Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

ADVANCED SUBSIDIARY GCE

G491

PHYSICS B (ADVANCING PHYSICS)

Physics in Action

THURSDAY 27 MAY 2010: Afternoon
DURATION: 1 hour

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper

OCR SUPPLIED MATERIALS:
Data, Formulae and Relationships Booklet

OTHER MATERIALS REQUIRED:
Electronic calculator
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

DC (LEO/SW) MEP60362 30288

INSTRUCTIONS TO CANDIDATES

- **Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.**
- **Use black ink. Pencil may be used for graphs and diagrams only.**
- **Read each question carefully and make sure that you know what you have to do before starting your answer.**
- **Answer ALL the questions.**
- **Write your answer to each question in the space provided. If additional space is required, you should use the pages at the end of this booklet. The question number(s) must be clearly shown.**
- **Show clearly the working in all calculations, and give answers to only a justifiable number of significant figures.**

INFORMATION FOR CANDIDATES

- **The number of marks is given in brackets [ ] at the end of each question or part question.**
- **The total number of marks for this paper is 60.**
- **You are advised to spend about 20 minutes on Section A and 40 minutes on Section B.**
- **You will be awarded marks for the quality of written communication where this is indicated in the question.**

Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means, for example, you should

- **ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;**
- **organise information clearly and coherently, using specialist vocabulary where appropriate.**

Answer ALL the questions.

SECTION A

1 Here is a list of four units for physical quantities.

C s $\qquad$ C s^{-1} $\qquad$ J s^{-1} $\qquad$ V C

From the list write down the unit for

(a) power ____________

(b) current. ____________

[2]

2 A student makes the following measurements to find the tensile stress in a wire:

tension in wire = 147 ± 1 N
cross-sectional area = (0.86 ± 0.10) × 10^{-6} m^2

(a) Calculate the value of the tensile stress in the wire.

stress = ________________ **Pa [1]**

(b) **Calculate the largest possible value of the stress, given the uncertainties in the data.**

largest stress = ____________ Pa [2]

(c) **The student wishes to reduce the uncertainty in the value of the stress.**

State which measurement you would choose to improve to achieve this.

Explain your choice.

[1]

3 Fig. 3.1 shows an image of the Sun's corona during a total eclipse, when the Moon exactly covers the disc of the Sun. The image is 710 × 940 pixels in size.

diameter of Sun = 1.4×10^6 km

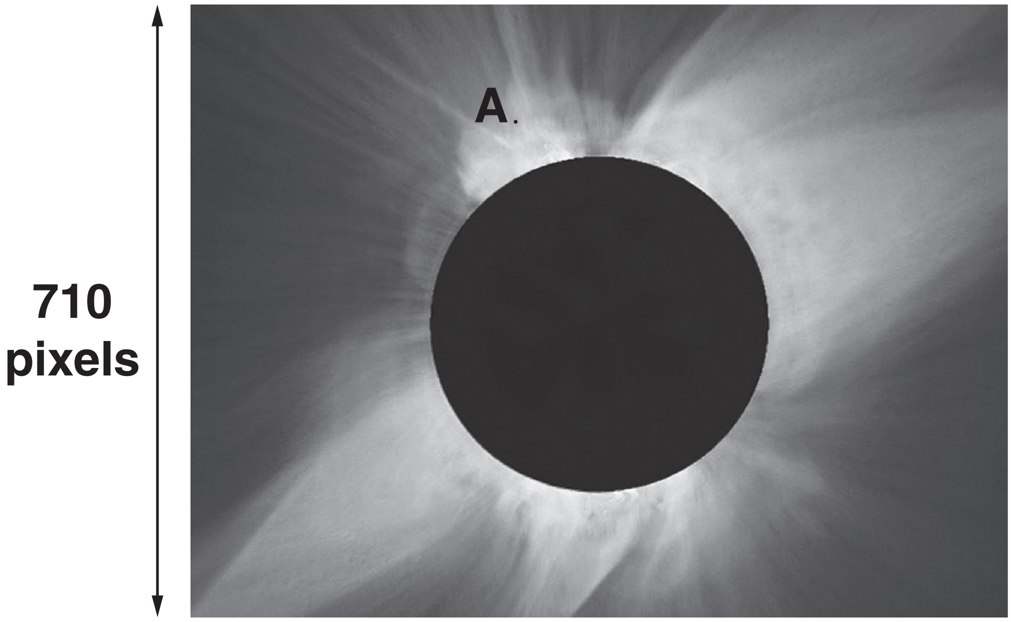


FIG. 3.1

(a) Estimate the resolution of the image of the Sun's corona, making your method clear.

resolution = ______ km pixel^{-1} [2]

(b) **Point A marked on the image is near the tip of a solar prominence.**

Estimate the height of point A above the Sun's surface.

height = ______________ km [1]

4 The Earth-based camera that took the image of the Sun shown in Fig. 3.1 had the image focused a distance of 0.012 m behind the lens.

Calculate the power of the camera lens.

Explain your reasoning clearly.

distance from Earth to Sun = 1.5×10^{11} m

lens power = ______________ D [2]

5 Fig. 5.1 shows graphs of current against p.d. for a semiconductor diode maintained at three different temperatures: 100 °C, 25 °C and –40 °C.

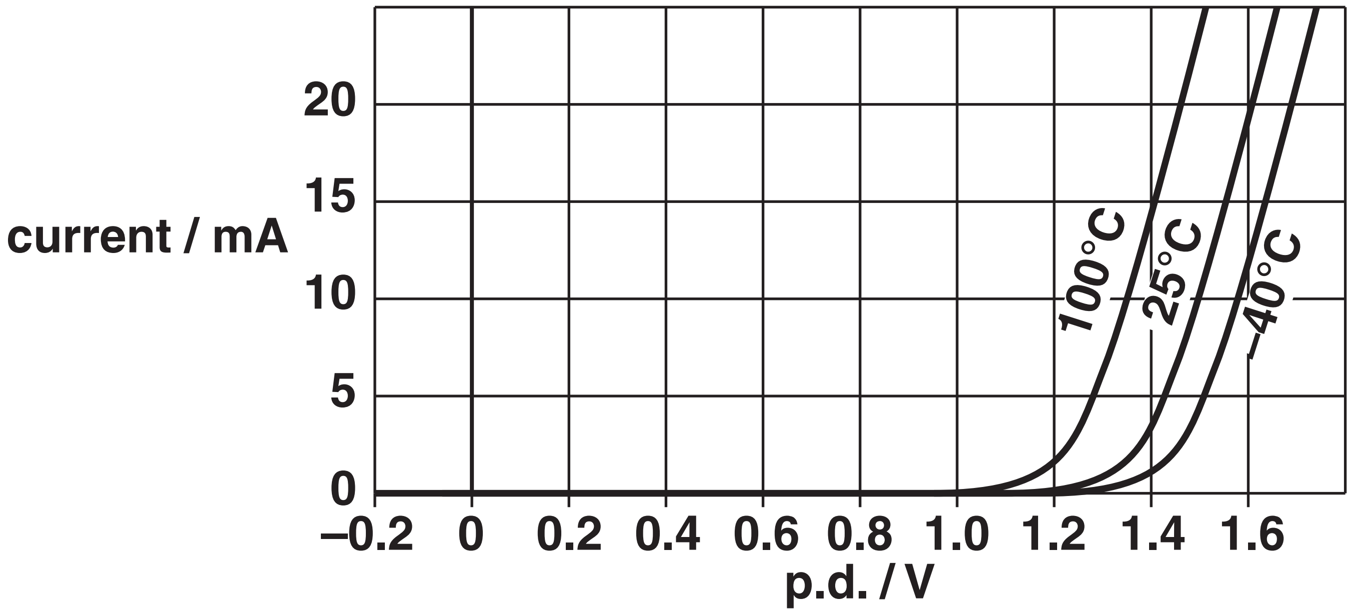


FIG. 5.1

(a) Describe TWO features of the graph for the diode at 25 °C.

1.

2.

[2]

(b) Describe how the graphs vary with increasing temperature.

[1]

6 A battery in a digital camera is supplying a constant current of 0.29 A.

(a) Calculate the charge supplied during 5 seconds.

charge = ______________ C [1]

(b) Calculate the number of electrons that flow from the negative terminal of the battery in this time.

Show your reasoning clearly.

$e = 1.6 \times 10^{-19}$ C

number of electrons = ________________ [2]

7 **A mobile phone can send text messages. The system is designed to code for small and capital letters of the alphabet, the numbers 0 to 9, and 12 different punctuation marks.**

Calculate the minimum number of bits that are required to code for this total number of alternative characters.

Show your reasoning clearly.

number of bits = ________________ [3]

[Section A Total: 20]

SECTION B

8 Fig. 8.1 shows a graph of how the resistance *R* of a light dependent resistor (LDR) varies with light intensity, up to a value of 2000 lux.

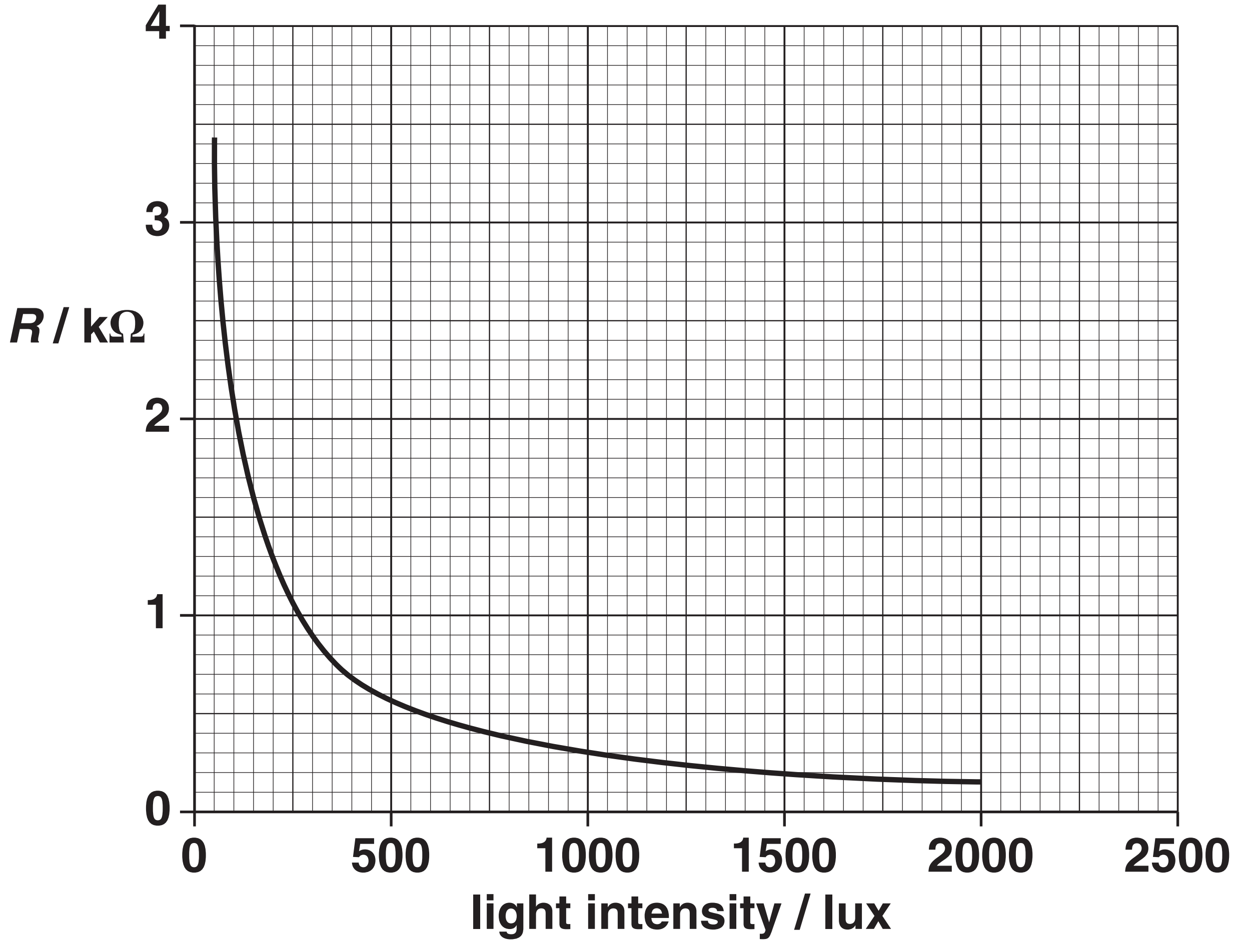


FIG. 8.1

(a) (i) Use the graph to find the resistance of the LDR at light intensities of

1 500 lux resistance of LDR = _________ Ω

2 2500 lux. resistance of LDR = _________ Ω

[1]

(ii) State which of the two values that you have recorded in (a)(i) you have more confidence in. Give reasons for your decision.

[2]

(b) The LDR is to be used (as a light sensor) as one component of a potential divider in a circuit with three further components:

- **fixed resistor**
- **6.0V battery**
- **voltmeter to measure the output p.d.**

The circuit is to be constructed so that the output p.d. <u>INCREASES</u> as the light intensity on the LDR increases.

Draw the circuit diagram.

[3]

(c) **It is required that the output p.d. of the circuit should be 1.6V at a light intensity of 500 lux.**

Calculate the value of the fixed resistor to achieve this. Make your method clear.

resistance = ______________ Ω [3]

[Total: 9]

9 **Fig. 9.1 shows a graph of p.d. against current for a 12V filament lamp.**

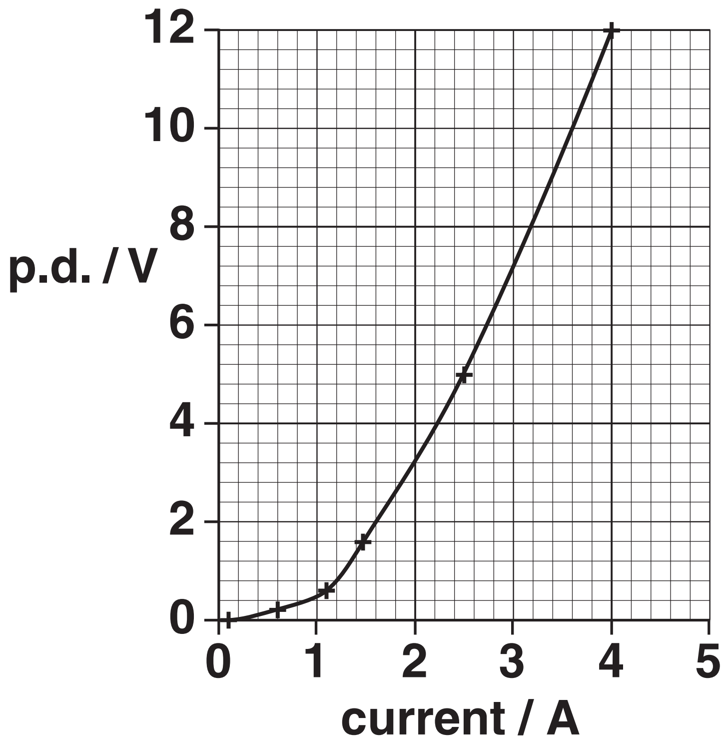


FIG. 9.1

(a) Calculate the power of the lamp when operating at 6.0V.

Show clearly how you obtain your answer.

power = ________________ W [2]

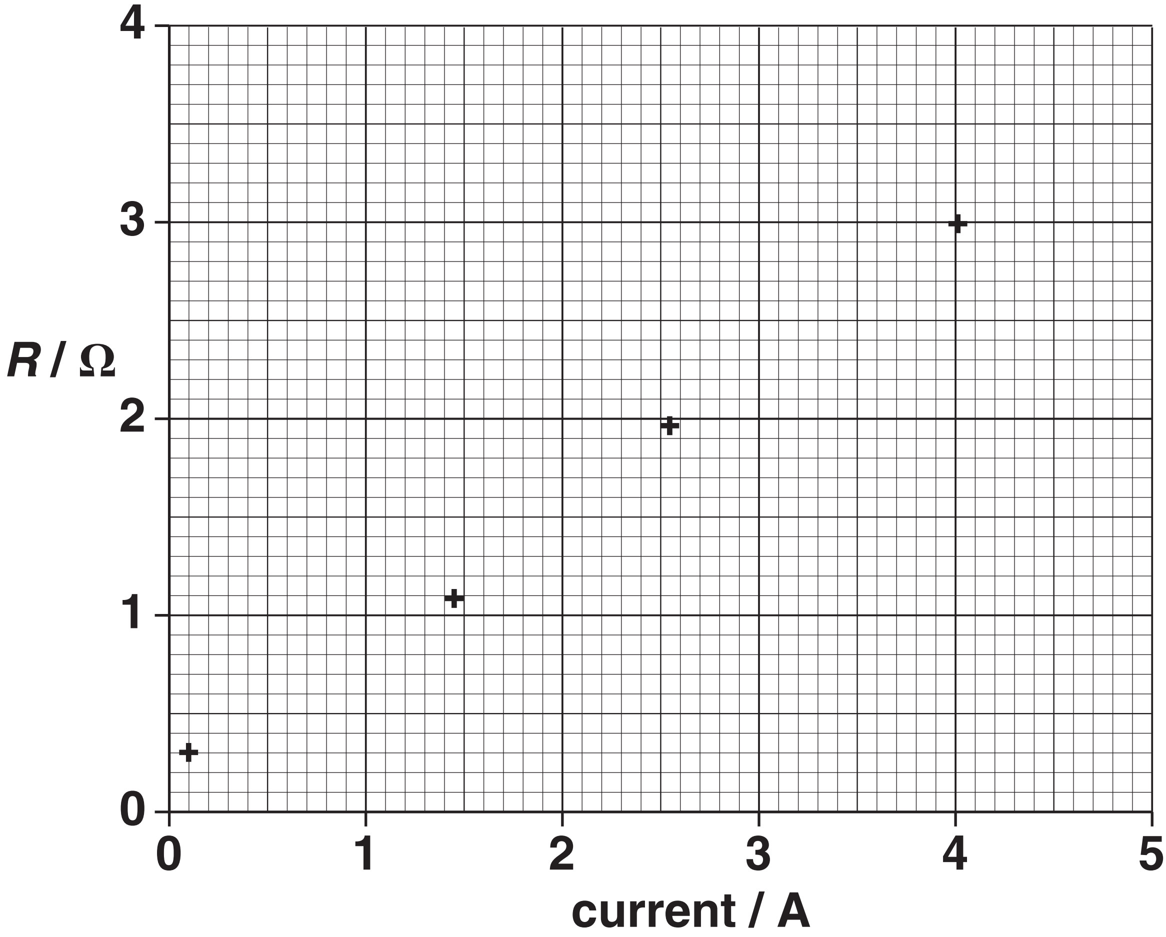
(b) Fig. 9.2 shows the data table for the graph of Fig. 9.1.

current / A	p.d. / V	R / Ω
0.10	0.03	0.30
0.60	0.21	
1.05	0.65	
1.45	1.58	1.09
2.54	4.98	1.96
4.01	12.00	2.99

FIG. 9.2

(i) Complete the third column of Fig. 9.2 for the resistance R of the filament. [1]

(ii) **Complete the graph in Fig. 9.3 of the filament resistance against current by plotting the two missing resistance values <u>AND</u> drawing the curve of best fit.** **[2]**



<u>FIG. 9.3</u>

(iii) Use the graph in Fig. 9.3 to explain how the conductivity of the filament material changes with temperature.

[2]

QUESTION 9 CONTINUES ON PAGE 20

(c) **Fig. 9.4 shows the current in the same filament lamp plotted against time, as recorded by a data-logger. The lamp is connected to a source of emf 12 V at time 0.05 s.**

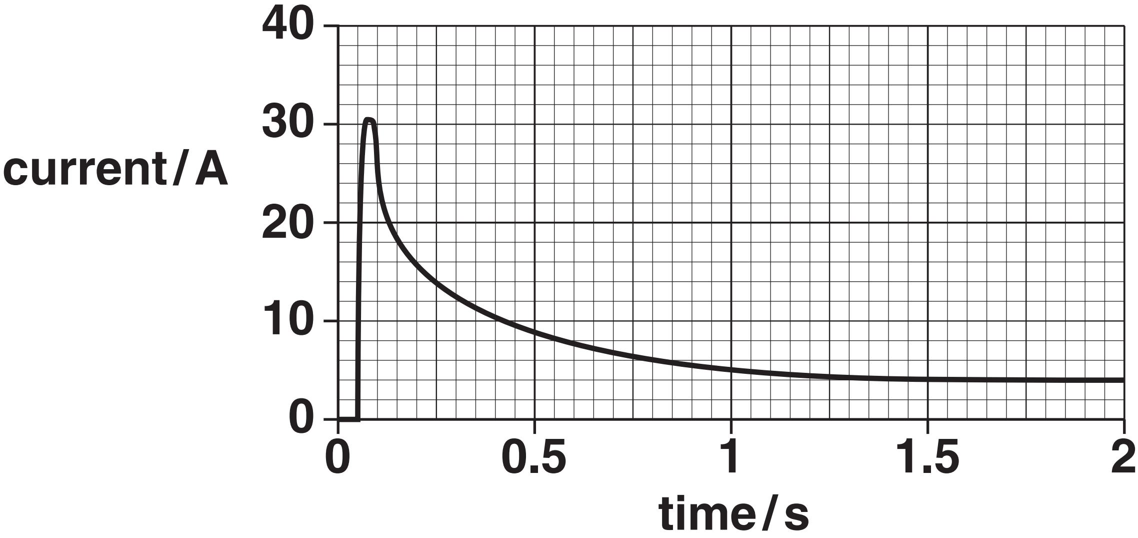


FIG. 9.4

(i) **Show that the data in the table of Fig. 9.2 indicate that the initial current could be as high as 40 A, when first connected to a source of emf 12 V.**

[1]

(ii) **Suggest a reason why it only reaches about 30 A as shown in Fig. 9.4.**

[1]

(iii) Give an explanation for ONE OTHER quantitative feature of the graph after the peak current.

[1]

[Total: 10]

10 This question is about “designer” materials.

(a) Sketch LABELLED diagrams below to illustrate the difference between the microstructures of a crystalline metal and an amorphous glass.

crystalline metal

amorphous glass

[3]

(b) Explain using features illustrated on your diagrams in (a) why metals are usually ductile, but glasses are brittle.

In your explanation, you should make clear how the differences in arrangement of atoms account for the large-scale behaviour of the materials.

You should use appropriate technical terms in your answer.

[4]

QUESTION 10 CONTINUES ON PAGE 24

(c) When molten titanium (Ti) is cooled it can solidify in two forms. One form is that of a metallic crystal. The other form is a glass-like state, in which rapid cooling "freezes in" the amorphous structure of the liquid metal.
By controlling the cooling, a composite solid form of titanium can be produced. This contains regions of both forms.
The composite is made of only one material – titanium.

(i) Name a composite material that is made of more than one material.

____

State its component materials.

______________________________________ [1]

(ii) Fig. 10.1 is a table of values of some properties of titanium metal and titanium composite at room temperature.

property	Ti metal	Ti composite
Young modulus	110 GPa	110 GPa
yield strength	300 MPa	1.35 GPa
tensile strain (max)	27%	10%

FIG. 10.1

Fig. 10.2 shows the stress against strain graph for titanium metal.

Draw on Fig. 10.2, opposite, the stress against strain graph for titanium composite using data from Fig. 10.1. [2]

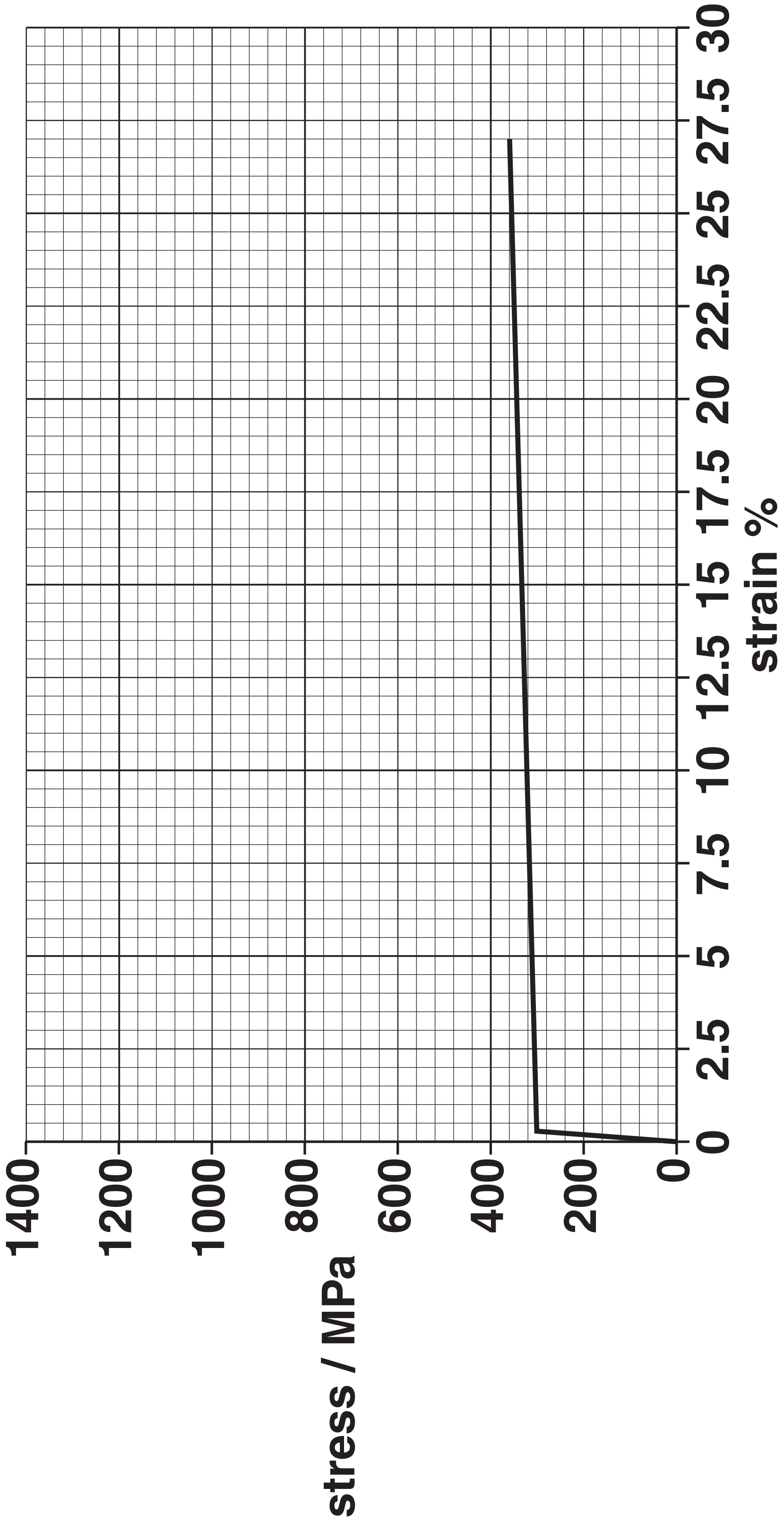

stress / MPa
1400
1200
1000
800
600
400
200
0
strain %
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30

FIG. 10.2

(iii) **A rod of titanium composite fractures perpendicular to its length. It takes 14 J of energy to create the new surface.**

Calculate the total fracture area created during this process.

fracture toughness of Ti composite = 0.34 MJ m^{-2}

fracture area = ______________ m^2 [2]

[Total: 12]

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11 This question is about digitising sound signals.

Fig. 11.1 shows a 25 ms length of the electrical waveform on one channel of recorded stereo music. In MP3 players this is called a "frame".

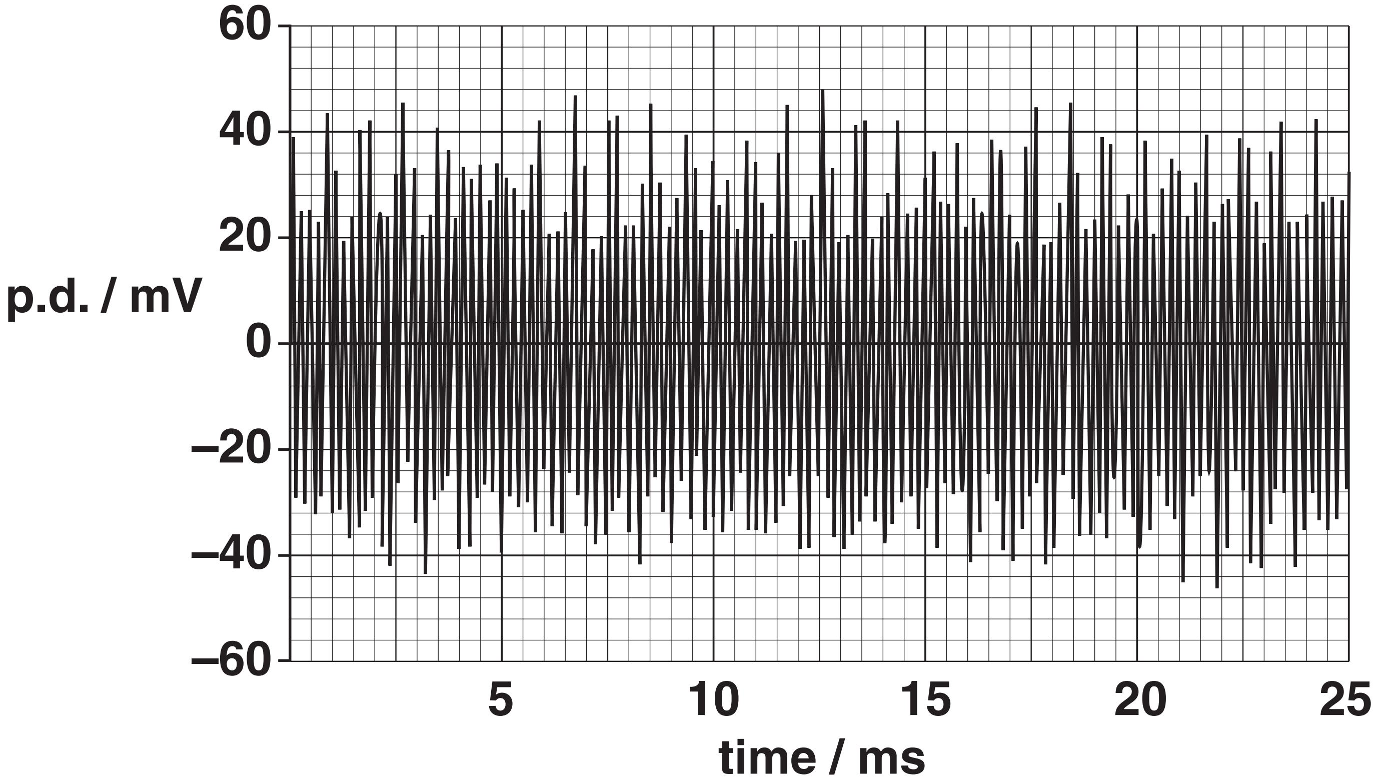

FIG. 11.1

(a) The sample is digitised to CD quality at a sampling frequency of 44.1 kHz using 16 bit sampling for each stereo channel.

(i) Show that the rate of information transfer in each channel is greater than 500 kbit s^{-1}.

[1]

(ii) The maximum peak to peak signal voltage is 100 mV.

Show that the voltage resolution of the digitisation is less than 2 μV.

[2]

(b) Fig. 11.2 shows the frequency spectrum of this 25 ms frame of recorded sound.

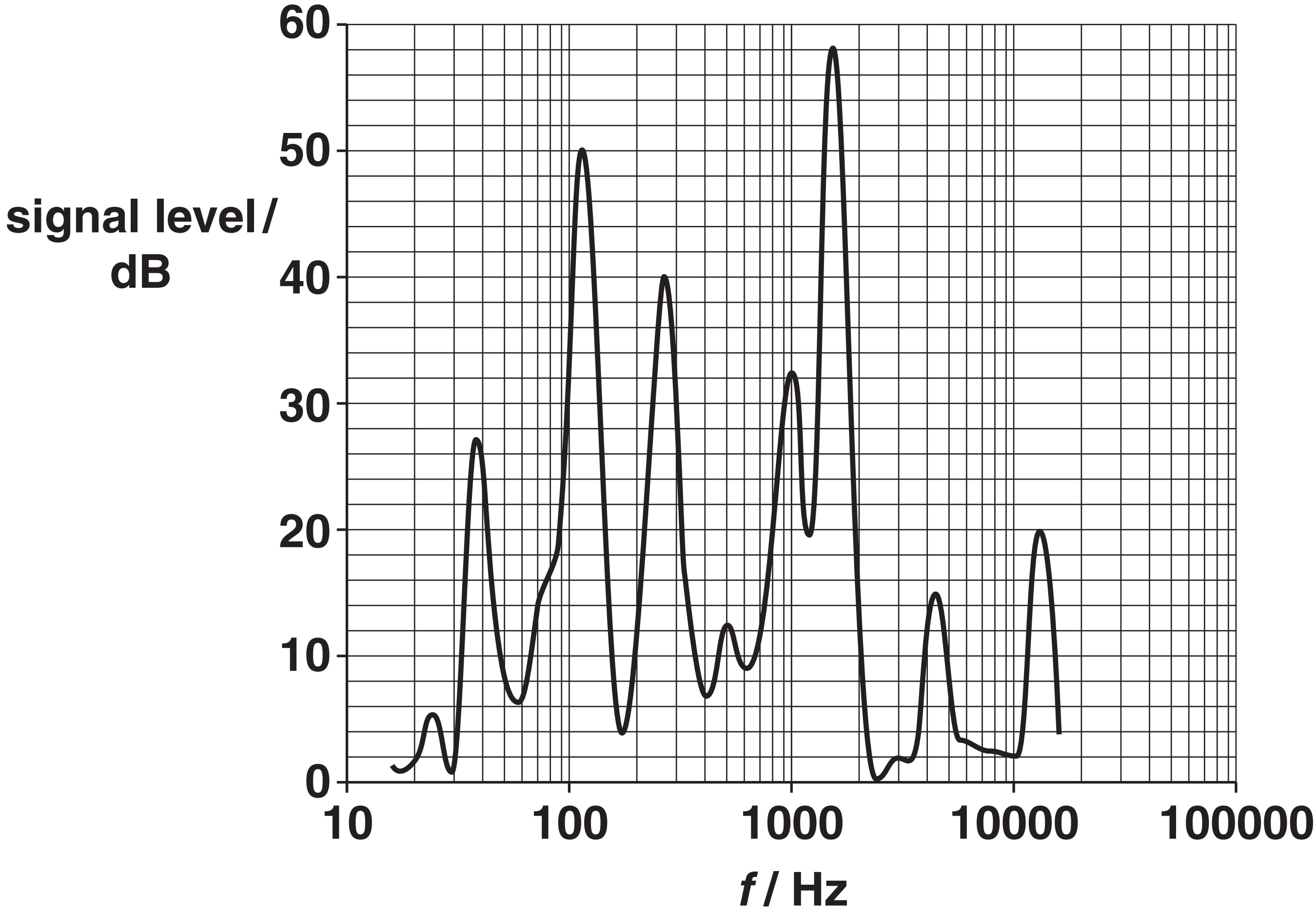

Fig. 11.2

Each increase of 10 dB in signal level represents a 10 times increase in sound intensity. The threshold of human hearing is taken as 0 dB.

(i) State by what factor the sound intensity increases as the signal level changes from 0 dB to 60 dB.

factor = ____________________ [1]

(ii) The dotted line in Fig. 11.3 shows the frequency response for an average human ear. This is the sound level at which a sound of that frequency can just be heard.

The ear's response is superimposed on the frequency spectrum of the music.

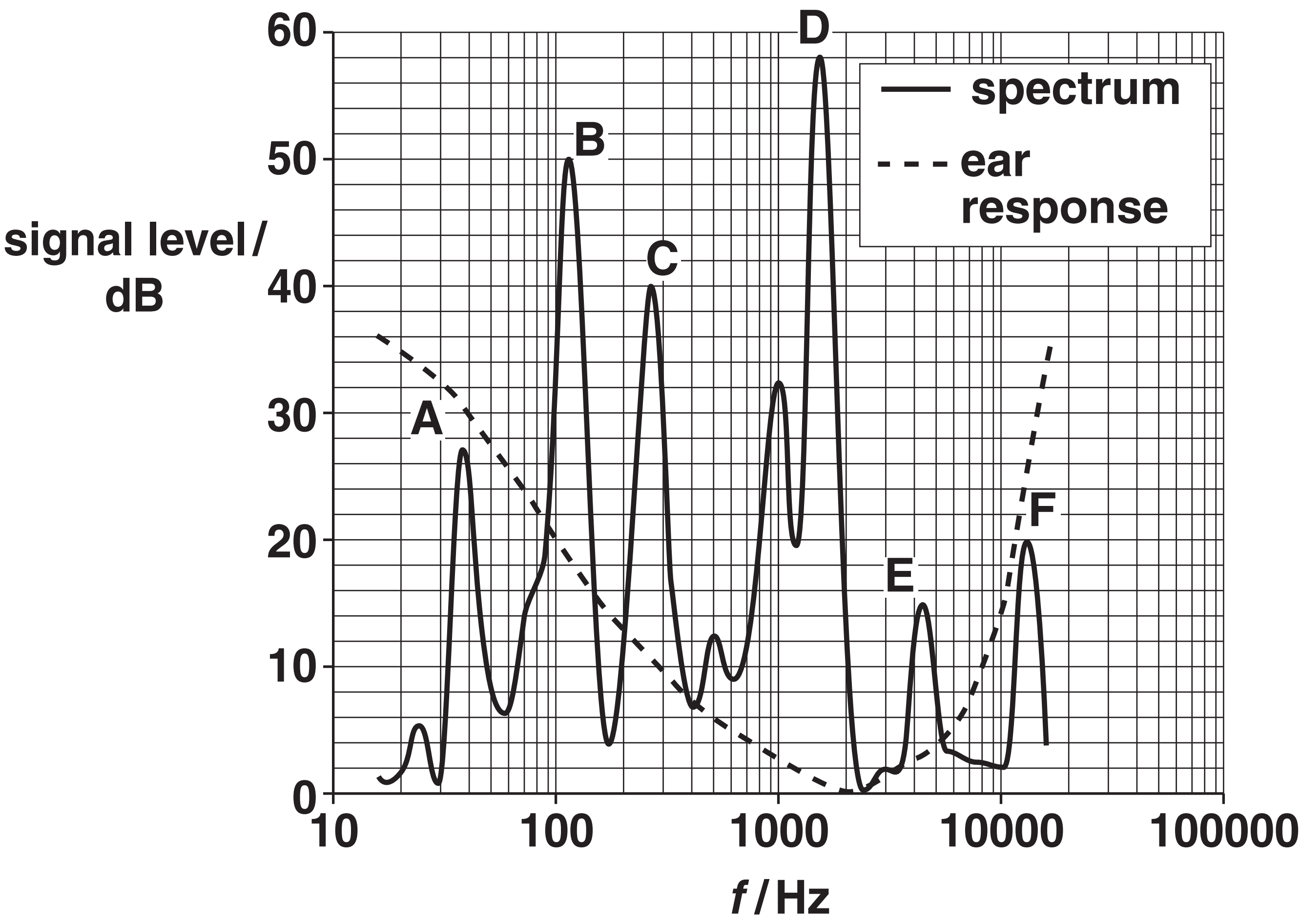

FIG. 11.3

1 State the frequency at which the ear is most sensitive to sound intensity.

frequency = ____________ Hz [1]

2 List which of the signal level peaks A, B, C, D, E or F, cannot be heard by the average human ear.

[1]

(c) An MP3 coder obtains a spectrum 40 times per second, each time analysing a frame of the sound signal similar to that shown in Fig. 11.1.
Inaudible frequencies in the spectrum of each frame are rejected.
Information is stored about each spectrum, using the 32 most important frequencies in each frame.
Each frequency peak is coded as 24 bits.
The MP3 player then uses the stored information to rebuild the waveform, which drives the earpiece.

Show that 1 second of MP3 coding for each channel requires less than 1/20 of the information capacity for 1 second of CD quality digitised signal as calculated in (a).

In your answer, you should explain your method clearly and completely.

[3]

[Total: 9]

[Section B Total: 40]

END OF QUESTION PAPER

ADDITIONAL PAGE

If additional space is required, you should use the pages below.
The question number(s) must be clearly shown.

ADDITIONAL PAGE

ADDITIONAL PAGE