OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS (B) (ADVANCING PHYSICS) 2860

Physics in Action

Wednesday **12 JANUARY 2005** Morning 1 hour 30 minutes

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

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 round 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 20 printed pages.

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Answer **all** the questions.

Section A

1 Fig. 1.1 shows a plot of strength against toughness for different materials. Four areas have been shaded and labelled **A, B, C** and **D**.

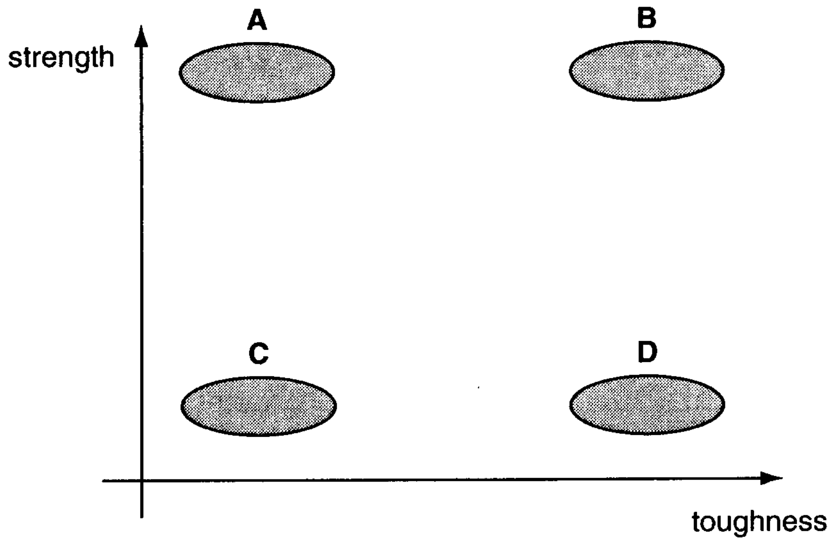


Fig. 1.1

Select the area of the graph, **A, B, C** or **D**, that best fits each of the following materials.

a material suitable for car bodies e.g. steel ....

a weak material that is easy to snap e.g. biscuit ....

a brittle metal e.g. cast iron under tension .... [3]

2 Fig. 2.1 and Fig. 2.2 show two satellite images, taken about two weeks apart in early 2000, of the Ninnis Glacier disintegrating into the Antarctic Ocean.

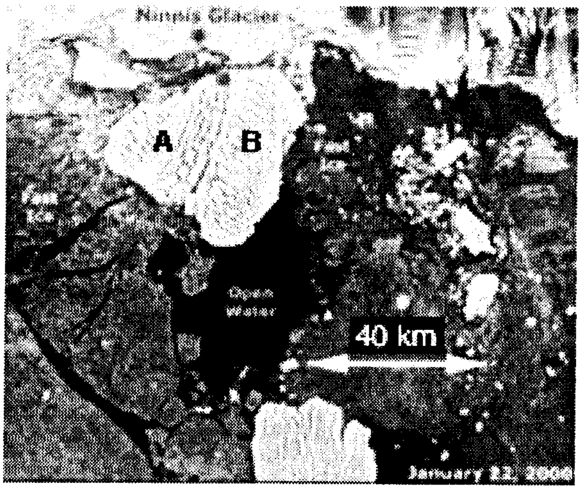


Fig. 2.1

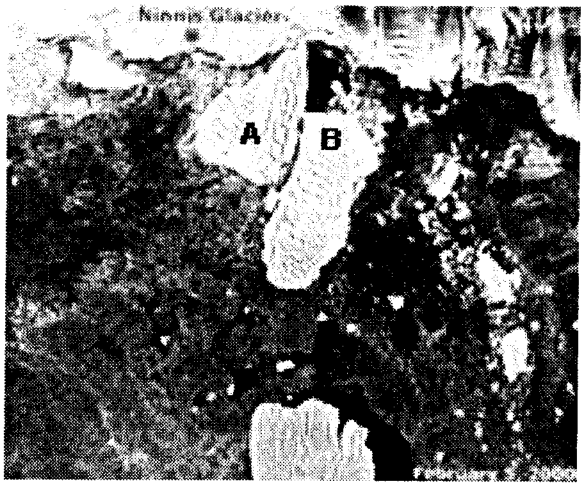


Fig. 2.2

(a) Both images are 300 pixels wide × 250 pixels high.
A 40 km scale marker has been added to Fig. 2.1.

Estimate the resolution of these images.

resolution = ... m pixel^{-1} [1]

(b) Estimate the distance ice shelf **B** has drifted during the two weeks.

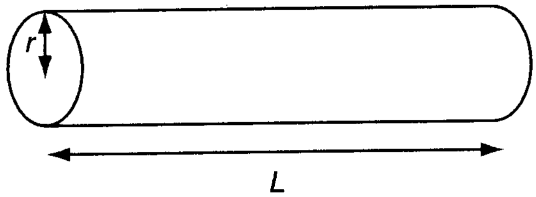
distance = ... km [1]

(c) Suggest **one** aspect of human importance of the evidence presented in this pair of images.

[1]

3 This question is about the conductance G of a cylindrical wire given by the following equation.

$$G = \frac{\sigma A}{L} = \frac{\sigma \pi r^2}{L}$$



(a) State what the term πr^2 in the equation represents.

[1]

(b) Here is a list of multiplying factors.

$\times 4$ $\times 2$ $\times 1$ $\times \frac{1}{2}$ $\times \frac{1}{4}$

Select the factor that best describes the variations given below.

If the length L of the wire is doubled, the conductance G will be ....

If the radius r of the wire is halved, the conductance G will be ....

[2]

For Examiner's Use

4 Fig. 4.1 shows a ladder of conductivity values on a logarithmic scale, for three classes of conducting material.

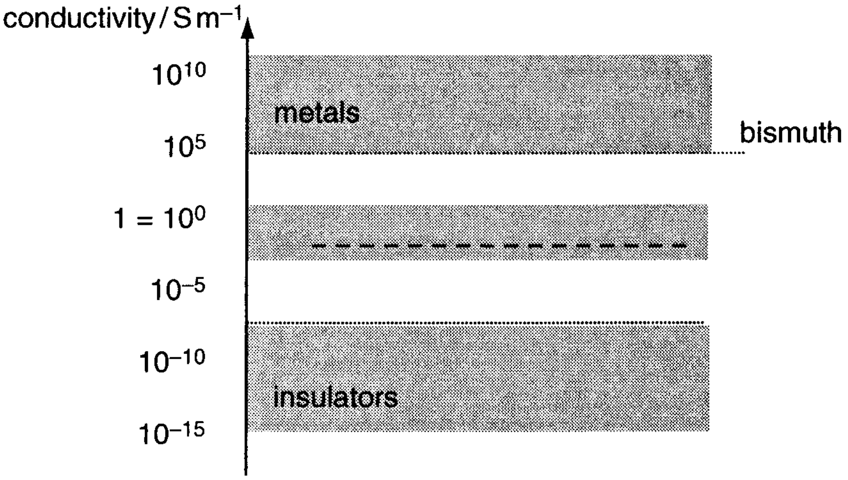


Fig. 4.1

(a) Label on Fig. 4.1 on the dashed line, the third class of conducting material. [1]

(b) The lowest conductivity of a metal indicated on the ladder is $9 \times 10^{5}\,\mathrm{S\,m^{-1}}$ for the metal bismuth.

Calculate the **resistivity** of bismuth. Give a suitable unit.

resistivity = ... unit .... [3]

For Examiner's Use

5 Figs. 5.1 and 5.2 show the frequency components (spectra) of two sounds from a voice recognition system.

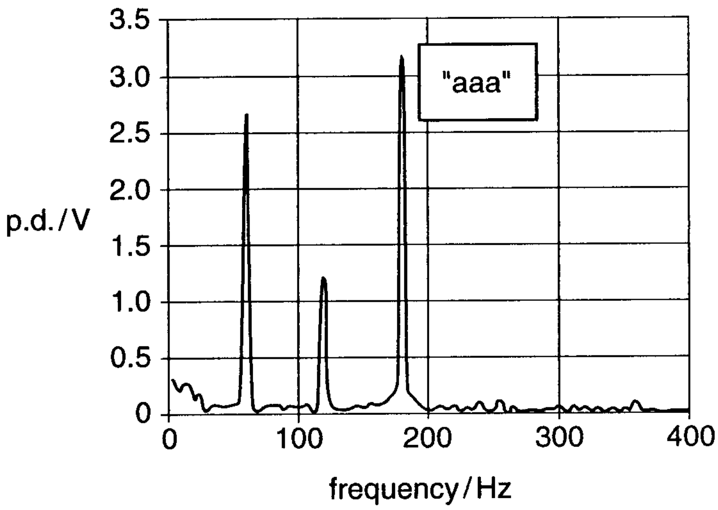


Fig. 5.1

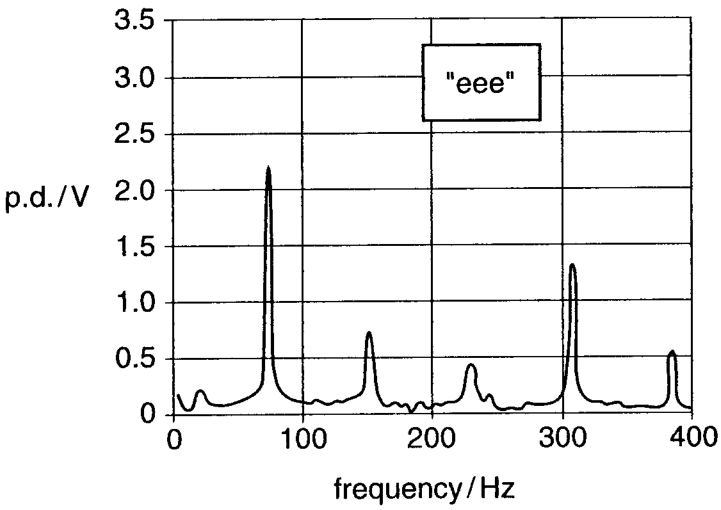


Fig. 5.2

(a) In Fig. 5.1, the voice was making an "aaa" sound, in Fig. 5.2 an "eee" sound.

Describe **two** differences between the sound spectra that would help you to distinguish between the sounds, by inspecting the spectra.

[2]

(b) The fundamental frequency component waveform of the "eee" spectrum at 77 Hz is shown in Fig. 5.3.

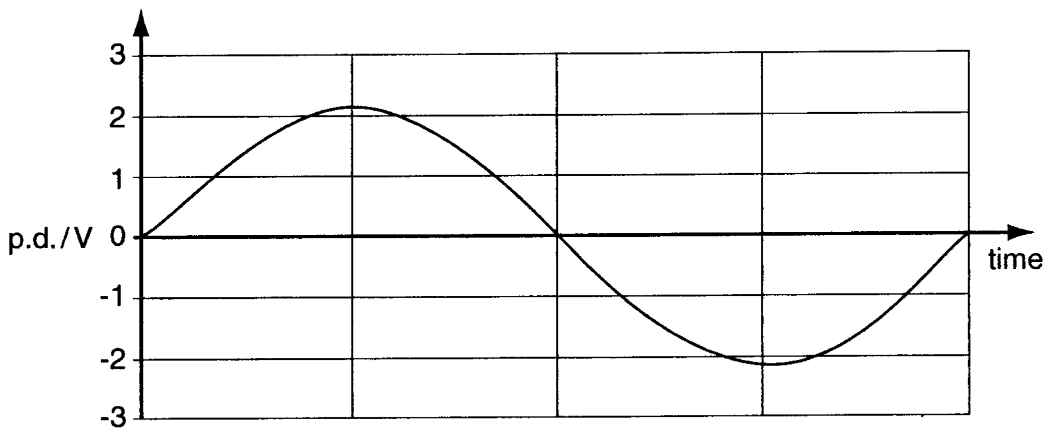


Fig. 5.3

Using information from Fig. 5.2, draw on Fig. 5.3 a waveform for the fourth harmonic component at 308 Hz at **four times** the fundamental frequency. [2]

For Examiner's Use

6 Three equal resistors each of 100 Ω resistance are connected in the circuit shown in Fig. 6.1.

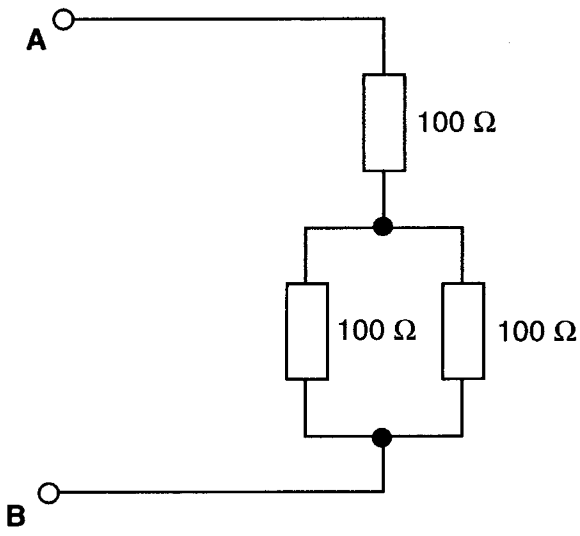


Fig. 6.1

(a) Calculate the total resistance of the circuit between points **A** and **B**.
Show your working.

resistance = ... Ω [2]

(b) The circuit is connected across a 12 V battery of negligible internal resistance.

Calculate the current drawn from the battery.

current = ... A [1]

[Section A Total: 20]

[Turn over

Section B

7 Read the paragraph below about the properties of spider silk.

Spider silk is a very strong material. It also requires a large energy to create new surface area or to break it. It is twice as strong as stainless steel, having a breaking stress of $2.0 \times 10^9\,N\,m^{-2}$. Yet, it can be stretched by more than one third of its original length and recover without permanent distortion.

(a) Here is a list of words describing mechanical properties of materials

elastic **hard** **plastic** **tough**

Choose **two words from this list** that best state the mechanical properties of spider silk as described in the paragraph.

.... and .... [2]

(b) A 'spiderwoman' weighs 550 N.

Calculate the **minimum** cross-sectional area of spider silk needed to support her weight.

cross-sectional area = ... m^2 [2]

(c) **(i)** Explain the meaning of *elastic limit* for a material.

[1]

(ii) At the elastic limit of spider silk, the strain is 0.35 and the stress is $1.6 \times 10^9\,N\,m^{-2}$.

Estimate the Young modulus for spider silk.

Young modulus = ... $N\,m^{-2}$ [2]

For Examiner's Use

(d) Spider silk consists of long chain polymer molecules.

Spider silk can 'be stretched by more than one third of its original length and recover without permanent distortion'.

(i) Sketch and label diagrams of a possible molecular structure for spider silk before and during stretching.

diagram of molecules before the silk is stretched

diagram of molecules while the silk is stretched

(ii) Describe how your proposed structure does enable spider silk to be stretched as described above.

[3]

[Total: 10]

For Examiner's Use

8 An active temperature sensor produces an emf $\mathcal{E}$ which depends on temperature. The points in Fig. 8.1 show how the emf varies with temperature. A straight line fitting the data up to 40 °C has been added to the graph.

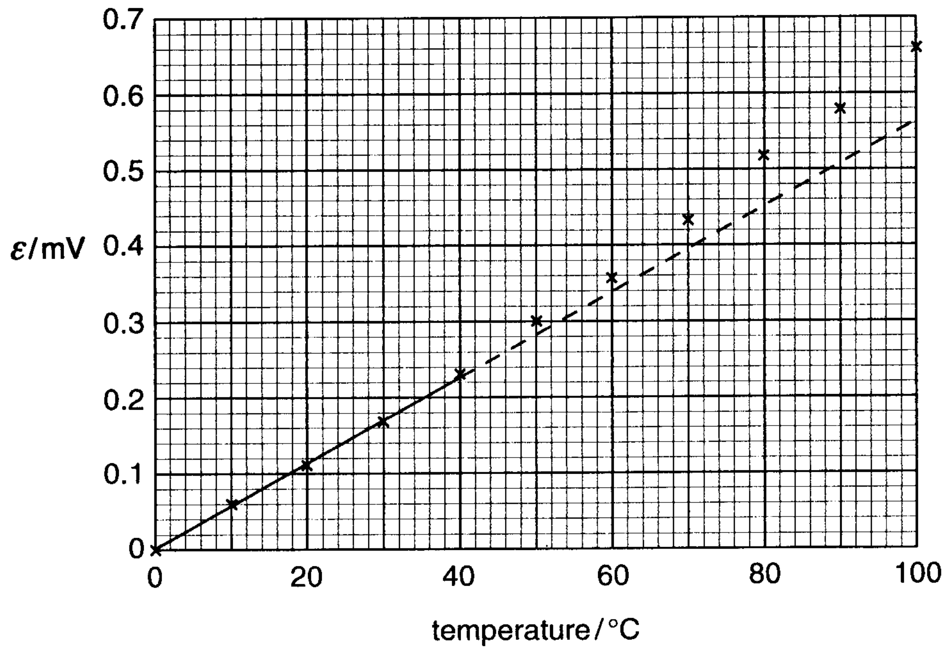


Fig. 8.1

(a) **(i)** Describe the relationship between the emf $\mathcal{E}$ and the temperature in °C shown by all the data points of Fig. 8.1.

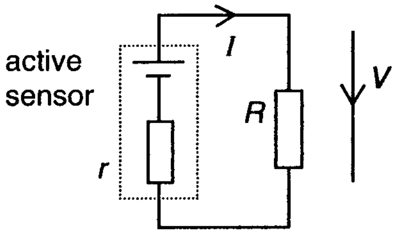
[2]

(ii) Estimate the **sensitivity** of the temperature sensor in the range 0 °C to 40 °C from the data points in Fig. 8.1.
Use units of μV °C^{-1} for the sensitivity.
Make your method of estimating the sensitivity clear.

sensitivity = ... μV °C^{-1} [2]

For Examiner's Use

(b) (i) Fig. 8.2 shows an active sensor of internal resistance r producing an emf $\mathcal{E}$ connected to an external resistance R.



The p.d. V across the sensor, and the current I in the circuit are given by the equations

$$V = \mathcal{E} - Ir \quad \text{and} \quad I = \frac{\mathcal{E}}{(R + r)}.$$

Fig.8.2

Combine the equations to show that $V = \dfrac{\mathcal{E} R}{(R + r)}$.

[2]

(ii) The active temperature sensor has internal resistance $r = 0.2\,\Omega$.
Using **(b)(i)**, show that if an instrument of external resistance $R = 10\,\Omega$ is used to measure the p.d. across the sensor, it will show a reading that is about 98% of the emf $\mathcal{E}$.

[2]

(c) Instruments available to measure the output from the temperature sensor are given in the table below.

instrument	full scale deflection	sensitivity	internal resistance
moving coil meter	300 mm	$10\,\mu V\,mm^{-1}$	$10\,\Omega$
cathode ray oscilloscope	100 mm	$1.0\,mV\,mm^{-1}$	$25\,M\Omega$
digital voltmeter	$200\,\mu V$	$0.1\,\mu V$ steps	$2.0\,M\Omega$

The most suitable of these instruments to use for this sensor in the temperature range 0 to 100 °C is the **moving coil meter**.
Give **two** reasons why the **moving coil meter** is the most suitable, using the data in the table.

[2]

[Total: 10]

[Turn over