OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS (B) (ADVANCING PHYSICS) 2860

Physics in Action

Friday **9 JUNE 2006** 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	**40**	
C	**30**	
TOTAL	**90**	

This question paper consists of 23 printed pages and 1 blank page.

[Turn over

Answer **all** the questions.

Section A

1 Here is a list of units.

kg m^{-3} J m^{-2} N m N m^{-2}

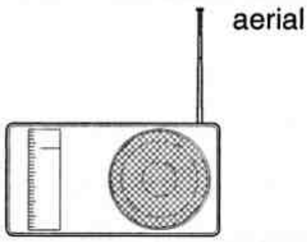
Choose the correct unit for

(a) Young modulus ....

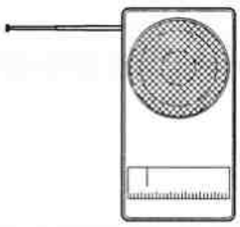
(b) density. .... [2]

2 A teacher uses a portable radio to demonstrate some properties of waves.
He tunes in to a VHF station.

(a) He obtains the strongest signal when the aerial is vertical as shown below.



However, the signal fades to a minimum when he rotates the radio through 90°, as shown below.

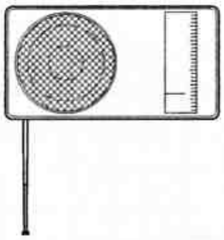


State the property of transverse waves that this experiment demonstrates.

[1]

For Examiner's Use

(b) The teacher rotates the radio once more through another 90°, as shown below.

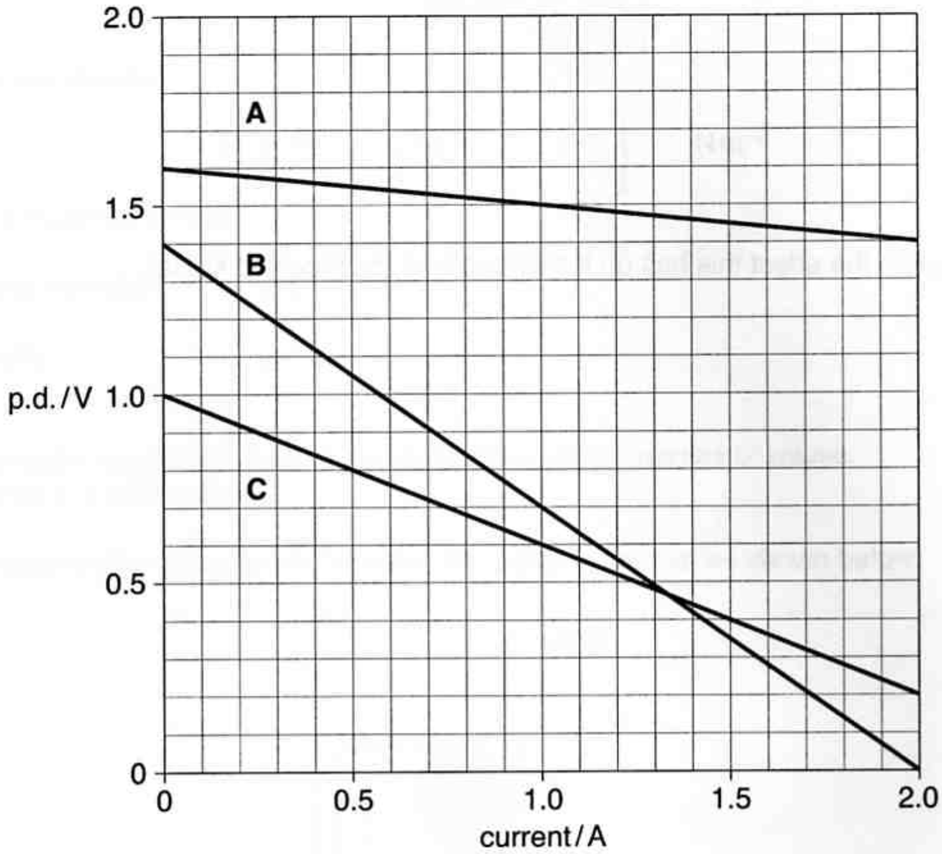


State and explain the effect this has on the strength of the received signal.

[2]

[Turn over

3 The graph below shows how the p.d. across three different cells **A**, **B**, and **C** decreases as more current is drawn from each.



State which of the cells **A**, **B** or **C**

(a) has the smallest emf ....

(b) will deliver the most electrical power at a current of 1.0 A ....

(c) has the smallest internal resistance. ....

[3]

4 Fig. 4.1 shows part of a scanning tunnelling microscope (STM). Electrons flow between a fine tip and the surface.

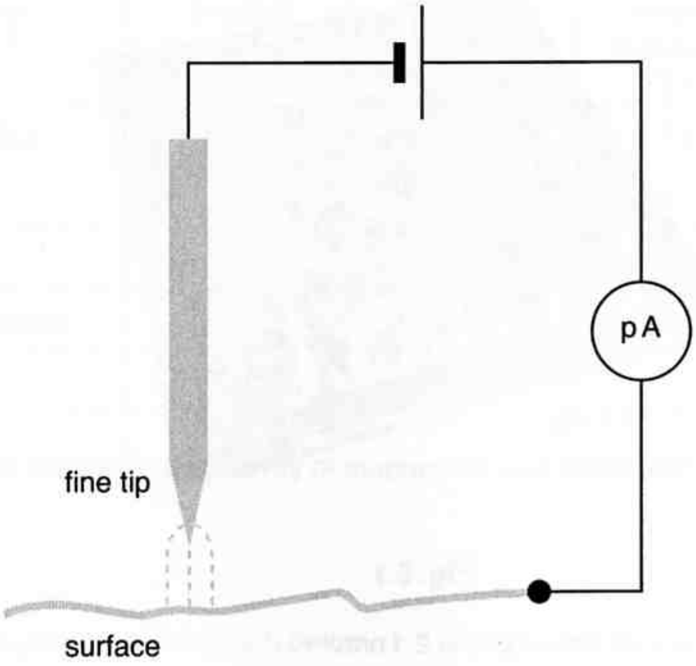


Fig. 4.1

20 million electrons per second flow between the tip and the surface.

Calculate the current in the circuit.

charge on electron, $e = 1.6 \times 10^{-19}$ C

current = ... A [2]

5 Fig. 5.1 shows an STM image of 34 iron atoms arranged in a rectangle on a copper surface.

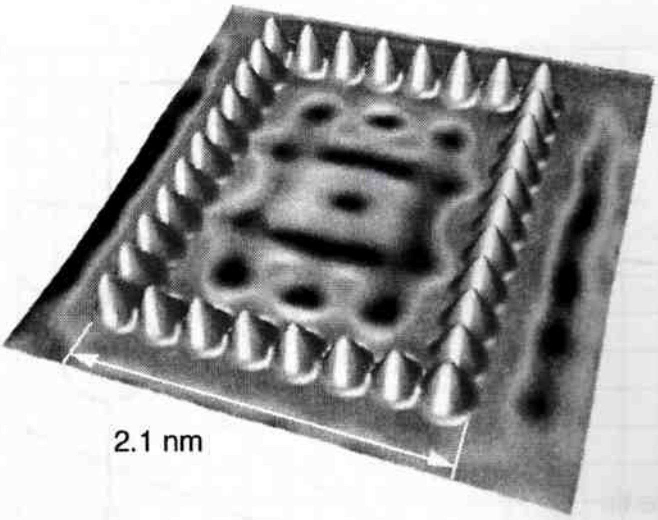


Fig. 5.1

The length of the front row of iron atoms is 2.1 nm.

Calculate the diameter of an iron atom.
Give your answer to 2 significant figures.
Show your working clearly.

diameter of iron atom = ...m [2]

For Examiner's Use

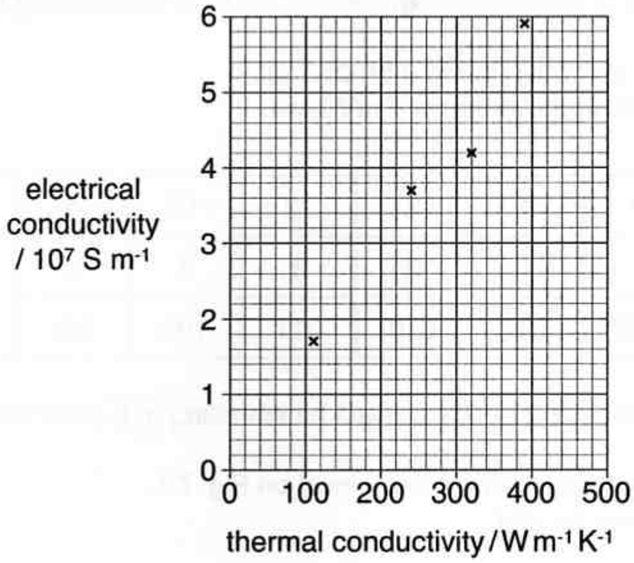
6 The table shows the thermal and electrical conductivities of five pure metals.

	thermal conductivity / $W\,m^{-1}\,K^{-1}$	electrical resistivity / Ω m	electrical conductivity / $S\,m^{-1}$
aluminium	240	2.7×10^{-8}	3.7×10^{7}
copper	385	1.7×10^{-8}	5.9×10^{7}
gold	310	2.4×10^{-8}	4.2×10^{7}
magnesium	150	4.0×10^{-8}	
zinc	110	5.9×10^{-8}	1.7×10^{7}

(a) Calculate the electrical conductivity of magnesium and record the value in the table.

[1]

(b) The data are plotted on the graph below.



Plot the point for magnesium on this graph. [1]

(c) **(i)** State the trend shown by this graph.

[1]

(ii) What microscopic feature of metals explains this trend?

[1]

7 This question is about sampling an analogue signal and converting it into a binary digital code. The signal to be sampled is shown in Fig. 7.1.

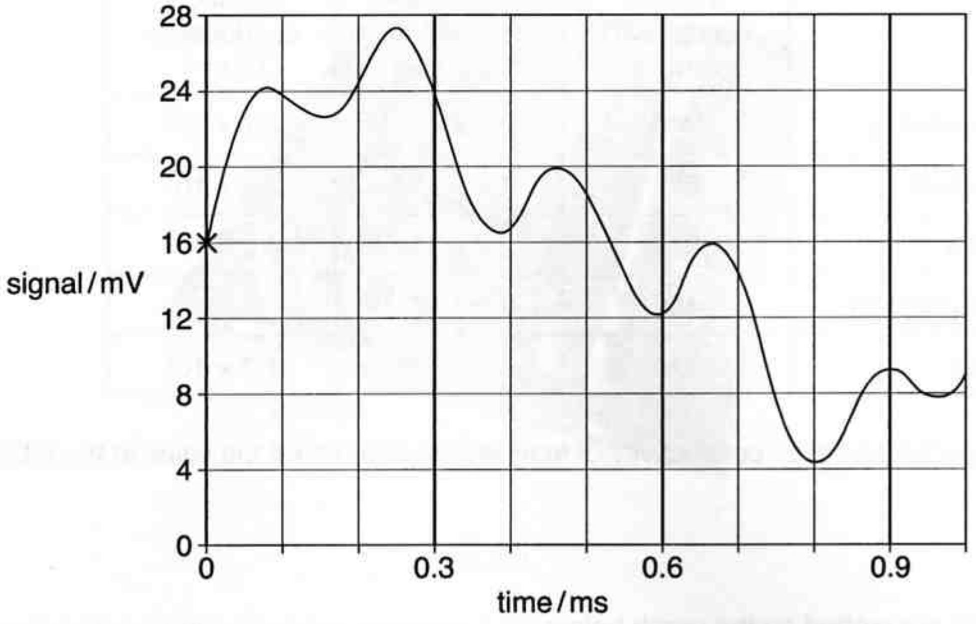


Fig. 7.1

The analogue signal is to be coded using 3 bit coding.
Each sample is to be taken to the **nearest** 4 mV level.

closest voltage / mV	0	4	8	12	16	20	24	28
level	0	1	2	3	4	5	6	7
binary code	000	001	010	011	100	101	110	111

(a) Sample the signal shown in Fig. 7.1 using 3 bit sampling at 0.3 ms intervals.

Plot your sampling points to the **nearest** 4 mV level on Fig. 7.1.
The first one has been done for you. [2]

(b) **(i)** Complete the first 9 bits of the digital code, for the first three samples at times 0.0, 0.3 and 0.6 ms in that order.
The first sample has been done for you.

1	0	0						

[1]

(ii) Suggest **one** way that a signal reconstructed from this digital code would be different from the original signal shown in Fig. 7.1.

[1]

[Section A Total: 20]

Section B

8 This question is about the heated **front windscreen** of a car.
The heater consists of resistance wires which are embedded in the glass.

(a) The power of the heater needs to be 180 W for satisfactory de-misting.

A car battery of negligible internal resistance supplies 12 V to operate the heated screen.

(i) Calculate the current required to deliver a power of 180 W.

current = ... A [2]

(ii) Show that the resistance of the heater when operating is about 1 Ω.

[2]

[Turn over

(b) The heater consists of 200 wires inside the glass.
These wires are connected in parallel to the 12 V supply as shown in Fig. 8.1.

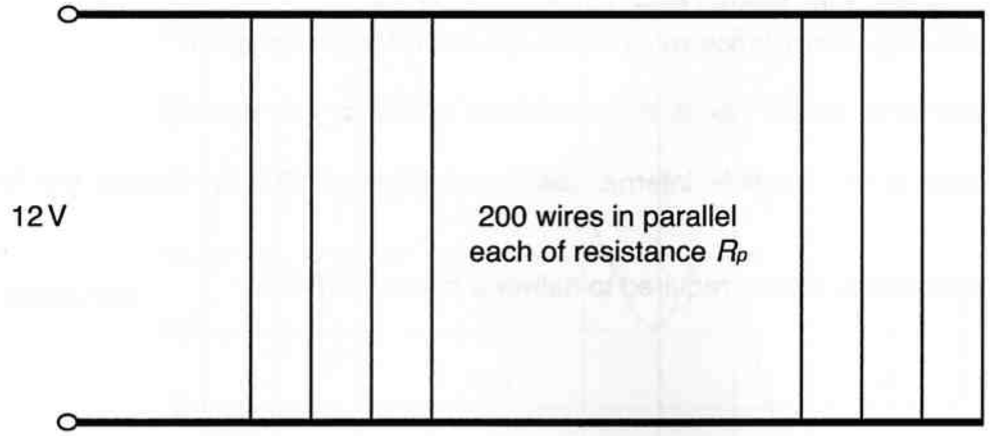


Fig. 8.1

Each of the 200 wires has a length of 0.70 m and resistance R_p of 160 Ω.

The material of the wire has resistivity $\rho = 6.0 \times 10^{-7}\,\Omega\,m$.

Calculate the **diameter** of the wire.

diameter = ... m [4]

(c) An alternative design has a heater of the **same power** rating. The wires are connected in **series** as shown in Fig. 8.2.

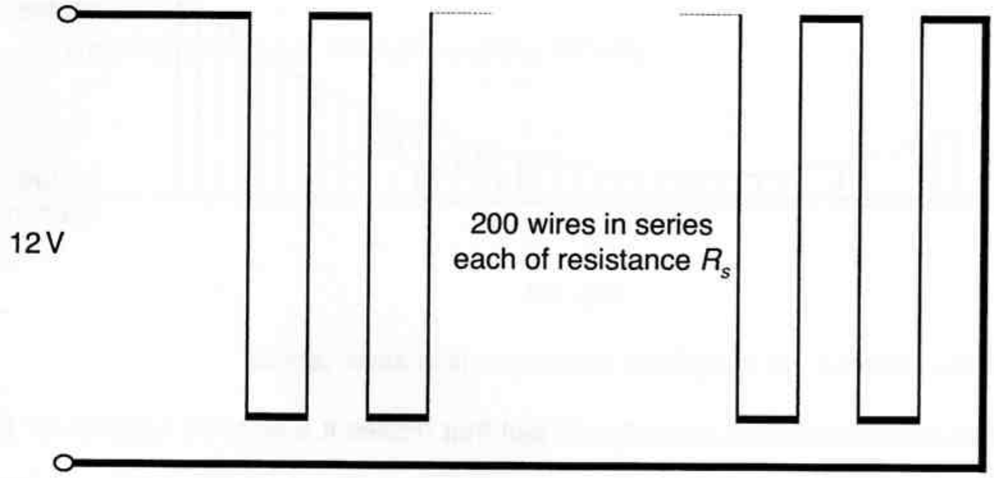


Fig. 8.2

The 200 wires are made of the **same material**, are each of length 0.7 m, but of resistance R_s.

(i) Calculate the resistance R_s of each wire in this series arrangement, required to keep the resistance of the heater about 1 Ω.

R_s = ... Ω [1]

(ii) This series design would not work in this application, because the wires would have to be so thick that they would block the driver's vision.

Justify this statement.

[2]

[Total: 11]

For Examiner's Use

9 Fig. 9.1 shows a diagram of part of a suspension bridge.

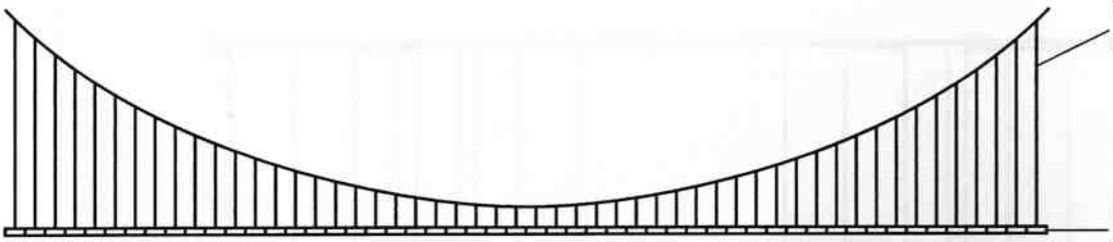


Fig. 9.1

(a) (i) Bridge sections are hung from uniform vertical steel cables.

State **one** mechanical property of steel that makes it a suitable material for these vertical cables.

....[1]

(ii) Explain why this property is important.

[1]

(b) Two vertical cables support each bridge section as shown in Fig. 9.2.

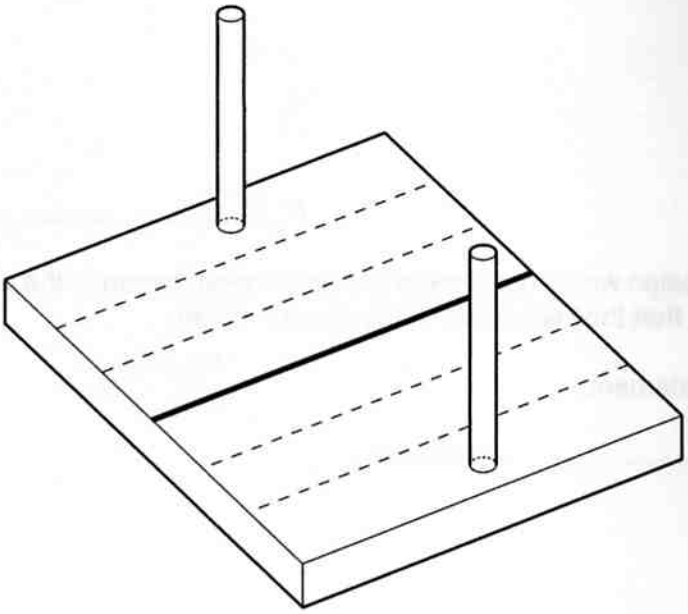


Fig. 9.2

(i) Each bridge section weighs 1.8 MN.
This weight causes a stress in each cable of 1.3×10^8 Pa.

Show that the cross-sectional area of **each** cable is about $7 \times 10^{-3}\,m^2$.

[3]

(ii) The longest vertical cables of the bridge are 150 m in length.

Calculate the extension of these cables when the bridge section is attached.

The Young modulus for steel = 2.1×10^{11} Pa.

extension = ... m [3]

(c) (i) Fig. 9.3 shows one freely hanging uniform vertical cable **before the bridge section is added**.

Suggest why the stress in the cable at **P** is greater than the stress at **Q**.

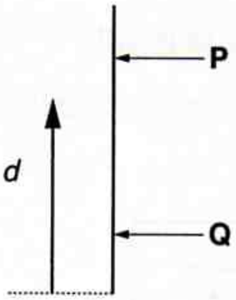
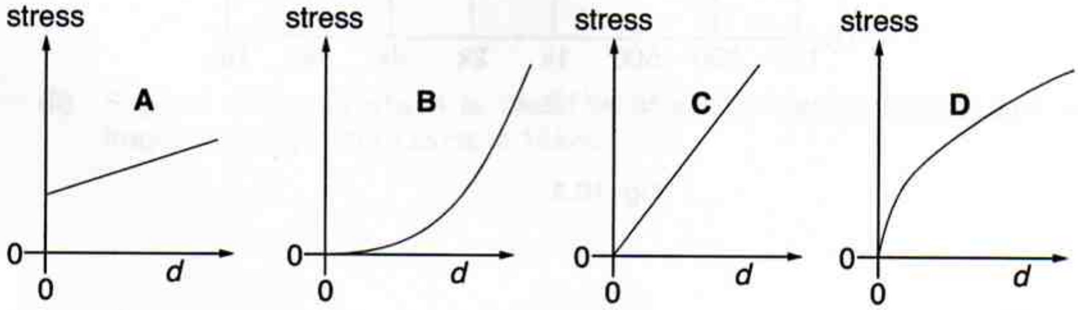


Fig. 9.3

[1]

(ii) Here are four graphs, **A, B, C, D.**

Select the graph which best represents how the stress in the vertical cable (y-axis) varies with distance *d* from the **bottom** of the cable (x-axis) **before the bridge section is added**.



answer .... [1]

[Total: 10]

For Examiner's Use

10 This question is about sound absorption in the home.
Fig. 10.1 shows a diagram of the construction of a sound-absorbing panel.

It consists of acoustic wool and strips of wood sandwiched between plasterboard sheets.
Fig. 10.2 shows the sound reduction achieved across a range of frequencies.

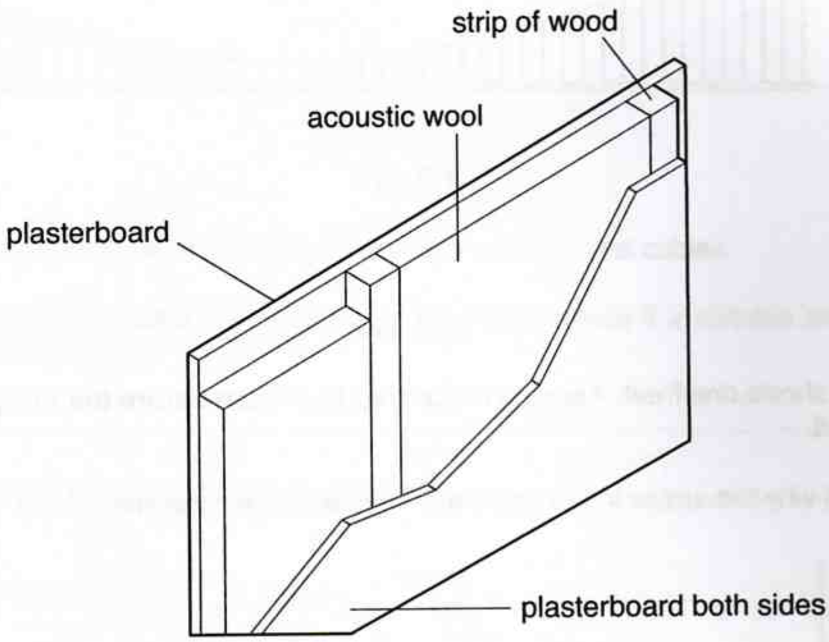


Fig. 10.1

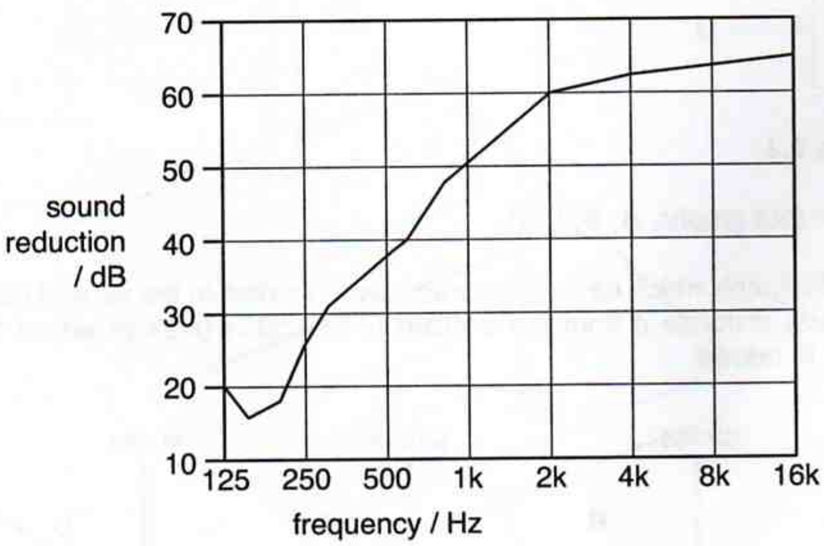


Fig. 10.2

For Examiner's Use

(a) (i) Acoustic wool consists of a flexible mat of fibres in air as shown in Fig. 10.3.

Fig. 10.3

Suggest a reason why acoustic wool is good at absorbing sound energy.

[1]

(ii) Wood transmits sound **much better** than acoustic wool.

Suggest a reason why wood is needed for the construction of the panel.

[1]

(b) (i) The frequency scale of Fig. 10.2 is logarithmic.

What feature of the scale shows this?

[1]

(ii) Suggest a reason why it is useful to display sound absorption data over the frequency range from 125 Hz to 16 kHz.

[1]