Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Secondary Education
June 2006

DESIGN AND TECHNOLOGY (ELECTRONIC PRODUCTS)
Written Paper
Higher Tier

3541/H

H

ASSESSMENT and QUALIFICATIONS ALLIANCE

Wednesday 14 June 2006 1.30 pm to 3.30 pm

For this paper you must have:
- a pen, pencil, ruler, eraser, pencil sharpener and coloured pencils

You may use a calculator.

Time allowed: 2 hours

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3		7	
4			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

Instructions
- Use blue or black ink or ball-point pen. Use pencil and coloured pencils 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.

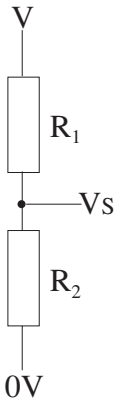
Potential Difference — Potential Difference = Current × Resistance ($V = I \times R$)

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

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

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

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

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

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 This question is about designing a circuit.

An advertising company has asked you to design a small electronic torch as a promotional gift.

(a) List **three** things which you need to consider before you begin to design the product. Give an explanation or reason for each. An example has been given to help you.

For example: The price must not exceed £2 otherwise it will be too expensive.

1 .....

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2 .....

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3 .....

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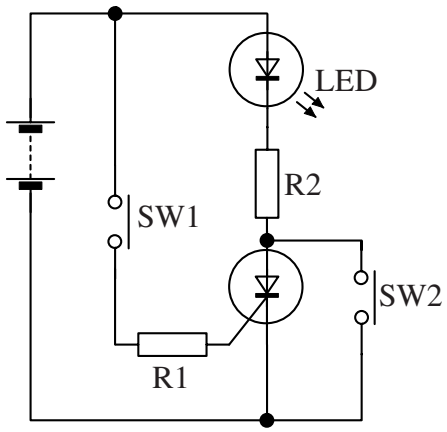
(6 marks)

(b) A circuit for the torch using a Thyristor and an LED is shown in **Figure 1**.

Figure 1



Explain what happens when the following actions are carried out in the order shown.

(i) SW1 is pressed and released.

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(2 marks)

(ii) SW2 is pressed and released.

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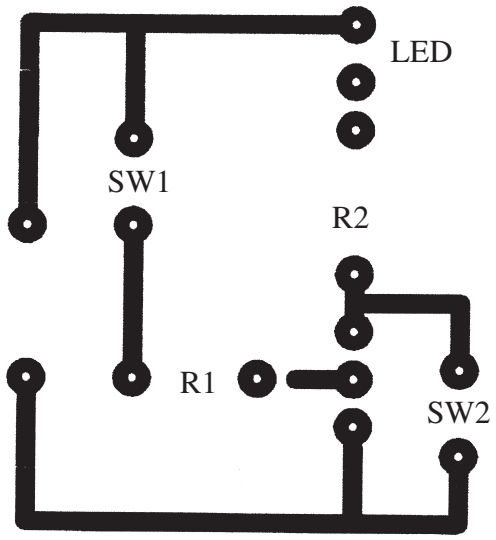
(2 marks)

(c) The PCB layout of the circuit in **Figure 1** is shown in **Figure 2**. It was produced using Computer Aided Design.

Figure 2



(i) When the circuit was built, it did not work.

On **Figure 2**, identify **two** mistakes which could be the cause of the problem by drawing a circle round each mistake.

(2 marks)

(ii) Describe the advantages of using Computer Aided Design for producing PCB layouts.

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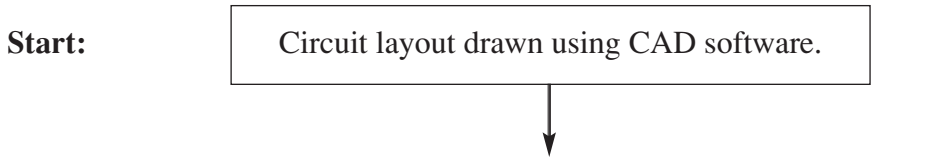
(4 marks)

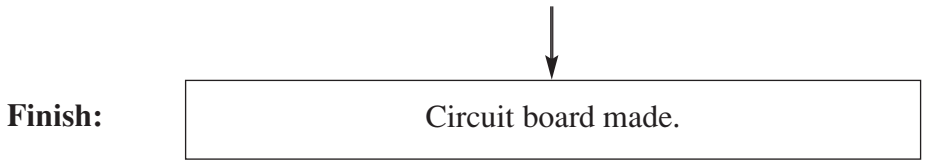
16

Turn over ►

2 This question is about producing a circuit on PCB.

(a) Using a production method you are familiar with, set out the stages needed when making a circuit board, prior to drilling and adding the components.





(10 marks)

(b) Health and Safety is important when making the PCB, drilling the holes and soldering the components in place.

Identify **two** different hazards and the precautions which need to be taken.

(i) Hazard 1: .....

Precaution: .....

.....

(2 marks)

(ii) Hazard 2: .....

Precaution: .....

.....

(2 marks)

(c) Identify **two** Quality Control checks you could make to the finished circuit after the components are soldered in place.

1 .....

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2 .....

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(2 marks)

(d) When the circuit was first tested it failed to work.

Describe how you would have checked that the circuit was receiving power from the battery.

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(2 marks)

18

3 This question is about designing the case for a product.

A student is designing a rear warning light for a bicycle.
The case for the light is to be made by vacuum forming.

(a) (i) Name a suitable material that could be used to make the case.

.....

(2 marks)

(ii) Explain, using notes and sketches, the stages in the vacuum forming process when making the case.

(5 marks)

(b) The warning light is battery powered, has an On/Off switch and four LEDs. Using notes and sketches, develop a design for the case which shows the following features:

- the position of the four LEDs;
- a way of holding the LEDs in the case;
- the position of the On/Off switch;
- how the battery can be easily changed.

(9 marks)

Quality of communication *(3 marks)*

(c) Use notes and sketches to show a method of attaching the case to the bicycle.

(6 marks)

Quality of communication *(2 marks)*

27

4 This question is about PIC microcontrollers.

The student developing the warning light from **Question 3** wants the LEDs to flash on and off and is considering using a PIC.

(a) Compare the use of a PIC with a 555 Timer IC to control the LEDs.

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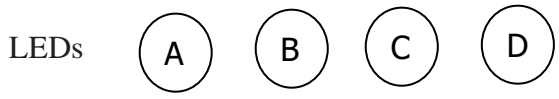
(4 marks)

(b) Using a programming system you are familiar with, produce a sequence of commands which would make a set of 4 LEDs, shown in **Figure 3**, switch on as shown below. Next to each of the commands, explain its purpose.

Figure 3



- All four LEDs go high for 1 second.
- A, B, C and D go high in sequence, each for 0.25 seconds.
- All four LEDs go high for 1 second.
- D, C, B and A go high in sequence, each for 0.25 seconds.
- This repeats continuously.
- **Between each statement, all LEDs go low for 0.25 seconds.**

Produce your programme on page 11.

Command **Explanation**

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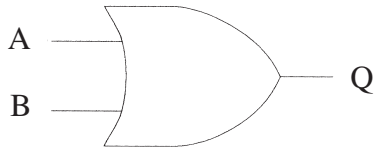
(14 marks)

18

5 This question is about logic gates and circuits.

Part of a simple alarm circuit uses an OR Gate, shown in **Figure 4**.

Figure 4



(a) (i) Complete the truth table below for the OR gate shown in **Figure 4**.

A	B	Q
0	0	
0	1	
1	0	
1	1	

(4 marks)

(ii) In truth tables what does the number '1' represent?

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(1 mark)

(iii) In truth tables what does the number '0' represent?

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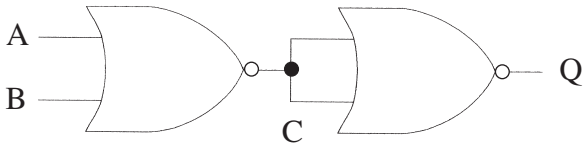
(1 mark)

(b) The only IC available is one which contains four NOR gates. **Figure 5** shows how an OR gate can be made from two NOR gates.

Figure 5



(i) In **Figure 5** what is the logic state at output Q when C is at logic '0'?

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(1 mark)

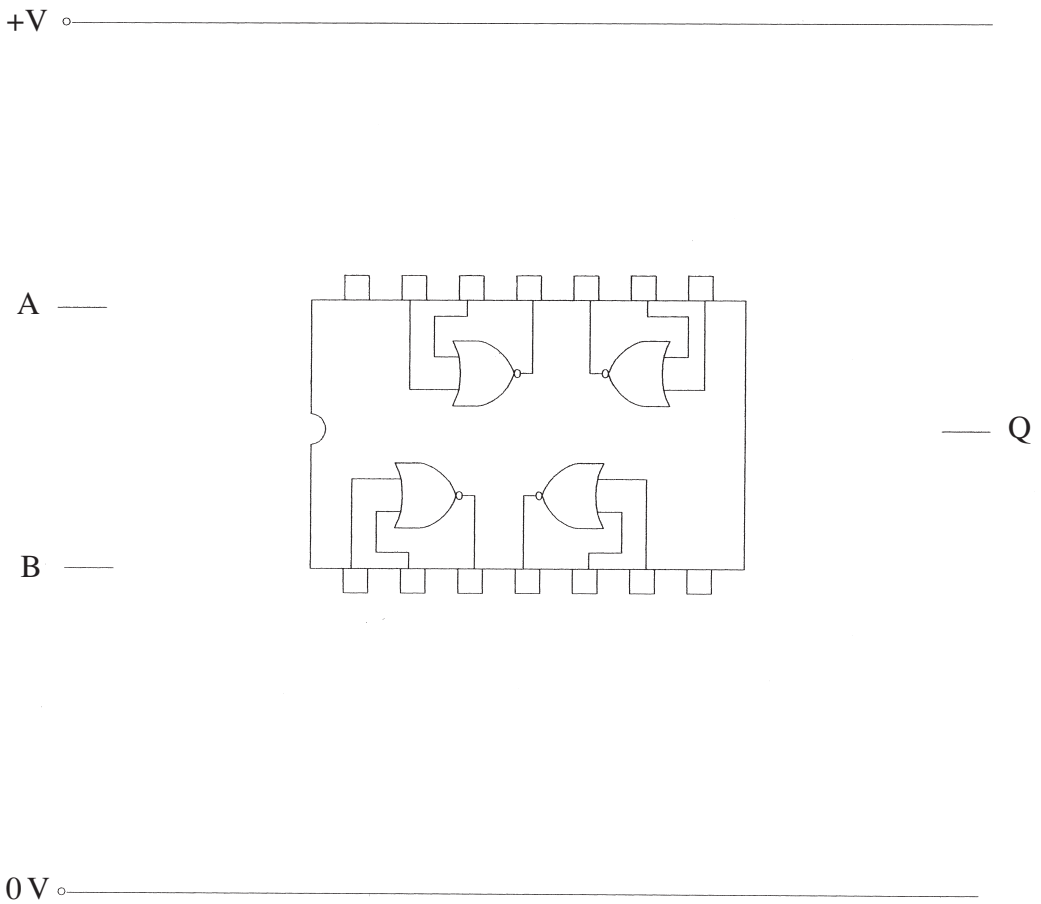
(ii) The circuit diagram in **Figure 6** shows the IC containing four NOR gates.

Complete the circuit diagram so that:

- two NOR gates are used to make an OR gate which is connected to the inputs A and B, and the output Q; *(5 marks)*
- Pin 14 is connected to +V and Pin 7 is connected to 0 V; *(2 marks)*
- all unused inputs are connected to 0V. *(4 marks)*

Quality of drawing *(3 marks)*

Figure 6



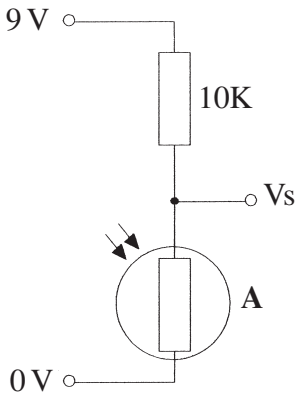
21

6 This question is about Operational Amplifiers and Potential Dividers.

A student wants to use a light sensor to act as an input trigger for a system that uses an LED.

(a) **Figure 7** shows the light sensor potential divider.

Figure 7



(i) Component A is a .....

(1 mark)

(ii) In bright light conditions component A has a resistance of 5 K. Calculate the value of the Vs output signal.

Formula: .....

Working:

Answer with units: .....

(4 marks)

(iii) Explain what happens to the Vs output voltage when the light level falls.

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(2 marks)

(b) An operational amplifier can be connected as a comparator.

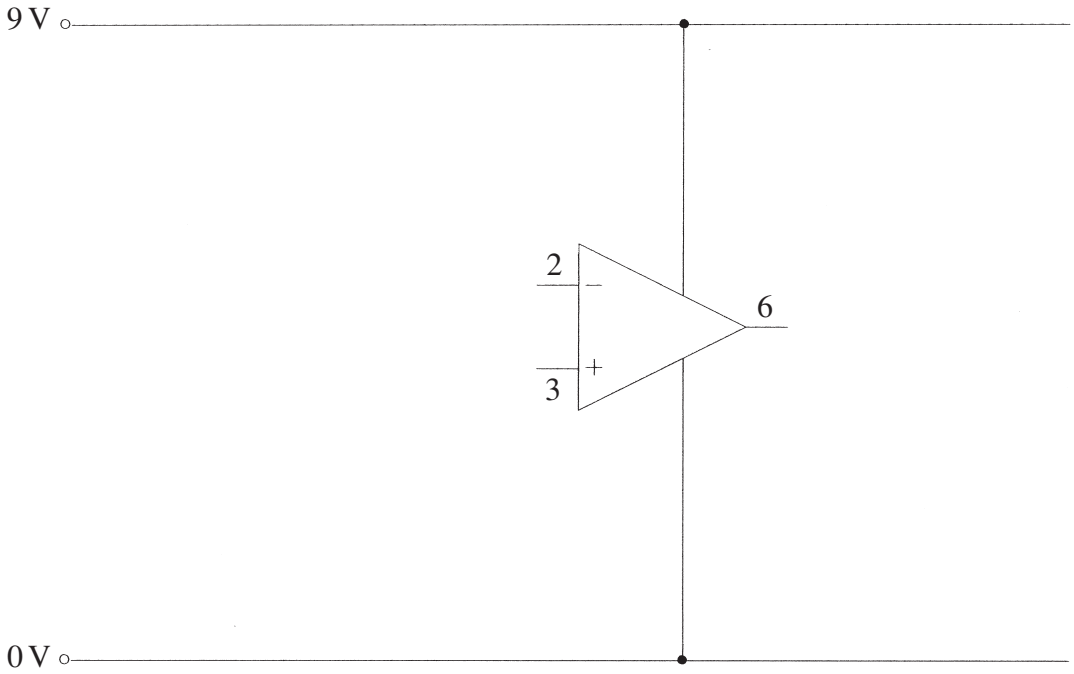
Complete **Figure 8** by adding:

(i) the light sensing potential divider from **Figure 7** to the non-inverting input to give a positive output from the amplifier when the sensor is in the dark; *(2 marks)*

(ii) a potential divider connected to the inverting input to give an adjustable reference voltage; *(2 marks)*

(iii) an LED with a resistor to indicate the output is high voltage. *(3 marks)*

Figure 8



Quality of drawing *(2 marks)*

16

Turn over for the next question

LEAVE MARGIN BLANK

7 This question is about social and environmental issues.

The development of electronic products is having a major impact on society.

(a) Explain how electronic communication has affected people's working lives.

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(3 marks)

(b) Explain how electronic communication has affected the consumer.

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(3 marks)

(c) Describe the consequences for the environment of the development of electronic products.

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(3 marks)

9

END OF QUESTIONS