OCR

RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS (B) (ADVANCING PHYSICS) 2860

Physics in Action

Friday **10 JUNE 2005** Morning 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Data, Formulae and Relationships Booklet
Electronic calculator
Ruler (cm/mm)

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	39	
C	31	
TOTAL	90	

This question paper consists of 19 printed pages and 1 blank page.

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[Turn over

Answer **all** the questions.

Section A

1 Here is a list of electrical units.

As Cs^{-1} Js^{-1} JC^{-1} VA^{-1}

Choose the correct unit for

(a) electric current .....

(b) resistance .....

(c) potential difference. .....

[3]

2 Fig. 2.1 shows an oscilloscope trace of a recording of a pure sound.
The signal trace is sampled at regular time intervals in order to digitise it.

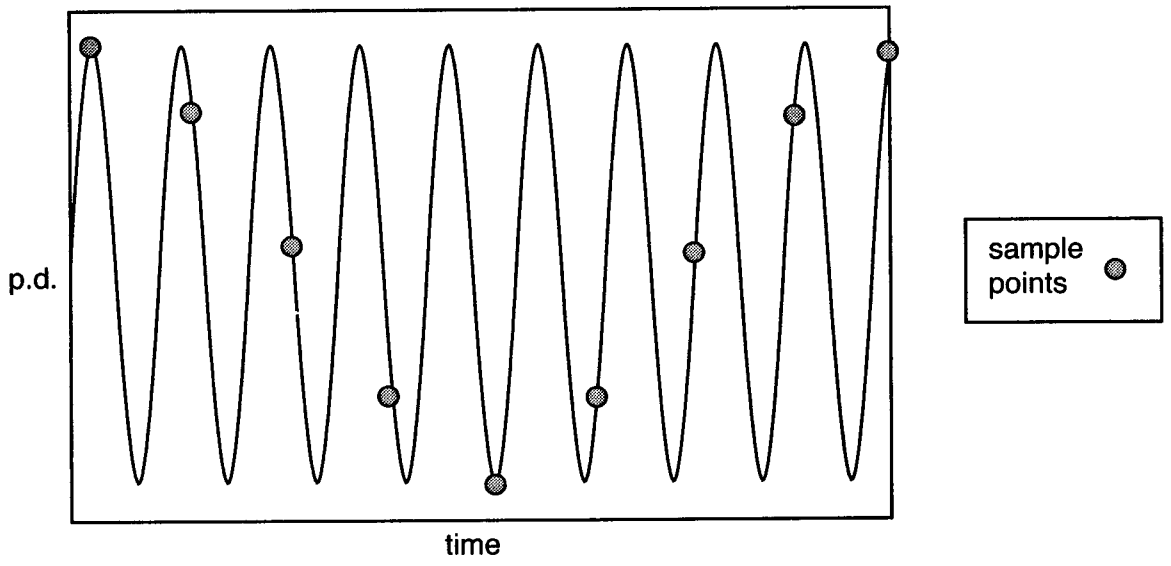

Fig. 2.1

A smooth analogue signal is reconstructed using the sample points.

(a) Sketch the reconstructed signal on Fig. 2.1. [1]

(b) Describe a difference in the sound created by the reconstructed signal, compared to the original sound.

[1]

(c) Suggest how the sampling could be altered to produce a reconstructed signal more like the original trace.

[1]

3 This question is about selecting materials for sports equipment.

Fig. 3.1 shows, on a plot of the Young modulus against density, ranges of values for different classes of material.

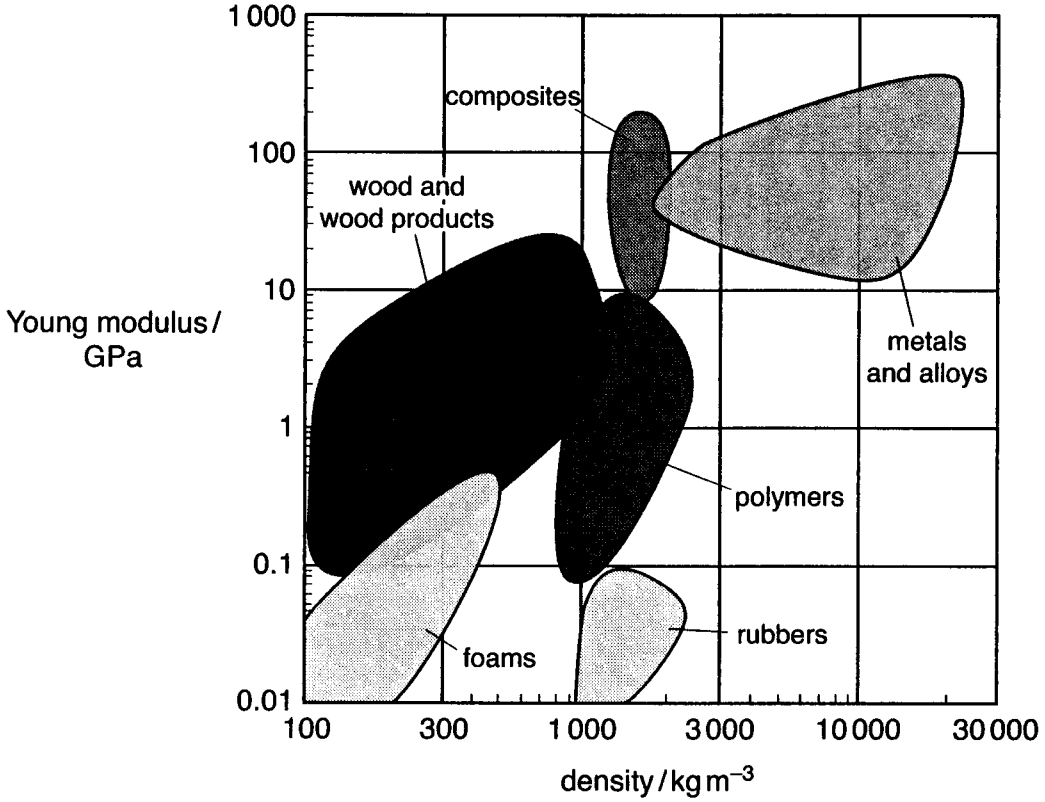

Fig. 3.1

(a) Foams are used for filling landing mats for high jumpers.

Explain this choice of material using information from Fig. 3.1.

[2]

(b) Some sports rackets are now made of a composite material rather than of metal.

Suggest and explain a reason for this change using information from Fig. 3.1.

[2]

[Turn over

4 **(a)** The grains in a photographic film are spaced about 12 μm apart.
One picture takes up an area of film that is 35 mm × 25 mm.

Show that the number of grains making up one picture is about 6×10^6.

[2]

(b) Each grain is either exposed or not and can therefore be digitised as 1 **bit** of information, either 1 or 0.

A CD can store about 650 **Mbytes** of information.

Calculate the number of these pictures that can be stored on the CD.

number of pictures = ...[2]

5 Fig. 5.1 shows an aluminium conductor on the surface of a computer chip.
It has a cross-sectional area $A = 2.0 \times 10^{-10}\,m^2$ and a length $L = 8.5 \times 10^{-4}\,m$.

conductivity σ of aluminium = $3.8 \times 10^7\,S\,m^{-1}$

Calculate the conductance G of this conductor.

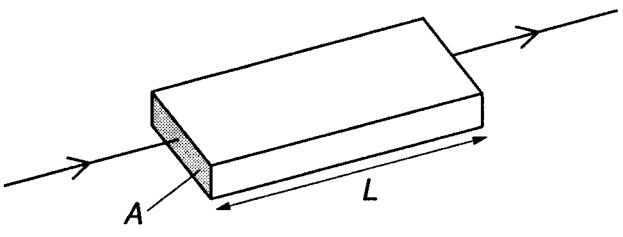

Fig. 5.1

G = ...S [1]

6 Fig. 6.1 shows the microstructure on the surface of a brass specimen.

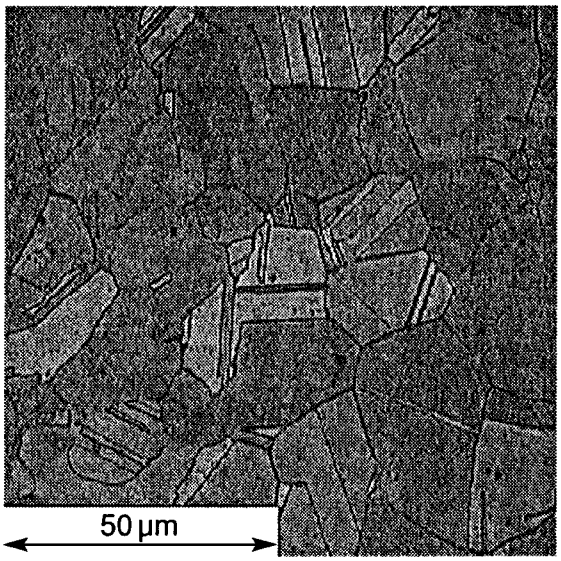

Fig. 6.1

The polycrystalline grain structure of the brass can be seen.

Explain the meaning of the term *polycrystalline*.

[2]

7 An ion beam delivers a charge of 60 nC during a time of 30 s.

(a) Calculate the current carried by the beam.

current = ...nA [1]

(b) Calculate the number of ions passing per second.

charge on each ion = 1.6×10^{-19} C

number of ions per second = ...[2]

[Section A Total: 20]

Section B

8 This question is about a sensing system to monitor the oil-level in a domestic oil tank. Fig. 8.1 shows a cylindrical tank of oil.

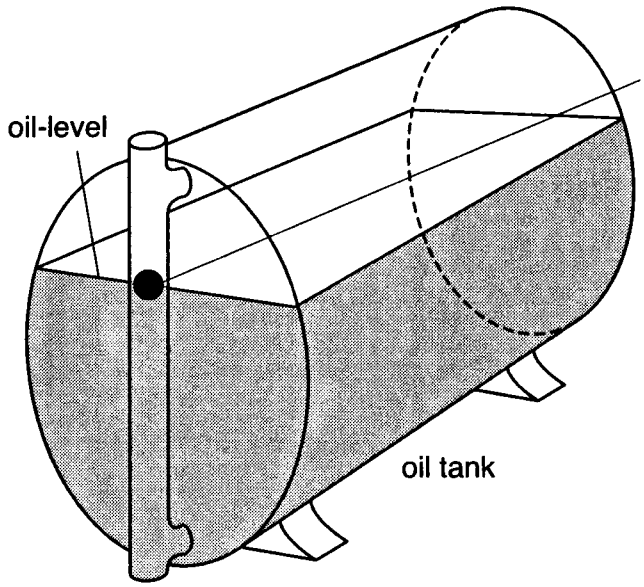

Fig. 8.1

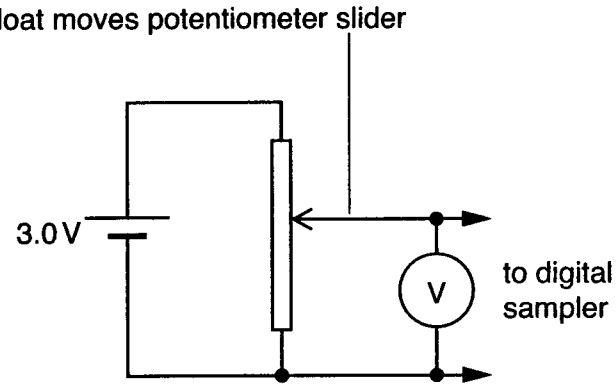

Fig. 8.2

Fig. 8.2 shows the circuit diagram of the sensor. The float rising and falling with the oil-level, moves the potentiometer slider. The potentiometer is **linear**. The voltmeter reads 0.0 V when the tank is empty and 3.0 V when it is full.

(a) (i) The voltage from the sensor is sampled digitally using a 3 bit sample.

Show clearly that 8 distinct levels can be represented by a 3 bit sample.

[1]

(ii) Show that the smallest change in voltage that can be represented by a 3 bit sample in this system is about 0.4 V.

[1]

(b) A radio transmitter sends a signal from the sensor to a receiver in the house. The wavelength of the signal is 0.68 m.

Calculate the frequency of this radio signal.

speed of electromagnetic waves $c = 3.0 \times 10^8 \text{ m s}^{-1}$

frequency = ...Hz [2]

(c) The oil tank in Fig. 8.1 is a horizontal cylinder holding 1200 litres when full.

(i) State the reading on the voltmeter when the volume of oil in the tank is 600 litres.

reading on the voltmeter = ...V [1]

(ii) The sensor circuit uses a very **high** resistance voltmeter.

Explain why this is necessary to maintain linearity.

[2]

(d) The graphs **A**, **B**, **C** and **D** in Fig. 8.3 show how the voltmeter reading from the **linear** potential divider in Fig. 8.2 varies with another quantity *x* (x-axis).

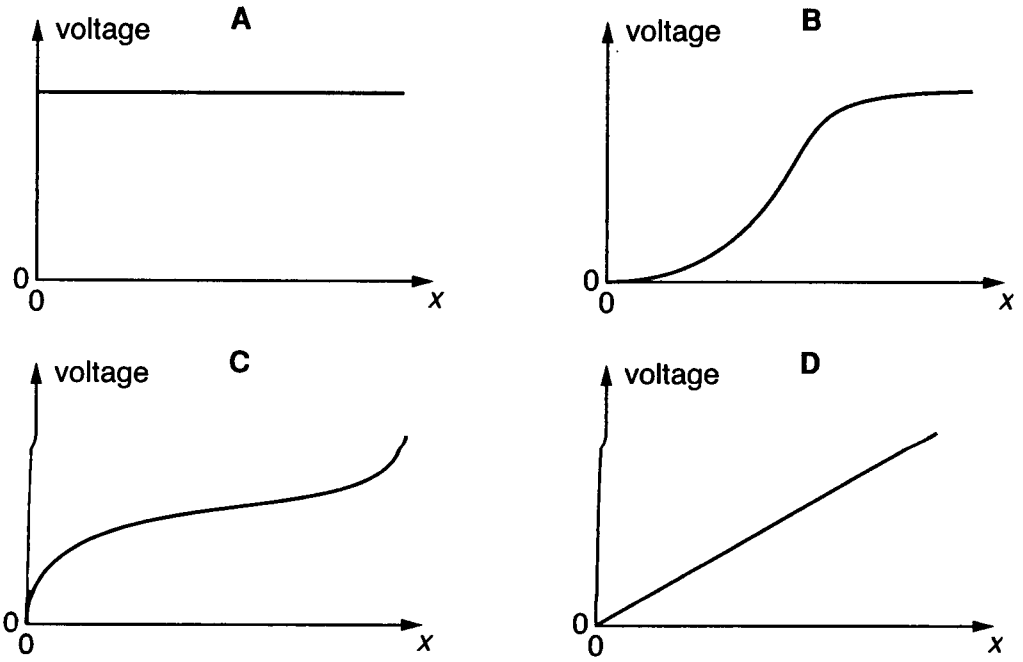

Fig. 8.3

Choose the graph that best represents how the reading on the voltmeter varies with

(i) the **depth of oil** in the tank (x-axis) .....[1]

(ii) the **volume of oil** in the tank (x-axis). .....[1]

[Total: 9]

9 A solar cell is being tested as a source of electrical power.

(a) The solar cell is connected in a circuit with a load resistor, an ammeter and a voltmeter in order to measure its power output.

Complete the circuit diagram Fig. 9.1 to show the ammeter and the voltmeter correctly connected into the circuit.

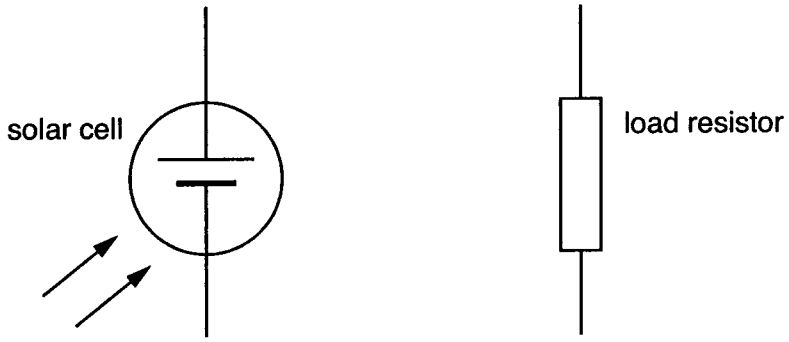

Fig. 9.1

[2]

(b) Fig. 9.2 shows the arrangement for illuminating the solar cell from an extended light source.

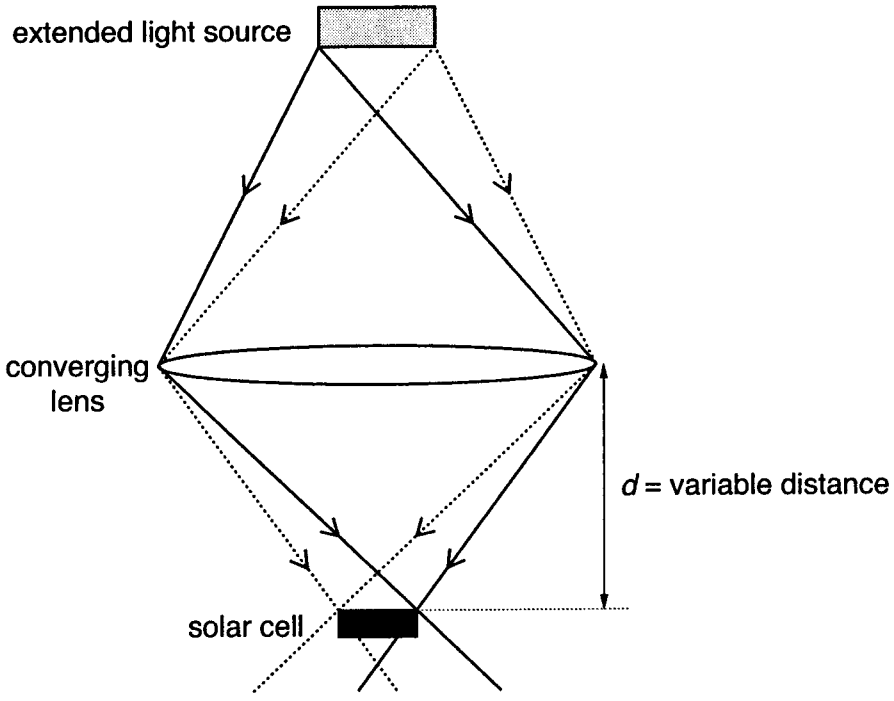

Fig. 9.2

The distance *d* is varied by moving the solar cell towards or away from the converging lens, to alter the intensity of illumination.

Fig. 9.3 gives a graph of the current delivered by the solar cell plotted against distance *d*.

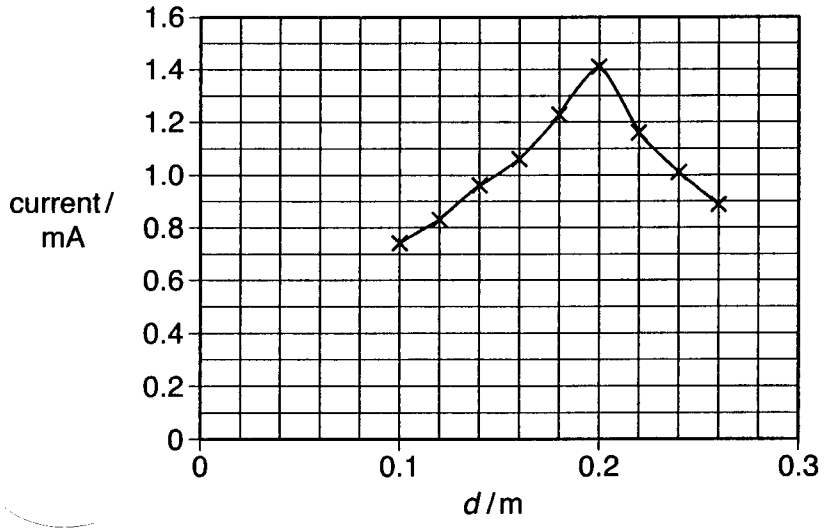

Fig. 9.3

(i) For the arrangement shown in Fig. 9.2, explain why the current varies with *d* as shown in Fig. 9.3.

[2]

(ii) Calculate the maximum power dissipated by a load resistor of 110 Ω.

maximum power = ...W [2]

Question 9 is continued over the page.

(c) Fig. 9.4 shows two wavefronts from point **P** on the extended light source heading towards the lens.

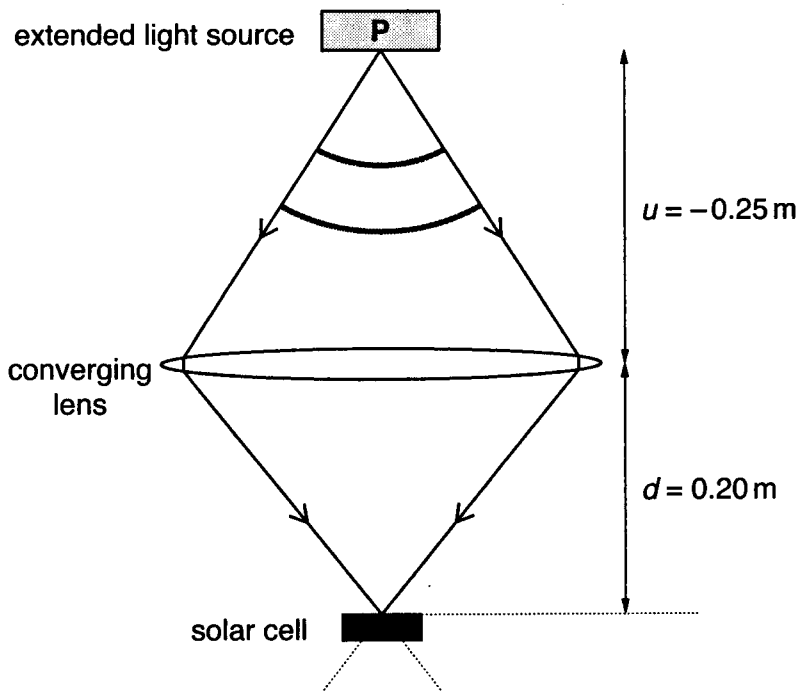

Fig. 9.4

On Fig. 9.4, draw the same **two** wavefronts to show their curvature and spacing **after** passing through the converging lens. [2]

(d) **(i)** The curvature of wavefronts entering the lens in Fig. 9.4 is –4.0 D.

Calculate the curvature of wavefronts leaving the lens, when $d = 0.20$ m.

curvature leaving = ...D

(ii) Calculate the curvature added by the lens, and the focal length of the lens.

curvature added = ...D

focal length = ...m
[3]

[Total: 11]

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