac{Th}{Tl}$

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 ▶

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

1   **Figure 1** shows a circuit to be used as a timer.
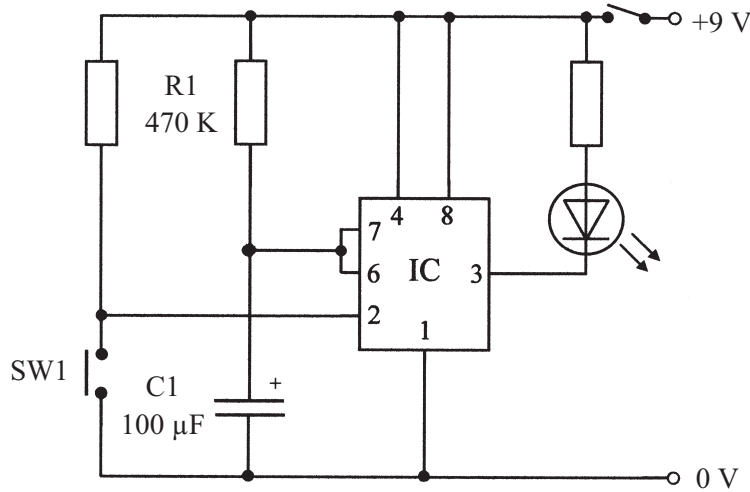

Figure 1

(a)   Name the type of circuit shown in **Figure 1**.

....

(1 mark)

(b)   Complete **Figure 2** by:

(i)   identifying **three** components from the circuit in **Figure 1** that need to be connected the right way round;

(3 marks)

(ii)   explaining what features of each component help to make sure that it is connected into the circuit the right way round.

(6 marks)

Component	Explanation

Figure 2

(c)   Name the **two** components that control the length of the time delay.

(2 marks)

(d)   Explain the function of **SW1**.

....

(1 mark)

(e)   Calculate the time delay of the circuit shown in **Figure 1**.

Formula ....

Working

Answer and Units ....

(3 marks)

(f)   The time delay, when tested, did not match what was expected.

Explain why the tolerance of the capacitor was a likely cause.

....

....

(2 marks)

(g)   State the readings and units that you would expect to find at the following places on the circuit when it is working.

   (i) The voltage at Pin 3 when SW1 is pressed.

   ....

   (1 mark)

   (ii) The voltage at Pin 3 when the voltage at Pins 7 and 6 reaches 6 V.

   ....

   (1 mark)

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Turn over ▶

2   This question is about designing a case for a timer circuit.

Figure 3 shows a *full size* drawing of the PCB and the components of the circuit.

(a)   Sketch **two** different ideas for the casing of the timer.

Your ideas should show well drawn and labelled sketches that include suggestions of both the different materials and suitable construction methods that could be used.

(9 marks)
Quality of drawing *(3 marks)*
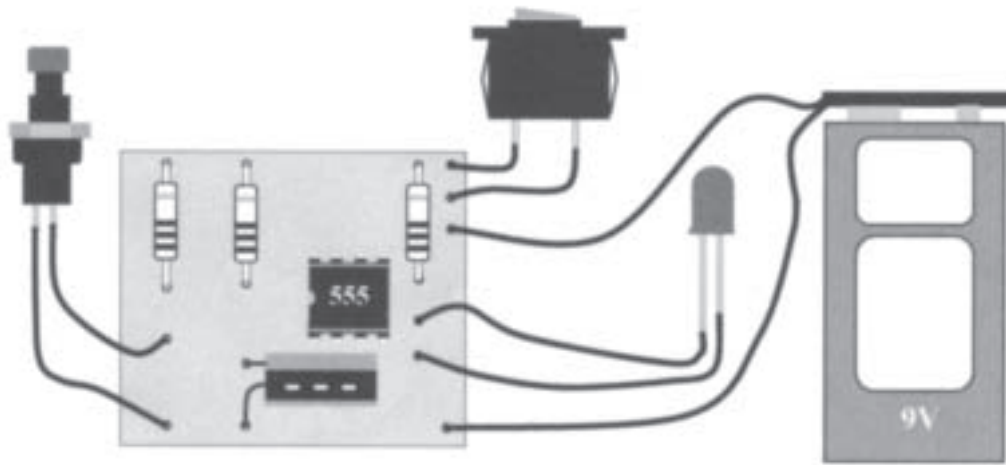
Figure 3

(b)   Choose **one** of your ideas and show using notes and quality sketches the details of:

●   the specific material used for the case;   *(1 mark)* ▶

●   the method of construction for the material chosen;   *(2 marks)*

●   the sizes/dimensions of the case;   *(2 marks)*

●   how the circuit and battery are made accessible;   *(3 marks)*

●   the positions of the two switches and the LED.   *(3 marks)*

Quality of drawing *(3 marks)*

Turn over ▶

3   **Figure 4** shows the outline of a disco light box controlled by a PIC and the layout of the lamps.

Lamps	Outputs
Red	1
Blue	2
Yellow	4
Green	8
Amber	16
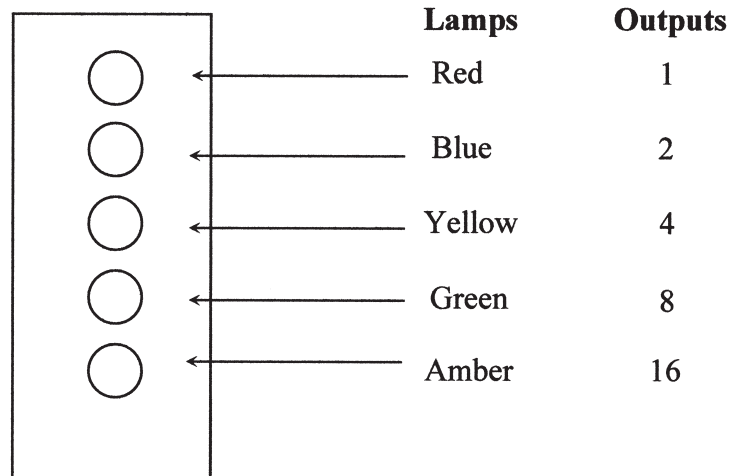
Figure 4

Figure 5 shows part of a flow chart and the layout of the PIC program controlling the lamps.

Flow Chart

Green Lamp ON

For 0.2 sec

Yellow Lamp ON

For 0.1 sec

Red and Blue Lamp ON

PIC Program
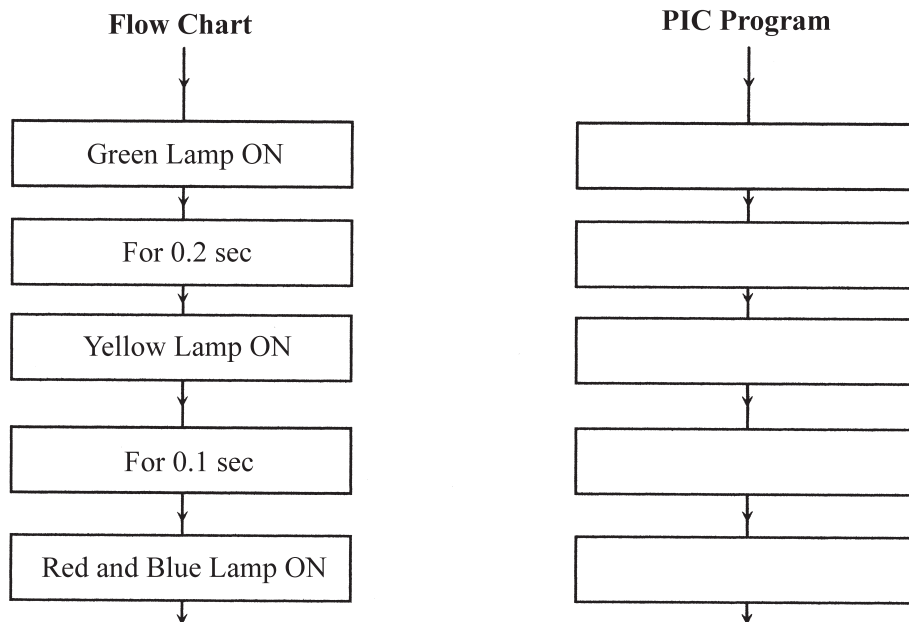
Figure 5

(a)   Complete the program for the part of the flow chart in **Figure 5** using a suitable programming method of your choice.

(5 marks)

(b) **Figure 6** shows the lamps connected to the outputs of the PIC microcontroller.
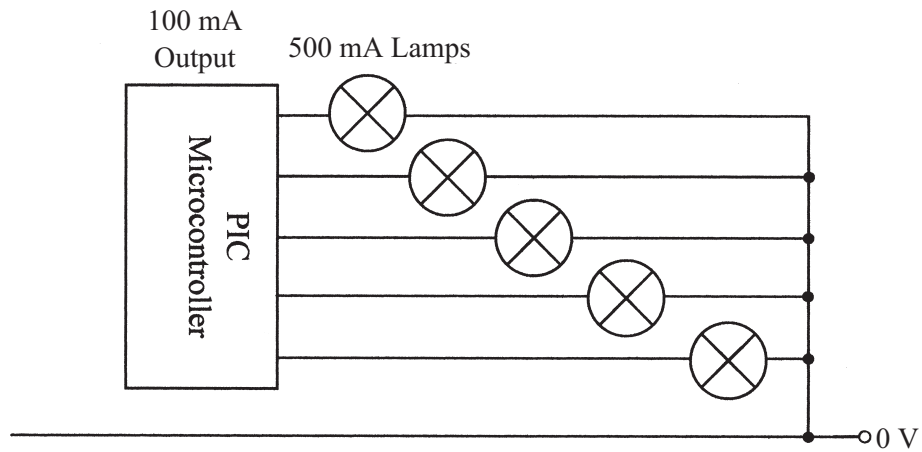
Figure 6

(i) Give the reason for the lamps not working when the circuit was switched on.

....

....

(2 marks)

(ii) Explain how the addition of a Darlington Driver would improve the function of the circuit.

....

....

(2 marks)

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

4 A student decides to make a "steady hand" game.

The circuit will include a **4017 IC** to count the number of lives that each player has.

Figure 7 shows the pin layout information of the IC, taken from a catalogue.
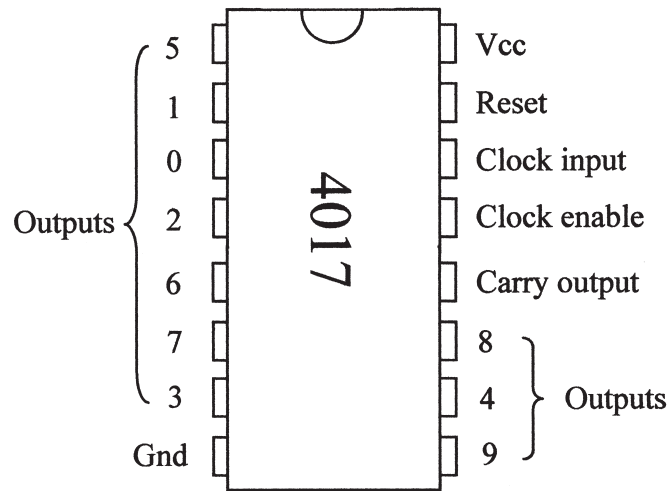
Figure 7

Figure 8 shows the incomplete circuit for the counter. When the game is switched on the game ready LED comes on. The player is to have **five** lives.

Each time the hand loop touches the wire shape another LED lights up.
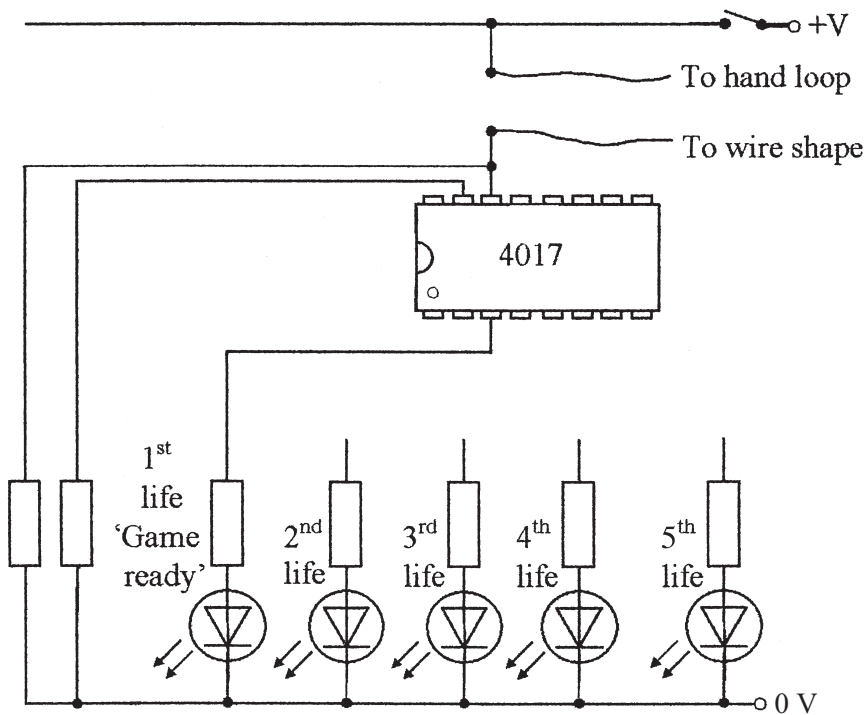
Figure 8

(a) Complete **Figure 8** so that the following are added:

● the 4017 connections to the +V and 0 V rails;   *(2 marks)*

● the 4 LEDs are connected so that they come on in the correct order;   *(3 marks)*

● a reset switch connected;   *(2 marks)*

● the count stops and the game resets when the wires touch for the 5th time;   *(1 mark)*

Quality of circuit diagram.   *(2 marks)*

(b) When the hand loop wire touched the wire shape the LEDs counted randomly.

(i) State the reason for the problem.

....

....
(1 mark)

(ii) Name **one** type of sub system/component which could be fitted between pin 14 and the wire loop that could solve the problem.

....
(1 mark)

__
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TURN OVER FOR THE NEXT QUESTION

5   **Figure 9** shows a circuit that is to automatically control the temperature in a greenhouse by switching a heater on and off.
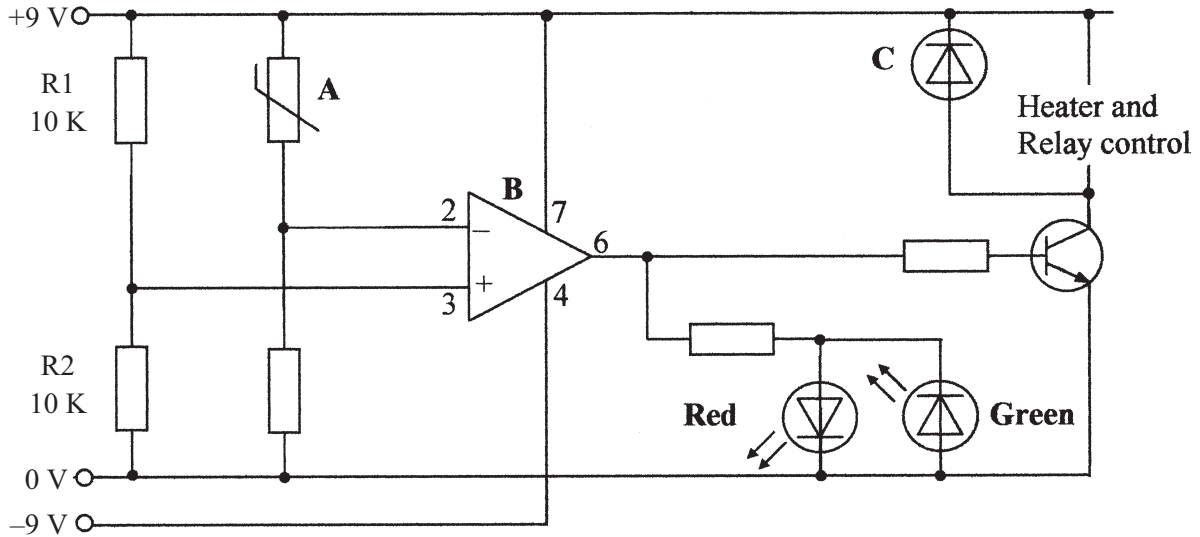
Figure 9

(a)   Name the components labelled in **Figure 9**.

  (i)   **A** ....
  (1 mark)

  (ii)   **B** ....
  (1 mark)

(b)   Explain the function of component **B**.

  ....

  ....
  (3 marks)

(c)   Give the names of pins 2, 3 and 6 of component **B**.

  2   ....

  3   ....

  6   ....
  (3 marks)

(d)   Explain the reason for including component **C** in the circuit.

....

....
(2 marks)

(e)   (i) State which LED lights up when it is cold.

....
(1 mark)

(ii) Explain the reasons for your choice.

....

....

....

....
(4 marks)

(f)   The circuit is to be modelled and tested on a protoboard/breadboard.

Complete **Figure 10** by adding **five** wire connections to make the circuit work as intended.
(5 marks)
Accuracy of positioning *(1 mark)*

Figure 10

Turn over ►
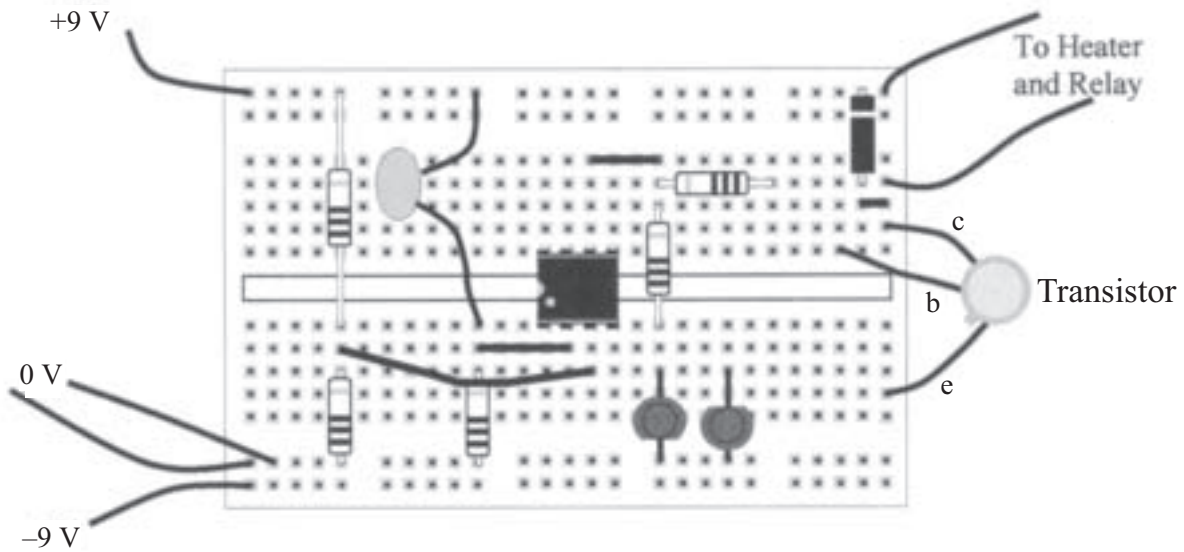
6   The PCB design shown in **Figure 11** is a student's first attempt.
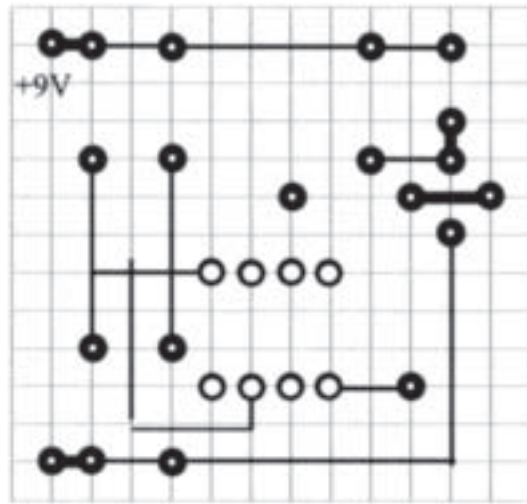
Figure 11

(a)   (i) Give **three** changes that would need to be made to the student's first attempt in order to improve the quality of the PCB design.

1 ....

2 ....

3 ....

(3 marks)

(ii) Describe the stages that you would use to change **one** of the problems identified in part (a) (i) when using a PCB CAD program. A starting point has been given.

Drag cursor over correction to be made and left click

....

....

....

....

....

....

(4 marks)

(b) Complete **Figure 12** by including the details of **two** further stages that would take place in the production of a circuit using veroboard or a PCB.

	First stage of production
Activity	Mark out and cut the board to size
Tools and Equipment	PCB guillotine or bandsaw
Health and Safety	Fingers clear of cutter, goggles for bandsaw
Quality Issues	Accurate measuring and marking out

	Further stage of production
Activity	
Tools and Equipment	
Health and Safety	
Quality Issues	

(4 marks)

	Further stage of production
Activity	
Tools and Equipment	
Health and Safety	
Quality Issues	

(4 marks)

Figure 12

Turn over ▶

7   **Figure 13** shows a symbol commonly found on the cases of electronic products and on their packaging.

Figure 13

(a)   Explain how the use of this symbol could have benefits for the environment.

....

....

....

(3 marks)

(b)   (i) Give **two** reasons why electronic products are packaged.

1   ....

....

2   ....

....

(4 marks)

(ii) Explain some of the problems that the use of packaging has on the environment.

....

....

....

....

(3 marks)

(c)   One of the most popular everyday electronic products is the mobile phone.

Explain how the rapid developments made by mobile phone manufacturers have provided both advantages and disadvantages for society and the environment. The advantage of one may not be used as a disadvantage for another.

   (i) **Society**

Advantage ....

Explanation ....

....

(3 marks)

Disadvantage ....

Explanation ....

....

(3 marks)

   (ii) **The Environment**

Advantage ....

Explanation ....

....

(3 marks)

Disadvantage ....

Explanation ....

....

(3 marks)

END   OF   QUESTIONS

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