Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

General Certificate of Secondary Education
Summer 2003
Higher Tier

DESIGN AND TECHNOLOGY   **3541/H**
(ELECTRONIC PRODUCTS)

H

AQA

ASSESSMENT and
QUALIFICATIONS
ALLIANCE

Monday 23 June 2003   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	
TOTAL	
Examiner's initials	

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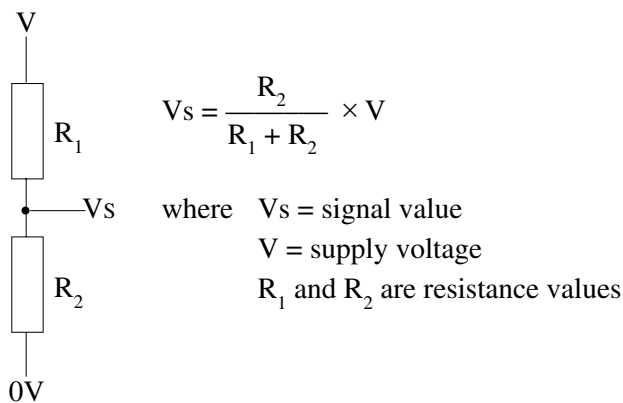
Potential Difference   Potential Difference = Current $\times$ Resistance $(V = I \times R)$

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

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

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

Inverting Op-Amps $\text{Gain} = \dfrac{-Rf}{Rin}$ 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 $= \dfrac{Th}{Tl}$

TP/0203/3541/H

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.

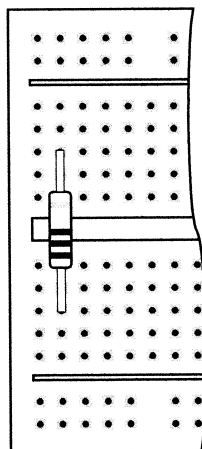1   **Figure 1** shows a resistor placed in a breadboard (protoboard).

Figure 1

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

   (i)   State the value of the resistor.

   ....
   (2 marks)

   (ii)   Explain the meaning of the Gold band.

   ....

   ....

   ....
   (2 marks)

(b)   (i)   Show, by adding another resistor to **Figure 1**, how a parallel combination would be set up.
   (2 marks)

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

   ....

   ....

   ....
   (2 marks)

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

Figure 2

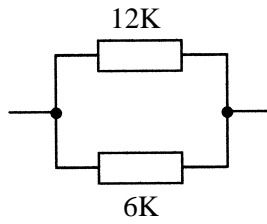Formula ....

Working

Answer and units ....

(4 marks)

(c) The two resistors can be replaced by a single resistor from the list of preferred values.

(i) Explain the term "preferred value" in relationship to resistors.

....

....

(2 marks)

(ii) State the value of a single resistor that would replace the two parallel resistors.

....

(2 marks)

16

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

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

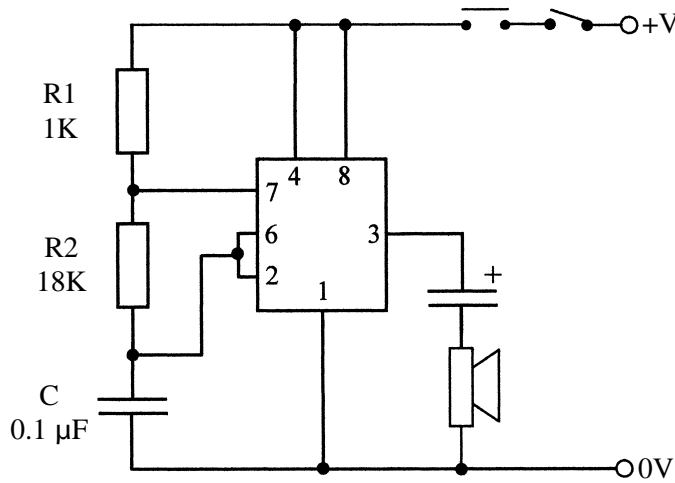**Figure 3** shows a pulse generator outputting through a loudspeaker.

Figure 3

(a) Give the name that best describes this type of circuit.

....

(1 mark)

(b) Complete the paragraph to explain how the frequency is created in **Figure 3**.

When the switches are closed C charges up through ....

When the potential difference across C reaches .... of the supply voltage the

output goes .... and C starts to discharge. When the voltage falls below $\frac{1}{3}$

of the supply voltage the output goes high and C begins to ....

(4 marks)

(c) Calculate the frequency of the circuit.

Formula ....

Working

Answer and units ....
(5 marks)

(d) The circuit is to be modelled and tested.

Complete **Figure 4** by adding the **six** wire connections to make the circuit work as intended.
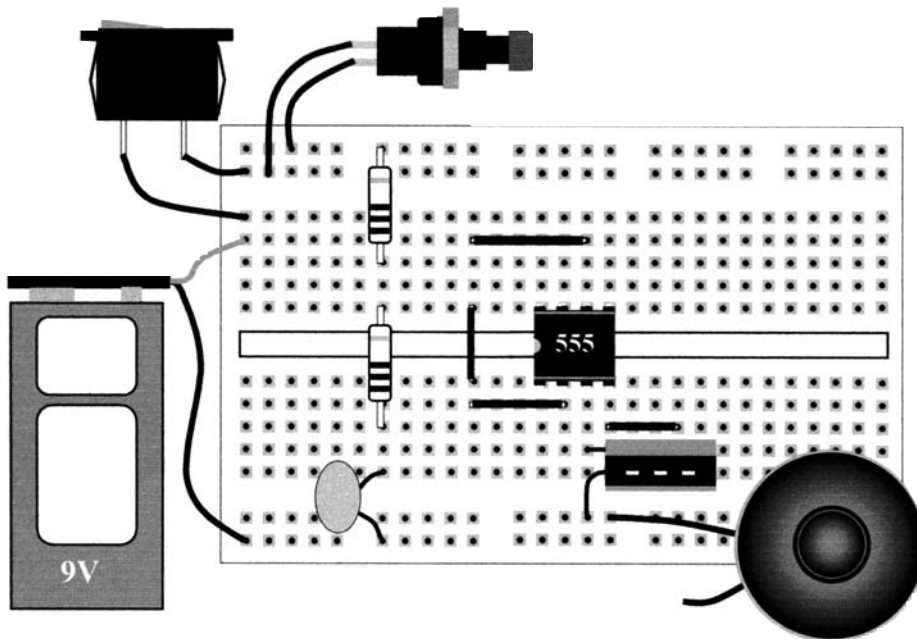

Figure 4

(6 marks)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Turn over ▶

TP/0203/3541/H

(e) The student realises that the alarm will only sound when the push switch is closed and decides to add a timer to control the amount of time the loudspeaker is on.

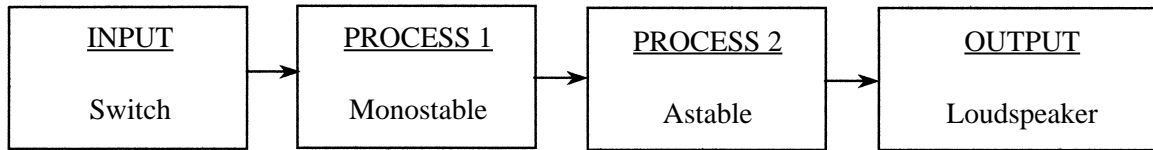**Figure 5** shows the modified system.

Figure 5

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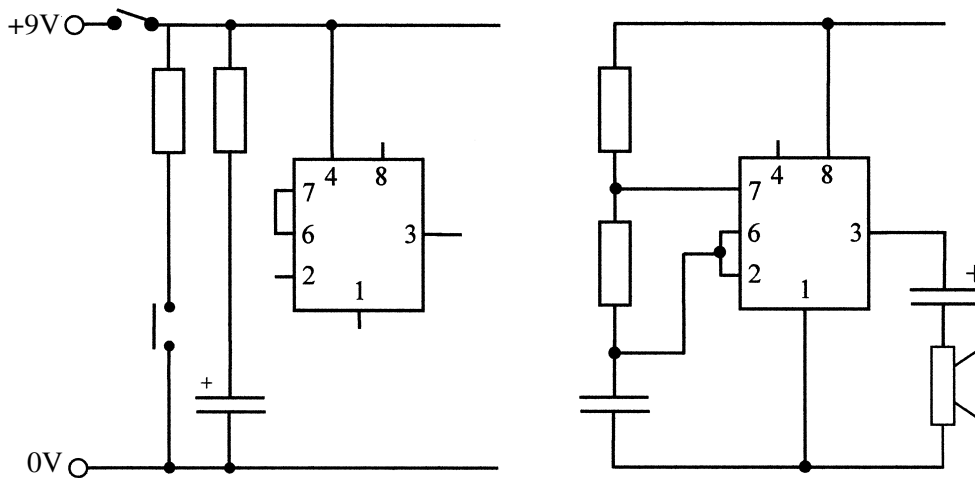

Figure 6

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.

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.
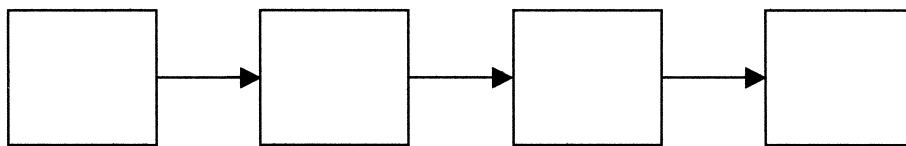
Figure 7

(3 marks)

31

3   A student has been investigating the design for an automatic lighting circuit to illuminate a shop window display when it gets dark.

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

1   ....

....

2   ....

....

3   ....

....
(3 marks)

(b)   **Figure 8** shows the symbol for a 741 op amp with its power supply connections and two battery snaps.
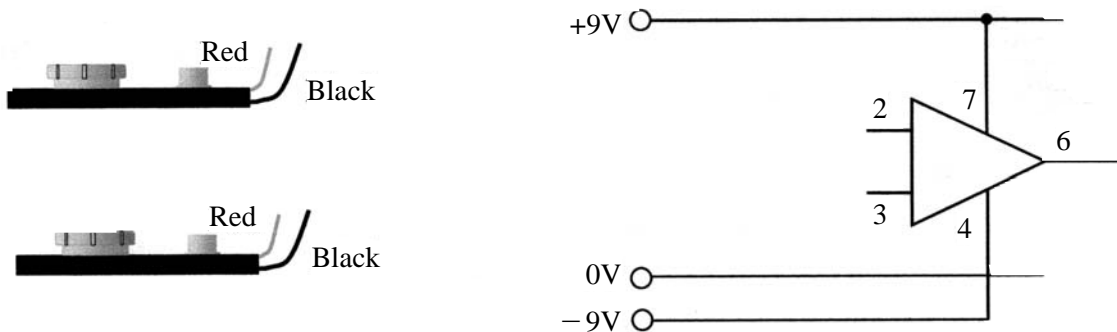
Figure 8

Show, by completing **Figure 8**, where the red and black leads would be connected to the 741 to provide a suitable power supply.

(3 marks)

(c) (i) Complete **Figure 9** by drawing a potential divider which will create an output of 4.5V.

Show the values of any additional component.

+9V o——————

10K

0V o————
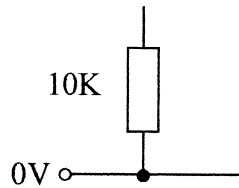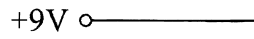
Figure 9

(2 marks)

(ii) Complete **Figure 10** by adding an LDR to the single resistor to create the potential divider for a dark sensor.

+9V o————

R1
400K

Vs

0V o————
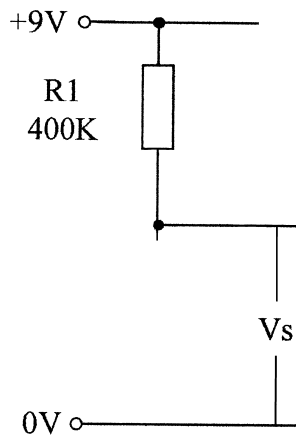
Figure 10

(1 mark)

(iii) The resistance of the LDR at the required light level is 500K.

Calculate the output Vs.

Formula ....

Working

Answer and units ....

(3 marks)

QUESTION 3 CONTINUES ON THE NEXT PAGE

Turn over ▶

(d) **Figure 11** shows the incomplete circuit diagram to control the lighting display.
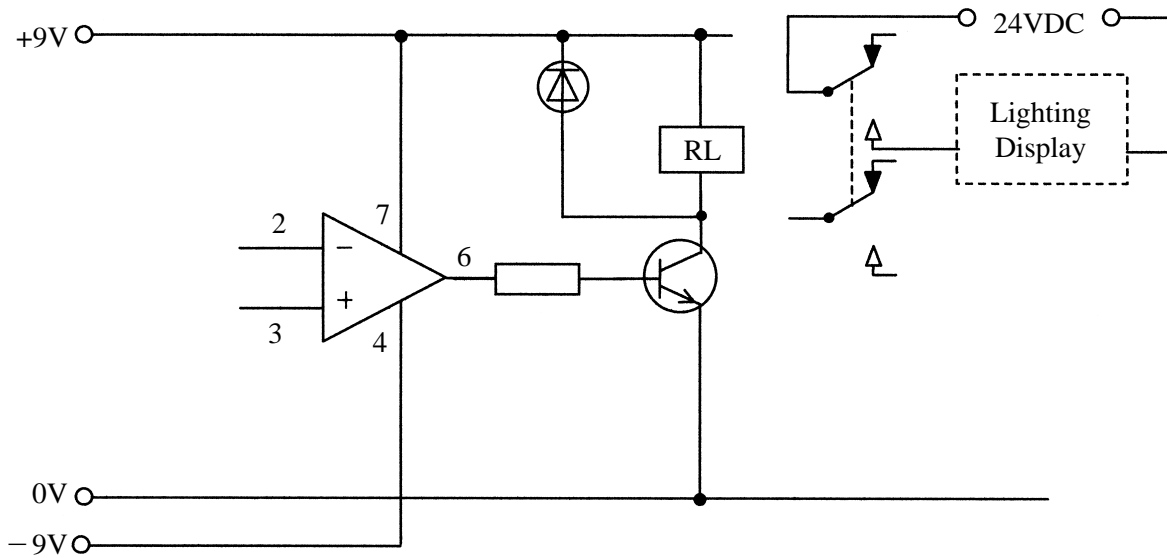
Figure 11

(i) Show, by completing **Figure 11**, where you would place the two potential divider circuits from **Figures 9** and **10**, in order for the relay to be switched when it gets dark.

(2 marks)

(ii) When the circuit was first tested the lighting display switched on and off continually as light levels changed.

Complete **Figure 11** to show how it would be modified to latch on when first triggered.
(3 marks)

(e) Explain how the voltages of the two inputs control the output of the op-amp.

....

....

....

....

....

....

....

(5 marks)

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

Give **three** advantages of using CAD to draw the PCB.

1   ....

2   ....

3   ....

(3 marks)

(g)   **Figure 12** shows the incomplete PCB design.
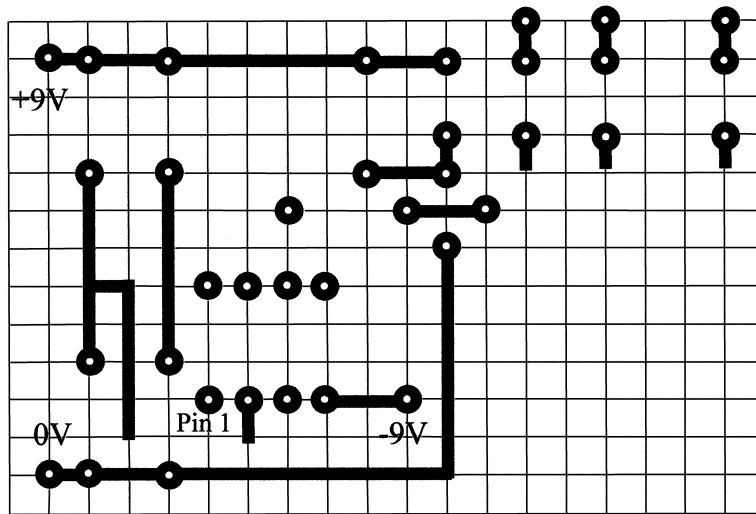
(viewed from the component side)

Figure 12

Complete **Figure 12** by adding **four** tracks from the op amp IC.

(4 marks)

29

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

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

Figure 13 shows the basic outline for the toy.
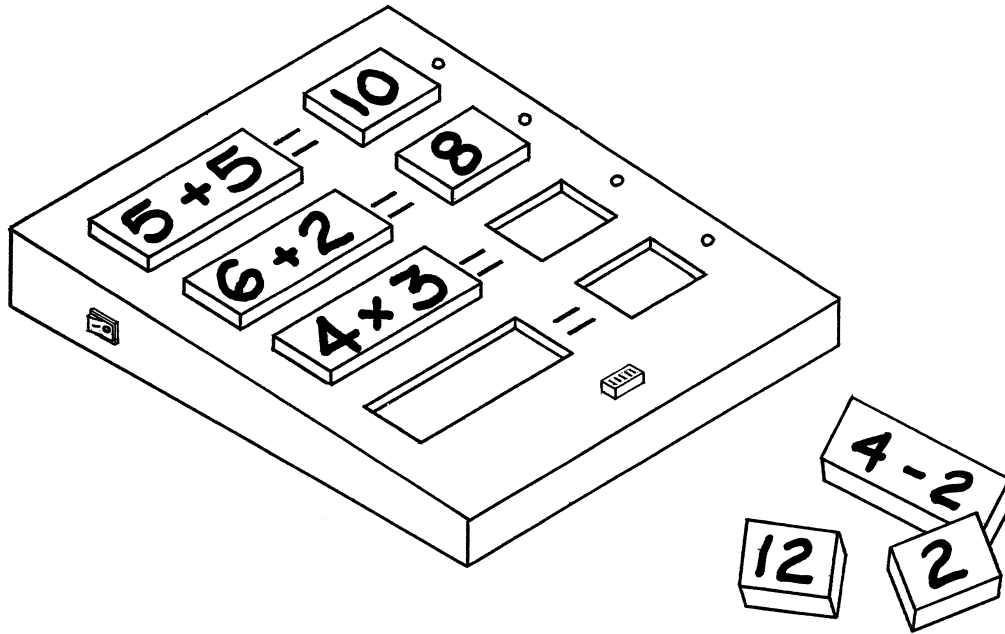
Figure 13

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 14**, 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 14

(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

Turn over ▶

(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)

(e) Complete **Figure 15** to show how the four LEDs and the buzzer will be turned on in the correct sequence when the four questions are answered correctly and the switches connected to suitable inputs.
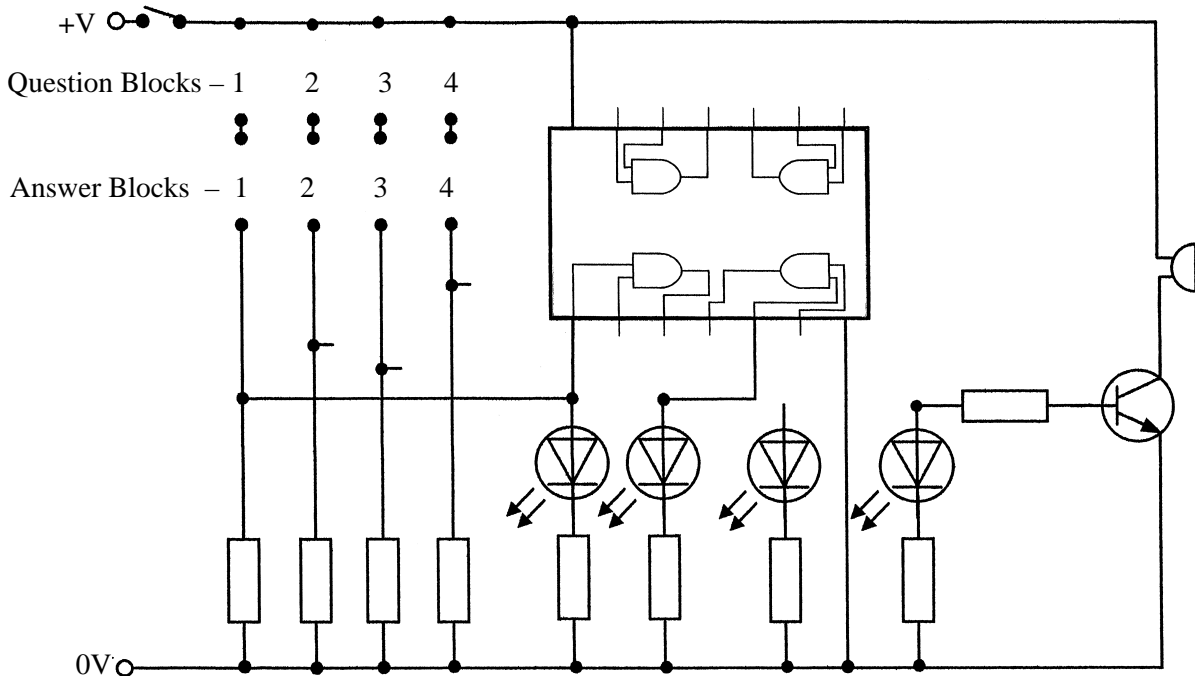

Figure 15

(7 marks)

Turn over ▶

36

5 Modern manufacturing methods using Computer Aided Manufacture (CAM) can provide many advantages.

(a) List **two** advantages that the use of CAM has had for:

(i) manufacturers;

1 ....

....

2 ....

....

(2 marks)

(ii) consumers.

1 ....

....

2 ....

....

(2 marks)

(iii) Comment on the effect that the use of CAM has had on employment.

....

....

....

....

(2 marks)

(b) Manufacturers have always had to balance the cost of developing and making a product against environmental considerations.

Complete the table, **Figure 16**, by adding the environmental issues that the manufacturer should consider at each of the stages of the life span of the 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 in use	1
	2
End of use	1
	2

Figure 16

(7 marks)

13

END   OF   QUESTIONS