OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS (B) (ADVANCING PHYSICS) 2860

Physics in Action

Friday **6 JUNE 2003** Afternoon 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Data, Formulae and Relationships Booklet
Electronic calculator

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Show clearly the working in all calculations and give answers to only a justifiable number of significant figures.

INFORMATION FOR CANDIDATES

You are advised to spend about 20 minutes on Section A, 40 minutes on Section B and 30 minutes on Section C.

- The number of marks is given in brackets [ ] at the end of each question or part question.
- There are four marks for the quality of written communication in Section C.
- The values of standard physical constants are given in the Data, Formulae and Relationships Booklet. Any additional data required are given in the appropriate question.

FOR EXAMINER'S USE		
Section	Max.	Mark
A	20	
B	40	
C	30	
TOTAL	90	

This question paper consists of 21 printed pages and 3 blank pages.

Registered Charity Number: 1066969

Answer **all** the questions.

Section A

1 Here is a list of materials.

aluminium concrete glass rubber silicon

Choose the material which best fits each description below of its microscopic structure.

(a) It consists of a lattice of positive ions immersed in a sea of many free electrons. These electrons give it a high conductivity and reflectivity.

material is .....[1]

(b) It is non-crystalline and amorphous in structure, breaking by brittle fracture and crack propagation. It is highly transparent due to its homogeneity and lack of free electrons.

material is .....[1]

(c) It is a very extensible material made from long chain polymers. Cross-linking of the chains by sulphur bonding makes the material stiffer.

material is .....[1]

2 Fig. 2.1 shows two vertical mirrors, placed at right angles to each other on a piece of squared paper, viewed from above.
A narrow horizontal beam of light is shown travelling across the paper to the point where it strikes the first mirror.

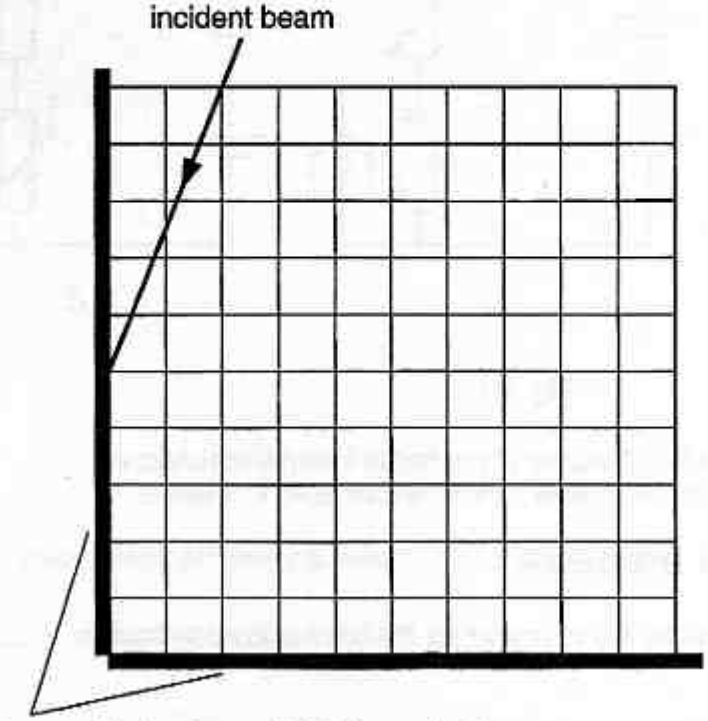


Fig. 2.1

(a) **Complete** the diagram to show two successive reflections of the incident beam.
Use the grid squares to help orient the reflected beams carefully. [2]

(b) Both motor vehicles and bicycles have rear facing reflectors. These are arrays of right-angled pairs of tiny mirrors.
Suggest and explain the purpose of this arrangement.

[2]

For Examiner's Use

3 A thermistor, fixed resistor and voltmeter are connected in three different potential divider circuits **A, B, C** as shown in Fig. 3.1.

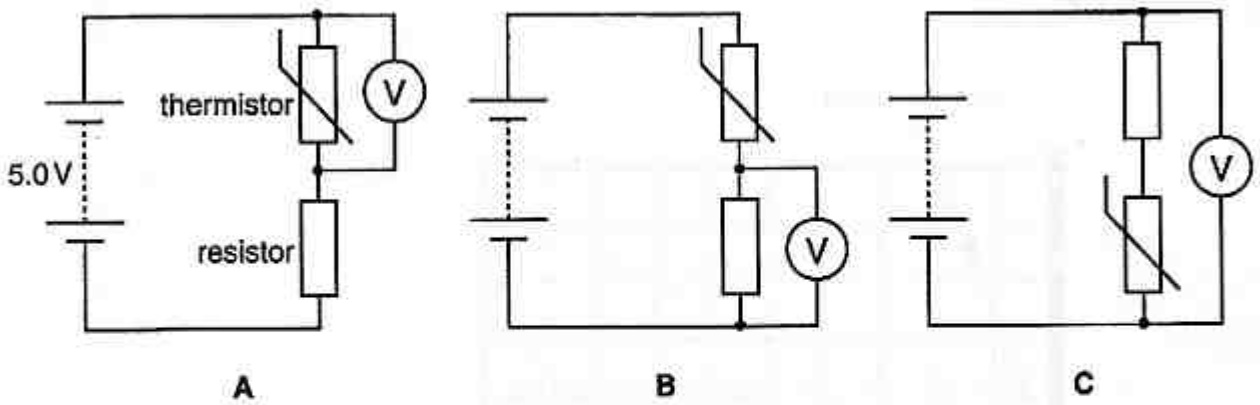


Fig. 3.1

Each divider is connected to a 5.0 V supply of negligible internal resistance.
The resistance of the thermistor decreases as the temperature increases.

State in which of the circuits **A, B, C** there is

(a) no change in p.d. recorded by the voltmeter as the temperature increases .....

(b) an increasing reading on the voltmeter as the temperature increases. .....

[2]

4 Read the paragraph below about a telephone signalling system before answering the questions about it.

The frequency range of sound transmitted by a telephone system ranges from 300 Hz to about 3400 Hz. When the signal is digitised, digital samples are taken 8000 times per second. Each sample of the signal is transmitted using 16 bits of information.

(a) State the meaning of the term **frequency**.

[1]

(b) Explain what is meant by **digital samples**.

[2]

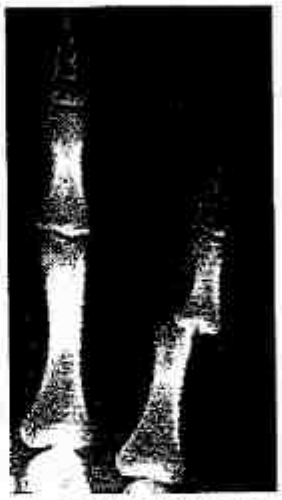
(c) State the meaning of the term **bit of information**.

[1]

5 Here are two X-ray images of a dislocated finger. Fig. 5.1 is the **original** and Fig. 5.2 shows the scanned X-ray which has been image **processed**.

original image

Fig. 5.1



processed image

Fig. 5.2

(a) State **one** difference in the appearance of the processed image as compared to the original.

[1]

(b) On the greyscale used, the pixel values vary from 0 to 255.
0 represents white and 255 represents black.

Describe how the pixel values could have been changed to produce the difference stated in **(a)**.

[1]

6 The graphs in Fig. 6.1 show how the potential difference across each of three cells **A, B** and **C** varies with current drawn from the cell.

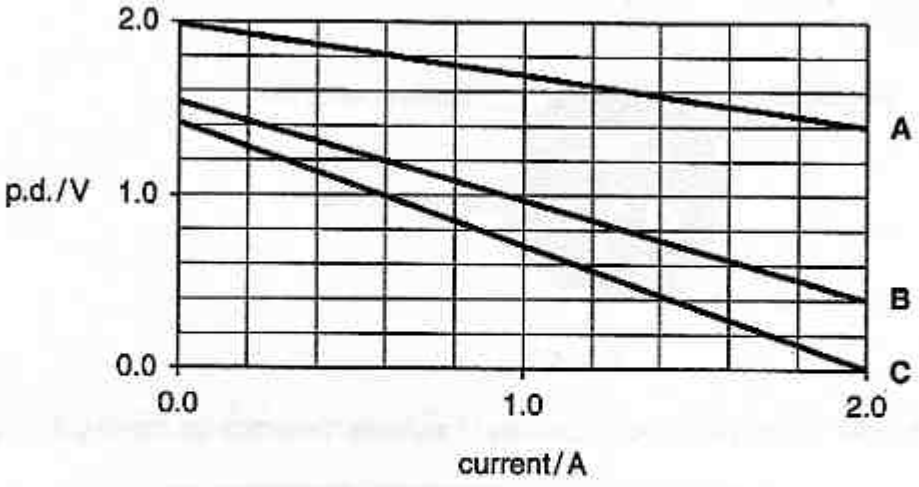


Fig. 6.1

State the cell **A, B** or **C** which

(a) has the greatest e.m.f. .....

(b) has the greatest internal resistance .....

(c) supplies a current of 2.0 A when the cell is short-circuited. ..... [3]

7 This question is about a beam of light emitted by an LED.
Light waves are emitted from a diode junction encapsulated in a curved plastic lens as shown in Fig. 7.1.

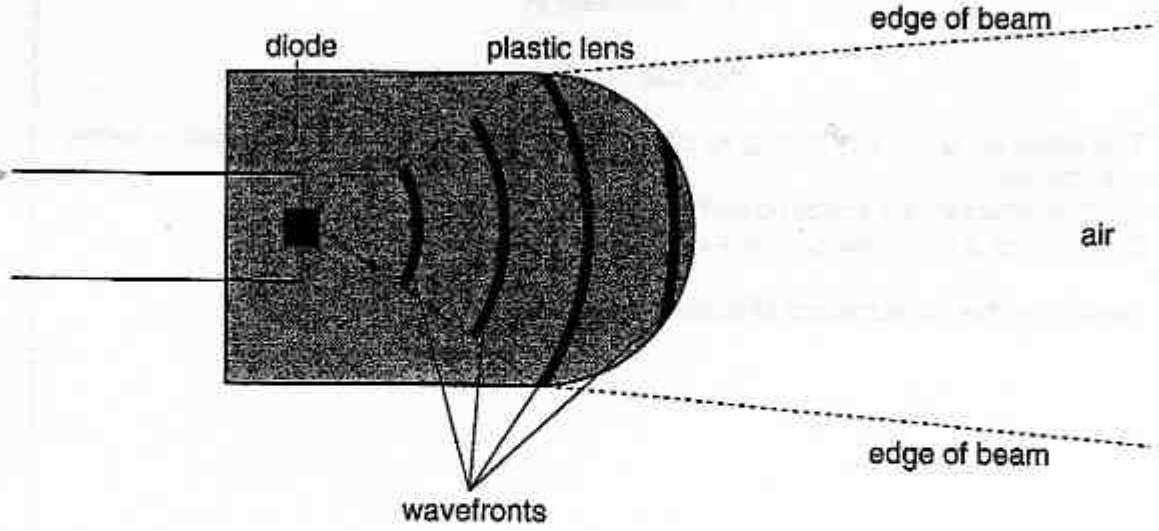


Fig. 7.1

Complete Fig. 7.1 to show **three** successive wavefronts in the beam after they have completely emerged from the plastic lens into air. [2]

[Section A Total: 20]

For Examiner's Use

Section B

8 This question is about aspects of a portable, flexible electrical extension cable, shown in cross-section in Fig. 8.1.

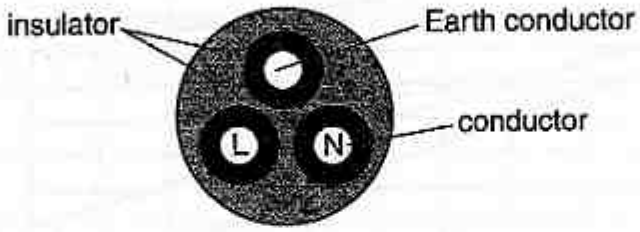


Fig. 8.1

(a) Complete the table for the required properties of suitable materials for making the cable.

	conductor	**insulator**
electrical conductivity		very low
suitable material	copper	

[2]

(b) The live **L** and neutral **N** conductors are connected in series with the load and the supply as shown in Fig. 8.2.

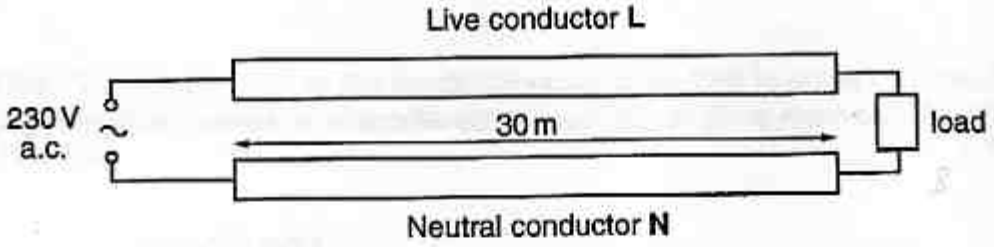


Fig. 8.2

(i) The cable is 30 m long, so that in total 60 m of conductor in the cable are in series with the load.
Each conductor has a cross-sectional area of $1.8 \times 10^{-6}\,m^2$.
Copper has a conductivity of $5.9 \times 10^{7}\,S\,m^{-1}$.

Show that the conductance of the cable is about 1.8 S.

[2]

(ii) The cable has a maximum current rating of 13 A.

Calculate the voltage dropped across the total resistance of the 60 m of conductor when there is a current of 13 A.

voltage dropped = ... V [2]

(iii) Show that the power dissipated in the cable under these conditions is of the order of 100 W.

[1]

(iv) The cable is stored by being tightly wound on a reel. The makers recommend that if the cable is used coiled on its reel, the current in it should be significantly less than 13 A.

Use the data from **(b)(iii)** to suggest and explain a reason for this recommendation.

[2]

[Total: 9]

9 This question is about the mechanical problems involved in winding a cable on a reel as shown in Fig. 9.1(a).
Fig. 9.1(b) shows part of a loop of the cable that is being bent elastically.

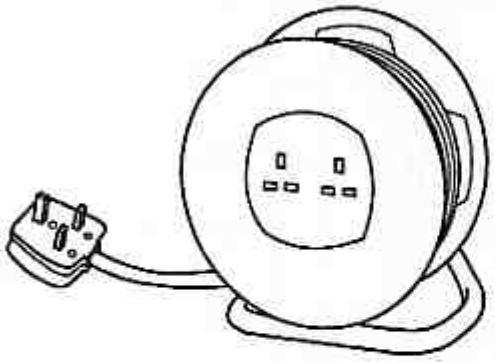


Fig. 9.1(a)

Fig. 9.1(b)

(a) Write the letter **T** at a point on Fig. 9.1(b) where the cable is in tension, and the letter **C** at a point where the cable is in compression. [2]

(b) A wire of copper conductor inside the cable is bent into a circular loop as shown in Fig. 9.2.
The wire has radius r and the circular loop has mean radius R.

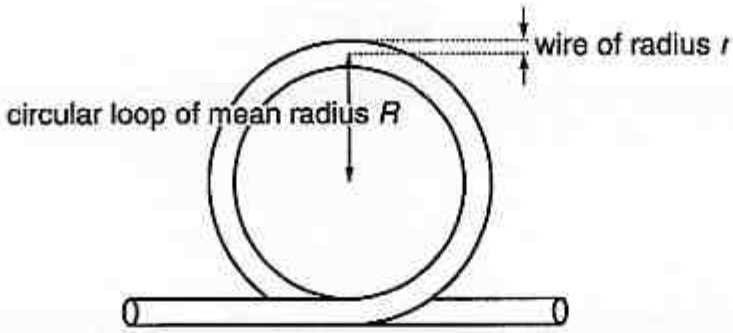


Fig. 9.2

Write appropriate symbols in the boxes below, to complete the analysis to show that the

maximum tensile strain in the wire $= \frac{r}{R}$

mean circumference for circular loop of wire $= 2\pi R$

outer circumference of circular loop of wire $= 2\pi (R + \square)$

therefore extension of the outer circular surface $= 2\pi (R + \square) - 2\pi R$

$= \square$

$$\text{strain at outer surface of wire} = \frac{\text{extension}}{\text{original circumference}} = \frac{\square}{\square} = \frac{r}{R}$$

[3]

(c) Because of the tension and compression in the cable, it may yield.
State the meaning of **yield**.

[1]

(d) (i) The conductors in the cable are usually made from several thin strands of copper rather than a solid conductor, as shown in Fig. 9.3.

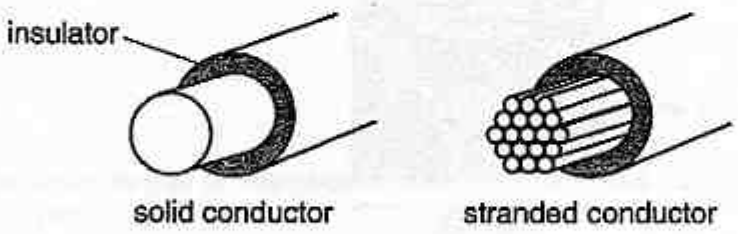


Fig. 9.3

The radius of the single solid copper conductor is 0.75 mm.
The strain at which the copper yields is 0.0020.

Use the relationship strain = $\frac{r}{R}$ to calculate the mean radius R of the smallest circular loop into which a solid copper conductor can be formed without yielding.

R = ... unit ..... [2]

(ii) A typical multi-stranded wire is illustrated in Fig. 9.3.
It contains 19 strands of wire, each of radius $r = 0.17$ mm

Calculate the mean radius R of the smallest circular loop into which the multi-stranded conductor can be formed without yielding.

R = ... unit ..... [2]

(iii) Explain the benefit of having a multi-stranded conductor rather than a solid conductor for the cable.

[1]

[Total: 11]