General Certificate of Secondary Education
June 2007

DESIGN AND TECHNOLOGY (ELECTRONIC PRODUCTS)
Written Paper
Higher Tier

3541/H

H

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Wednesday 13 June 2007   1.30 pm to 3.30 pm

For this paper you must have:
• a pen, a pencil, a ruler, an eraser and a pencil sharpener.
You may use a calculator.

Time allowed: 2 hours

Instructions
• Use blue or black ink or ball-point pen. Use pencil only for drawing.
• Fill in the boxes at the top of this page.
• Answer **all** questions.
• Answer the questions in the spaces provided.
• Do all rough work in this book. Cross through any work you do not want to be marked.
• Show the working of your calculations.

Information
• The maximum mark for this paper is 125.
• The marks for questions are shown in brackets.
• A list of formulae and other information, which you may wish to use in your answers, is provided on pages 2 and 3.
• You are reminded of the need for good English and clear presentation in your answers.

You may need to use one or more of the following formulae when answering questions which include calculations.
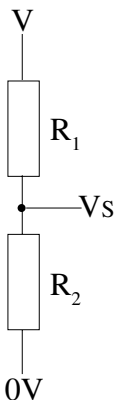
Potential Difference   Potential Difference = Current × Resistance $(V = I \times R)$

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

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

Electrical Power   Electrical Power = Current × 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 × 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 for the first question

Turn over ▶

TP/Jun07/3541/H

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

This question is about research and analysis.

You are advised to spend about 20 minutes on this question.

1 (a) A student is starting to design a project based on a steady hand game.

Describe **two** methods a student could use to find information about existing electronic games.

Method 1...

....

....

Method 2...

....

....
(4 marks)

(b) In order to find out the features which might be wanted by people who play electronic games, a survey could be conducted.

Write **three** different questions a student could ask and give a reason for **each** to show how this will help with the design of the product.

An example is given.

Example:

      Question – Should the game be portable?

      Reason – This will affect the size, weight and possible power source.

Question 1..

Reason ....

....

Question 2..

Reason ....

....

Question 3..

Reason ....

....
(6 marks)

(c) From the survey it would appear most people would prefer to use a battery-powered game. Give **two** reasons why.

Reason 1 ....

....

....

Reason 2 ....

....

....

(4 marks)

(d) Why do some people prefer to use re-chargeable batteries?

....

....

....

(2 marks)

(e) When batteries come to the end of their useful life they need to be disposed of.

  (i) How can this be achieved safely?

  ....

(1 mark)

  (ii) Give **two** reasons why batteries should be disposed of carefully.

  Reason 1 ....

  ....

  ....

  Reason 2 ....

  ....

  ....

(4 marks)

21

Turn over for the next question

Turn over ▶

This question is about monostable circuits.

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

2 **Figure 1** shows an incomplete circuit diagram for a monostable using a 555 Timer I C.

Figure 1

(a) Complete the circuit diagram for a monostable in **Figure 1** by

(i) adding a 100 K fixed resistor and a 22 μF capacitor to Pins 6 and 7 to give a time constant of approximately 2 seconds, *(3 marks)*

(ii) adding a fixed resistor and a suitable switch to Pin 2 so as to trigger the 555 Timer I C when the switch is pressed. Clearly label the resistor to show its value.
(4 marks)
Quality of drawing (2 marks)

(b) Describe what happens to the LEDs when the circuit is switched on and then triggered.

   (i) circuit switched on

....

....

....

(2 marks)

   (ii) circuit triggered

....

....

....
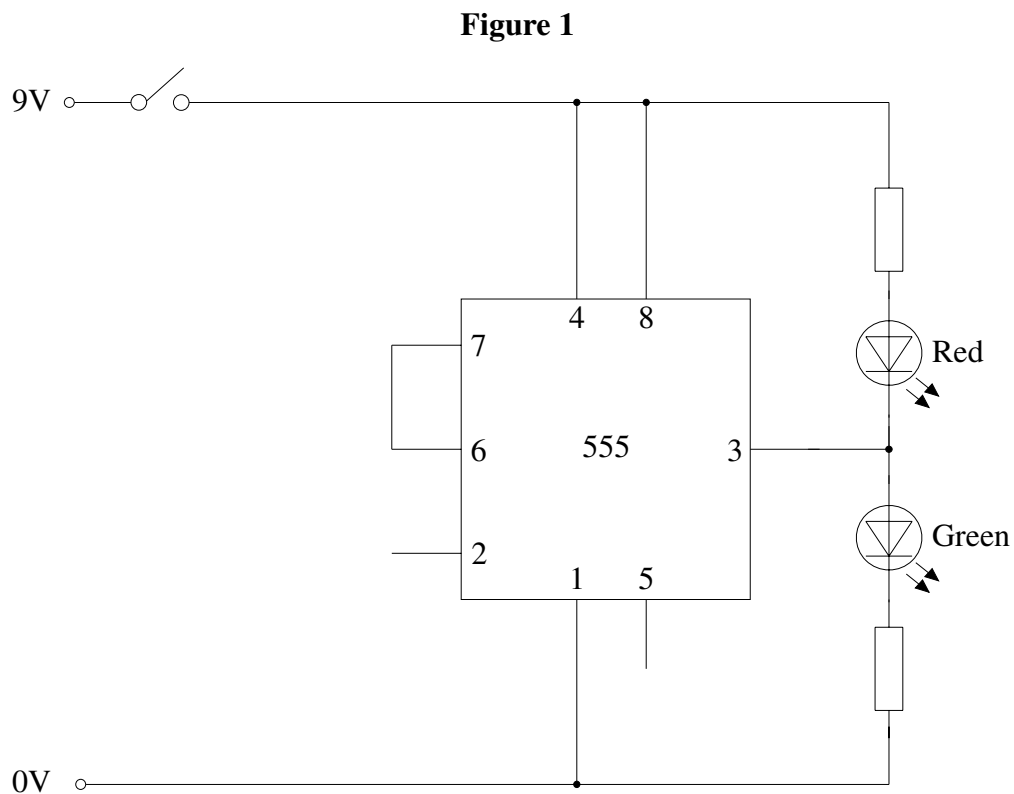
(2 marks)

Turn over for the next question

13

Turn over ▶

This question is about astable circuits.

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

3 A student wants a sound to pulse on and off as part of the output for a steady hand game. **Figure 2** shows an astable circuit that could produce such an output.
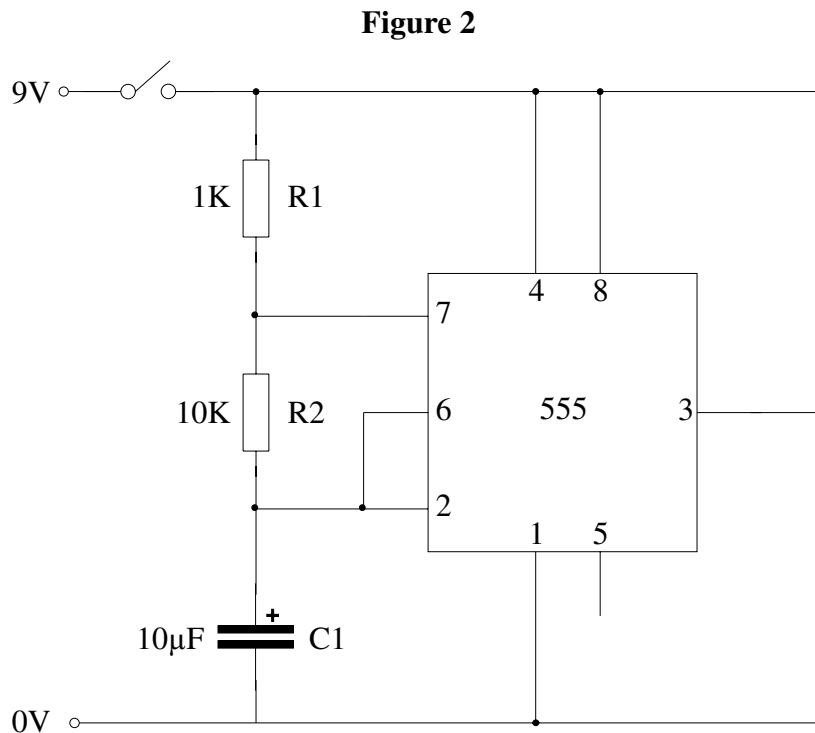
Figure 2

(a) Calculate the frequency of the output from Pin 3.

Formula ....

Working

Answer with units...
(5 marks)

(b) Add a buzzer to the output, Pin 3, of the 555 Timer I C in **Figure 2**, so that it will sound when the output goes high. *(2 marks)*

(c) The student wants to make the frequency half its present value.

Describe how this could be achieved.

....

....

....

(2 marks)

(d) Describe how the circuit can be changed so that the frequency can be adjusted easily after the circuit is produced.

....

....

....

(2 marks)

Turn over for the next question

$\overline{\textbf{11}}$

Turn over ▶

This question is about the systems approach and logic gates.

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

4 A student designing a steady hand game also wants to indicate the lives lost when playing the game. An LED lights to show that a life is lost.

Figure 3
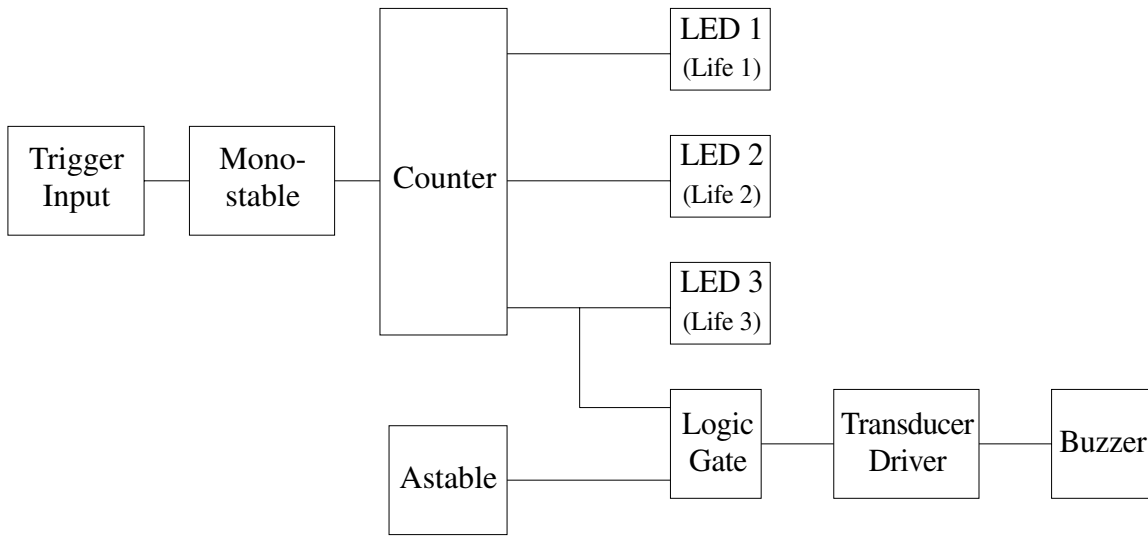
(a) A system diagram is shown in **Figure 3** which could be used for the steady hand game. Explain what each of the following building blocks does in this system.

(i) Monostable ....

....

....
(2 marks)

(ii) Astable ....

....

....
(2 marks)

(iii) Counter ....

....

....
(2 marks)

(iv) Logic Gate ....

....

....

(2 marks)

(v) Transducer Driver ....

....

....

(2 marks)

(b) **Figure 4** shows the logic gate used.

Figure 4
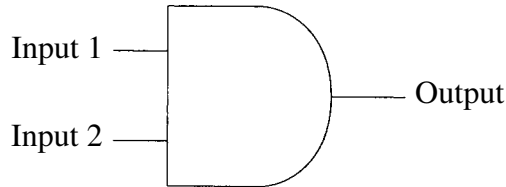
(i) What is the name of this logic gate?..

(1 mark)

(ii) Complete the truth table for the logic gate shown in **Figure 4**.

Input 1	Input 2	Output
0	0	
0	1	
1	0	
1	1	

(4 marks)

15

Turn over for the next question

Turn over ▶

This question is about designing the case for a product.

You are advised to spend about 30 minutes on this question.

5 A simple design for a steady hand game is shown in **Figure 5** which could house a similar circuit to the one developed in **Question 4**.

(a) On **Figure 5** label suitable materials for the track, wand and handle.

Figure 5

Track material ....

Wand material ....

Handle material ....
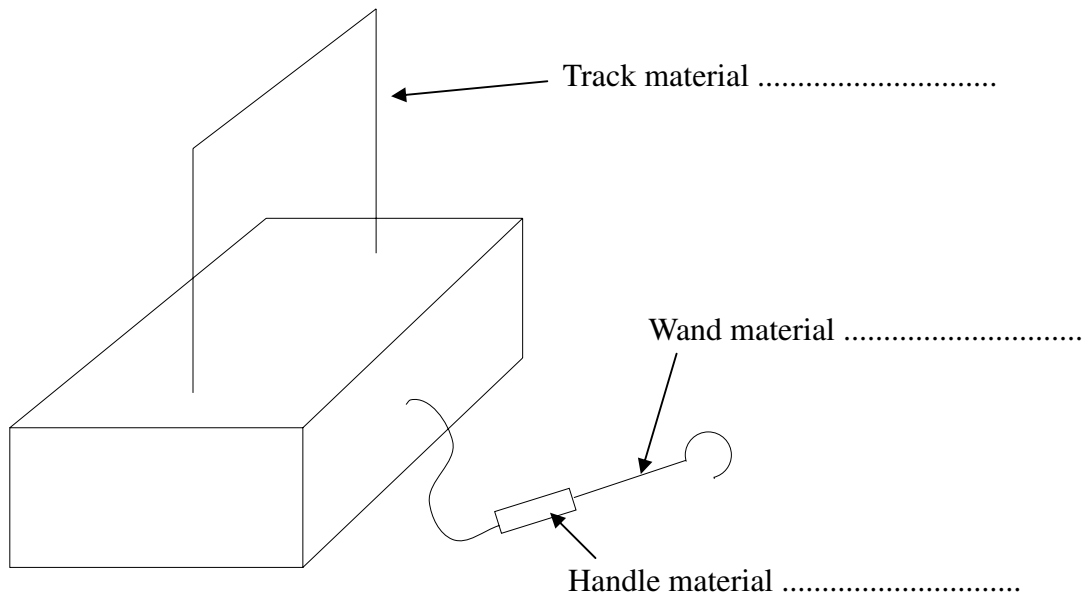
(3 marks)

(b) Suggest **three** improvements to the design in **Figure 5** above.

1 ....

2 ....

3 ....

(3 marks)

(c)   Using sketches and notes, show how you would improve the design of the steady hand game using the following specification points.

   (i)   a suitable specific material for the case   *(2 marks)*

  (ii)   your suggested improvements from part (b)   *(6 marks)*

(iii)   the position of the **three** LEDs   *(1 mark)*

(iv)   sound holes for a buzzer   *(1 mark)*

  (v)   a suitable on/off switch   *(2 marks)*

Quality of communication (3 marks)

Chosen specific material ....

Use the space below to complete your answer.

Turn over ▶

(d) Evaluate your case design for its suitability for commercial production in batches of 100.
Give reasons for any changes you suggest.

....

....

....

....

....

....

....

....

....

....

....

(6 marks)

27

There are no questions printed on this page

Turn over for the next question

This question is about Peripheral Interface Controllers (PICs).

You are advised to spend about 20 minutes on this question.

6 The student has decided to use a PIC to simplify the electronic circuit for the steady hand game and has drawn a PIC system diagram as shown in **Figure 6**.

Figure 6
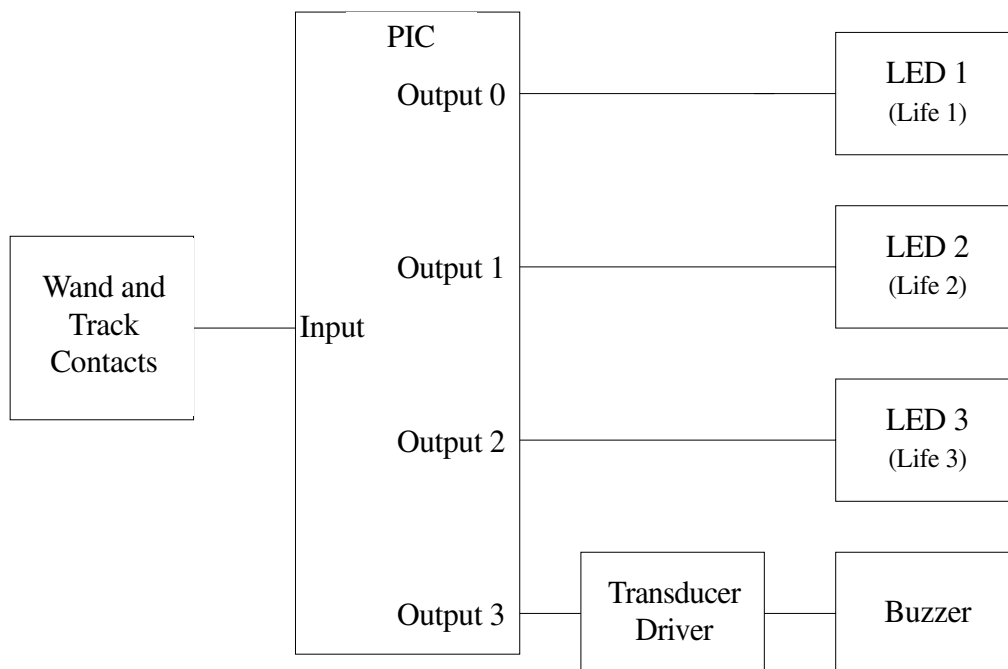
On page 17 in the space provided, using a programming method you are familiar with, design a PIC programme to satisfy the following conditions.

(a) Each time the wand and track touch, the PIC switches on an LED in the sequence 1, 2 and 3. Once an LED is lit it will stay on until reset. *(9 marks)*

(b) Once the wand and track touch, the PIC will ignore any further contact between the wand and track for 2 seconds. *(4 marks)*

(c) On the loss of the third life, the buzzer will switch on for 0.25s and then switch off for 0.25s. This is repeated three times. *(6 marks)*

(d) The PIC programme will re-set back to 'no lives lost'. *(3 marks)*

Turn over ►

This question is about industrial processes.

You are advised to spend about 5 minutes on this question.

7 A manufacturer wants to go into the commercial production of the steady hand game and is considering either vacuum forming or injection moulding the case.

   Compare the advantages **and** disadvantages of the two methods, and state the factors the manufacturer might need to consider.

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

   ....

                                                                                                    (6 marks)

6

This question is about the social, moral and environmental aspects of mobile telephones.

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

8 Mobile telephones have changed the way we communicate at work and during our leisure time. Compare the advantages **and** disadvantages of the increased use of this type of technology.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

Turn over ▶

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

(10 marks)

10

END OF QUESTIONS