Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

For Examiner's Use

General Certificate of Secondary Education
June 2008

DESIGN AND TECHNOLOGY (ELECTRONIC PRODUCTS)
Written Paper
Higher Tier

3541/H

H

Monday 9 June 2008 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 black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- 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.

For Examiner's Use			
Question	Mark	Question	Mark
1		5	
2		6	
3		7	
4		8	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

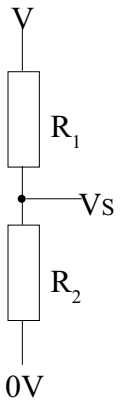
Potential Difference — Potential Difference = Current × Resistance — $(V = I \times R)$

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 This question is about research and specification.

A student is designing a road safety product to be positioned on the ground behind a car to warn other motorists that a car has broken down. The product must be able to be seen in poor light conditions.

1 (a) Describe **two** different methods of finding out information about existing road safety products.

Method 1.....

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(2 marks)

Method 2.....

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(2 marks)

1 (b) Outline a method of evaluating the success of existing warning devices.

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(2 marks)

1 (c) Write five specification statements relating to the road safety product which can be positioned behind a broken down car.

An example has been done for you.

e.g. LEDs are to be used to produce the light.

Specification 1 .....

.....

(1 mark)

Specification 2 .....

.....

(1 mark)

Specification 3 .....

.....

(1 mark)

Specification 4 .....

.....

(1 mark)

Specification 5 .....

.....

(1 mark)

11

Turn over for the next question

2 This question is about designing the case of the product.

2 (a) In the box below sketch a design idea for the road safety product to be positioned on the ground behind a car.

This should show the following aspects:

- the specific materials which would be used.
- how it is made stable whilst standing on the ground.
- suitable for storing in the car.

(6 marks)

2 (b) Using notes and sketches, develop your design for the case of the road safety product, to contain a circuit with six LEDs and an LDR, to detect the light level. Your design must include the following aspects:

- the position of the six LEDs.
- how the LEDs are held securely in place.
- the position of an off/on switch.
- the position of the LDR and how it is fitted in the case.
- access to the inside of the case.

(13 marks)
Quality of communication (3 marks)

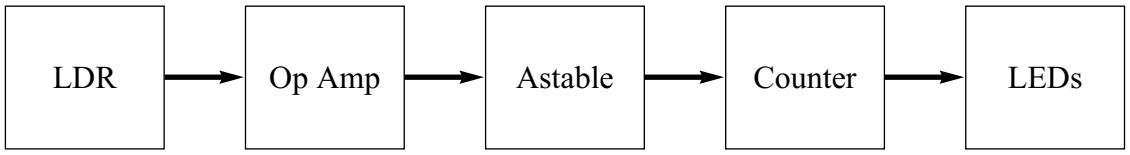
22

Turn over ►

3 This question is about developing a system for a product.

Figure 1 shows a possible system diagram for a road safety product.

Figure 1



3 (a) Which block represents an output stage?

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(1 mark)

3 (b) Which block represents an input stage?

.....

(1 mark)

3 (c) Which block could act as a Comparator?

.....

(1 mark)

3 (d) In which block would a 555 IC be used?

.....

(1 mark)

3 (e) Which block changes an analogue signal into a digital signal?

.....

(1 mark)

3 (f) Explain the difference between an analogue signal and a digital signal.

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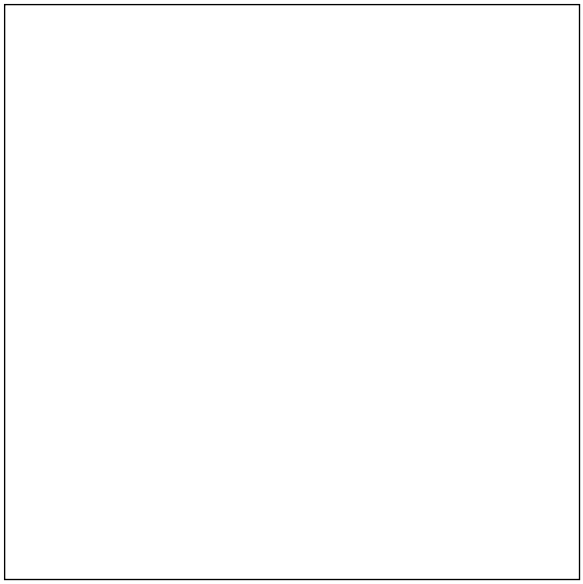
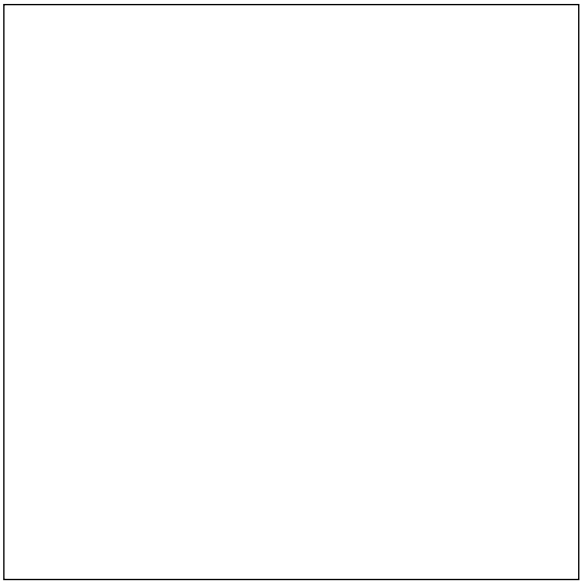
(2 marks)

3 (g) In the boxes provided below sketch the waveform of an analogue signal and a digital signal.

Analogue Signal



Digital Signal



(2 marks)

3 (h) Explain why an analogue signal can confuse an electronic system that includes logic gates.

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(2 marks)

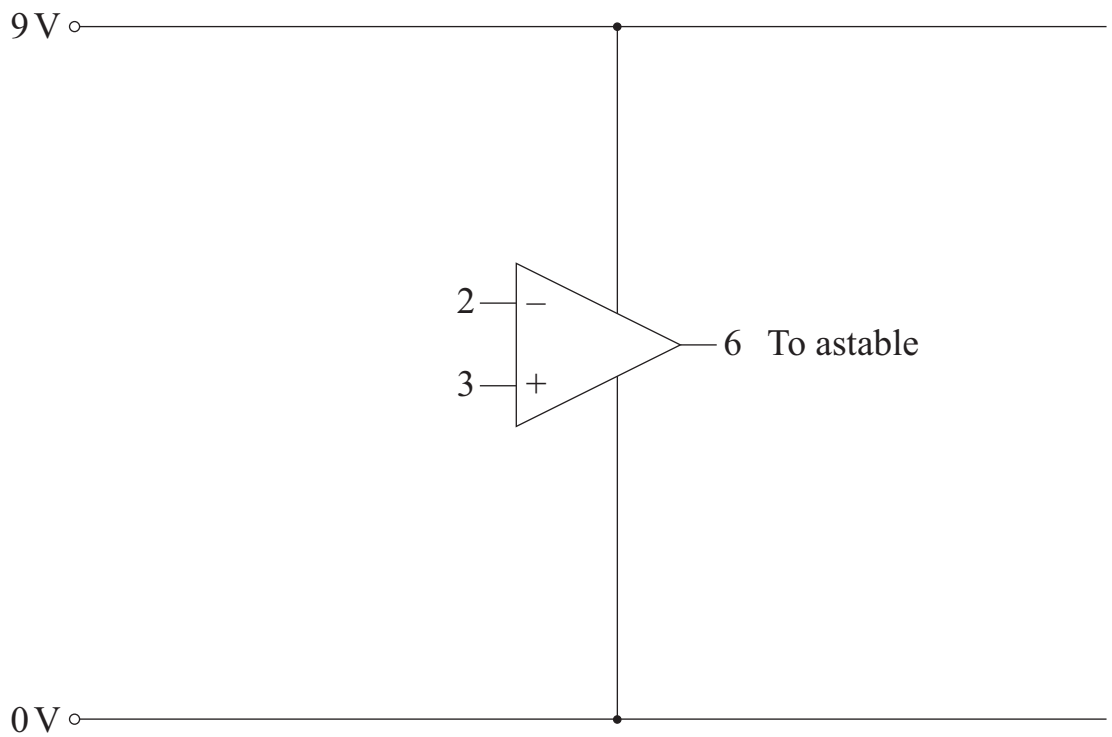
11

Turn over for the next question

4 This question is about the Operational Amplifier.

Figure 2 shows an incomplete circuit diagram for an operational amplifier to be connected as a comparator.

Figure 2



4 (a) What is the name given to the following pins?

Pin 6 .....

(1 mark)

Pin 2 .....

(1 mark)

Pin 3 .....

(1 mark)

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

4 (b) (i) a potential divider to Pin 2 of the operational amplifier to provide a reference voltage of 4.5V. State the values of the components used.

(4 marks)

4 (b) (ii) a potential divider to Pin 3 which includes an LDR and 10K resistor connected to cause Pin 6 to go high when the light level falls.

(4 marks)

4 (c) Name the component that could be added to the potential divider to adjust the light level which triggers the circuit.

.....

(1 mark)

4 (d) Describe how a change in light level controls the voltage at Pin 6 by completing the following sentence:

In darkness the resistance of the LDR is ..... and the voltage at Pin 3

is ..... than the voltage at Pin 2 making the voltage at Pin 6 .....

(3 marks)

4 (e) Calculate the voltage at Pin 3 when the LDR has a resistance of 100K.

Formula: .....

Working:

Answer (with units): .....

(4 marks)

19

Turn over for the next question

5 This question is about an astable.

5 (a) Circle the alternative name for the astable which also describes what it does.

Switch De-bouncer Pulse Generator Time Delay

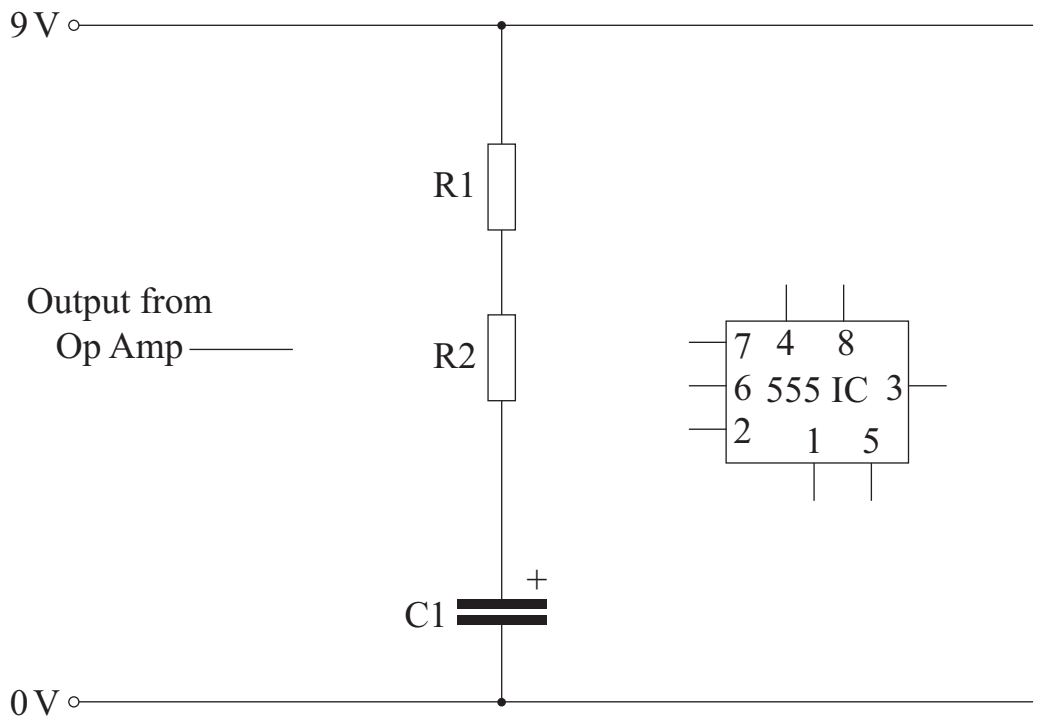
(1 mark)

5 (b) The operational amplifier circuit in **Question 4** can be used to control an astable circuit.

Complete the circuit diagram in **Figure 3** so that the astable works when the output of the operational amplifier goes high by drawing the following connections:

- the 0V and 9V power connections.
- the astable connections to R1, R2 and C1.
- the output from the operational amplifier to the 555 IC to control the astable circuit.

Figure 3



(7 marks)
Quality of drawing (2 marks)

5 (c) When R1 = 10K, R2 = 22K and C1 = 10µF the astable shown in **Figure 3** does not have an equal mark to space ratio.

5 (c) (i) Describe the effect this has on the output.

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(2 marks)

5 (c) (ii) Sometimes it is necessary to calculate the time the astable is **high**.

Calculate the time the output of the astable will be high when R1 = 10K, R2 = 22K and C1 = 10µF.

Formula: .....

Working:

Answer (with units): .....

(4 marks)

16

Turn over for the next question

6 This question is about designing a circuit.

The table in **Figure 4** shows the outputs for the pins of a 4017 IC Decade Counter.

Figure 4

Pin 1	Output 5	Pin 9	Output 8
Pin 2	Output 1	Pin 10	Output 4
Pin 3	Output 0	Pin 11	Output 9
Pin 4	Output 2	Pin 12	Divide by 10 Output
Pin 5	Output 6	Pin 13	Clock Enable
Pin 6	Output 7	Pin 14	Clock Input
Pin 7	Output 3	Pin 15	Reset
Pin 8	0V	Pin 16	+9V

6 (a) **Figure 5** on the opposite page shows an incomplete circuit diagram to make six LEDs flash in sequence using the 4017 IC Decade Counter driven by an astable such as shown in **Question 5**.

Pin 3 (Output 0) is already connected to LED 0.

Complete the circuit diagram in **Figure 5** by:

6 (a) (i) Connecting the 0V and 9V pins to the power rails.

(2 marks)

6 (a) (ii) Connecting the remaining 5 LEDs to the correct outputs, so that the LEDs come on in the sequence 0, 1, 2, 3, 4 then 5.

(5 marks)

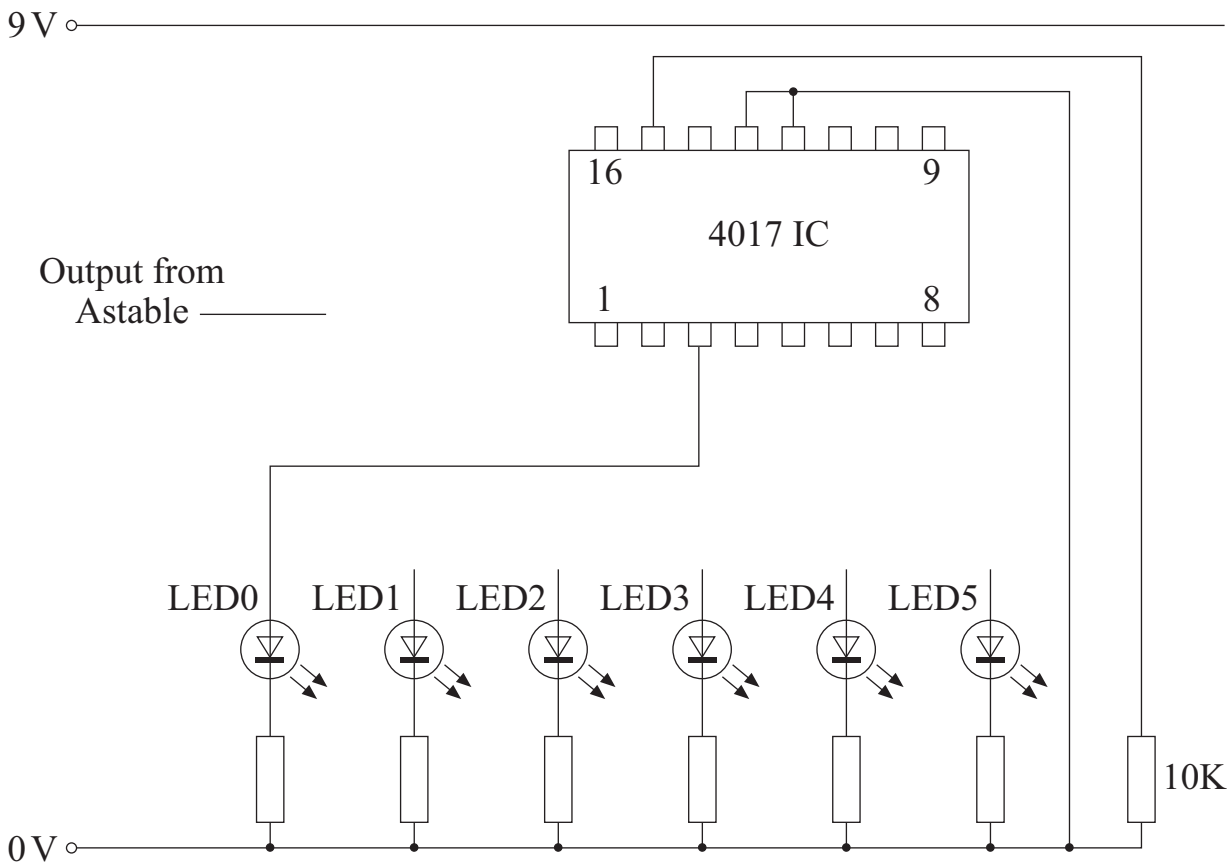
6 (a) (iii) Making the counter reset automatically to start the process again.

(1 mark)

6 (a) (iv) Connecting the output from the astable to the counter.

(1 mark)
Quality of drawing (1 mark)

Figure 5



6 (b) In **Figure 5**, Pin 15 the Reset, has a 10K fixed resistor connecting the pin to 0 volts. What is the purpose of the resistor in the circuit?

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(2 marks)

12

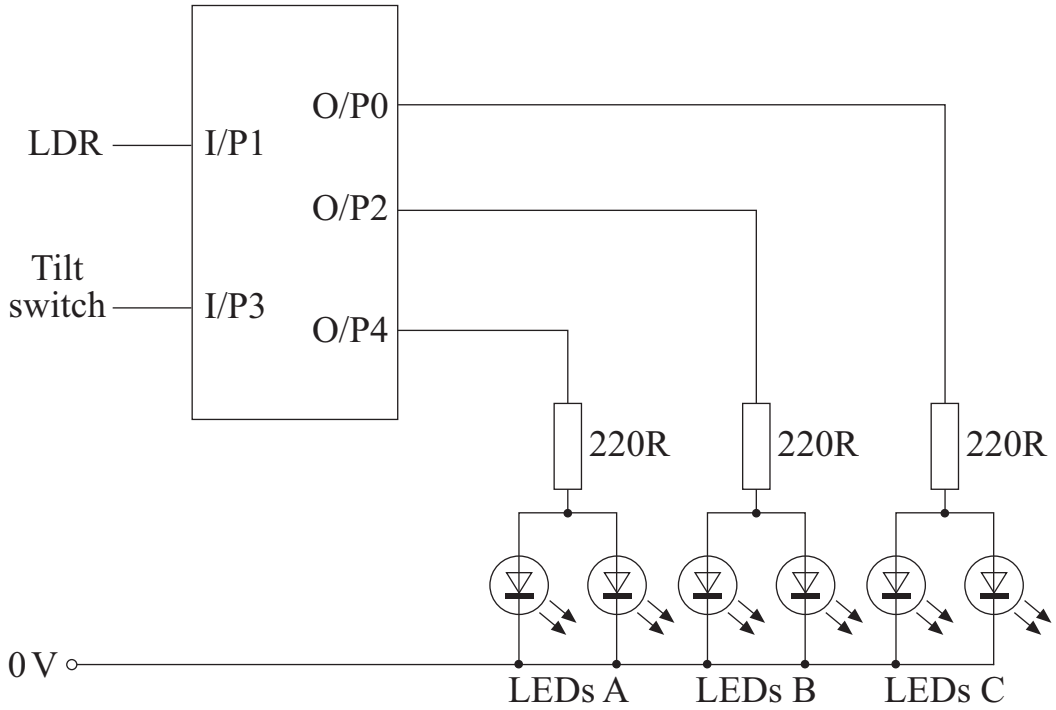
Turn over for the next question

7 This question is about a Programmable Integrated Circuit (PIC).

Figure 6 shows a circuit using an 8 pin PIC to control the LEDs for the road safety device.

A tilt switch has been added to activate the PIC when the product is positioned on the ground behind the car.

Figure 6



When nearly dark the LDR has an analogue value of 75 and as it gets darker its value falls. Using a programming system you are familiar with write a programme in the box provided on page 17 opposite to control the PIC so that it behaves as outlined below:

7 (a) The circuit activates when the tilt switch is on and the light level around the LDR is 75 or less.

(5 marks)

7 (b) When activated the LEDs flash in sequence A, B, C and B (only one pair of LEDs are on at a time). Each LED is to be on for 0.25s. This repeats 10 times.

(10 marks)

7 (c) All the LEDs then come on together for 0.5s and go off for 0.5s. This sequence is repeated 5 times.

(5 marks)

7 (d) The programme repeats until deactivated.

(2 marks)

Areas outside the box will not be scanned for marking

22

Turn over ►

8 This question is about Social and Environmental issues.

The rapid expansion of electronics has greatly improved road safety.

8 (a) Describe the impact on road safety of the use of Speed Cameras.

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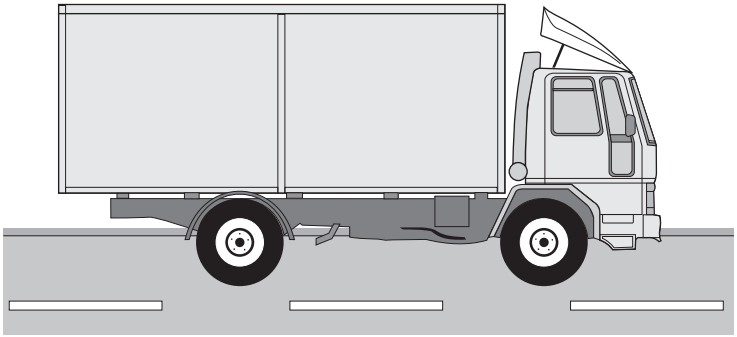
(6 marks)

8 A lorry, as shown in **Figure 7**, uses mirrors to allow the driver to have a clear vision of their position in relation to other road users.

Figure 7



8 (b) Describe ways in which electronic products could be used to improve the vision of the driver.

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(6 marks)

12

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED