OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS B (ADVANCING PHYSICS) 2860

Physics in Action

Monday **12 JANUARY 2004** Morning 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 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.

For Examiner's Use

Answer **all** the questions.

Section A

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

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

From the list

(a) write down the unit for electric potential difference ....

(b) write down a unit for electric current. .... [2]

2 A portable MP3 player has a memory of 64 Mbytes.
A song requires about 2 Mbytes of memory for storage in the MP3 player.

(a) Estimate the number of songs that the MP3 memory can store.

number of songs = ... [1]

(b) The same song on a CD is sampled at 44.1 kHz using 4 bytes per sample.
The song lasts for 150 s.

(i) Show that the information stored on the music CD is about 26 Mbytes.

[2]

(ii) Suggest **one** way in which the amount of memory needed to store a song can be reduced.

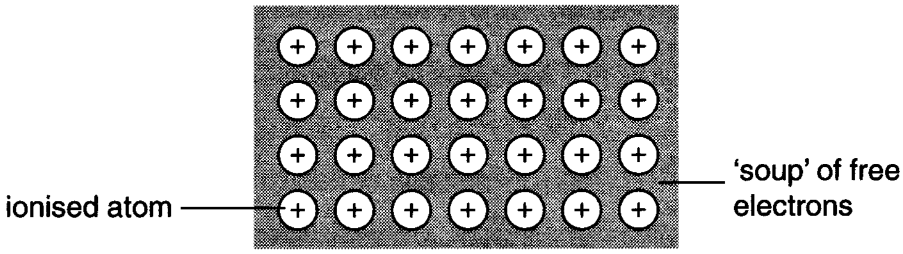
[1]

3 The diagrams below illustrate the microstructure of three different types of material. Here is a list of different types of material.

glass ionic crystal metal rubber

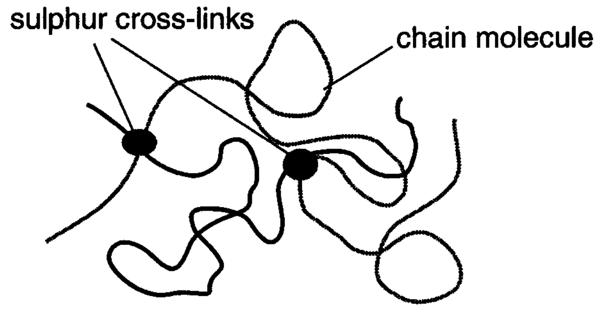
Choose from the list the type of material that best matches each microstructure.

(a)



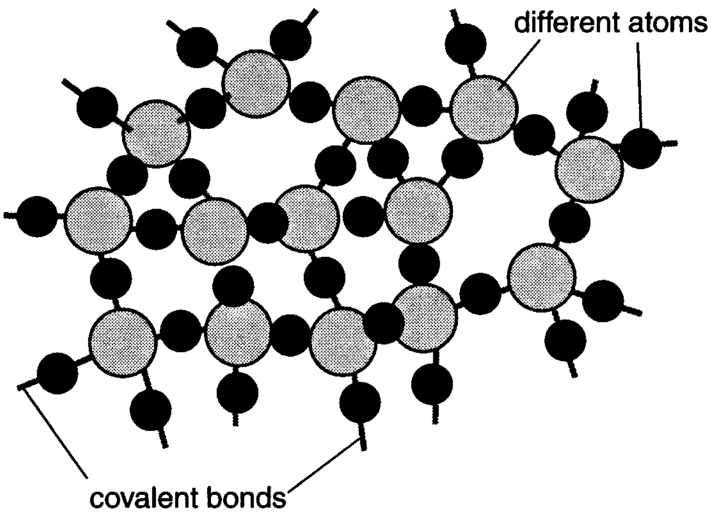
material ....

(b)



material ....

(c) Covalent bonds share electrons between neighbouring atoms. These bonds are directional: they lock atoms in place like scaffolding.



material ....

[3]

4 Jon measures the focal length f of a convex lens. He repeats the measurement several times. The mean value of the measurement is 0.125 m. The range over which the measurements vary due to experimental uncertainty is $\pm$ 0.005 m.

Jon correctly records the final result with the equation

$$f = 0.125 \pm 0.005\,\text{m}.$$

(a) The minimum value for f indicated by this equation is 0.120 m.

Write down the maximum value for f indicated by this equation.

maximum value for f = ...m [1]

(b) Jon calculates the power P of the lens using the relationship

$$P = \frac{1}{f}.$$

For the mean value $f = 0.125\,\text{m}$ $P = 8.00\,\text{D}$.

Calculate the maximum value of the power corresponding to the minimum value of the focal length 0.120 m. Consider sensible **significant figures.**

maximum power = ...D [1]

(c) Complete the equation below to indicate the range of values within which the power can be expected to lie.

P = 8.0 $\pm$ .... D [1]

For Examiner's Use

5 Fig. 5.1 shows an analogue voltage signal varying in time. It is sampled every 1.0 ms for conversion into a digital signal.

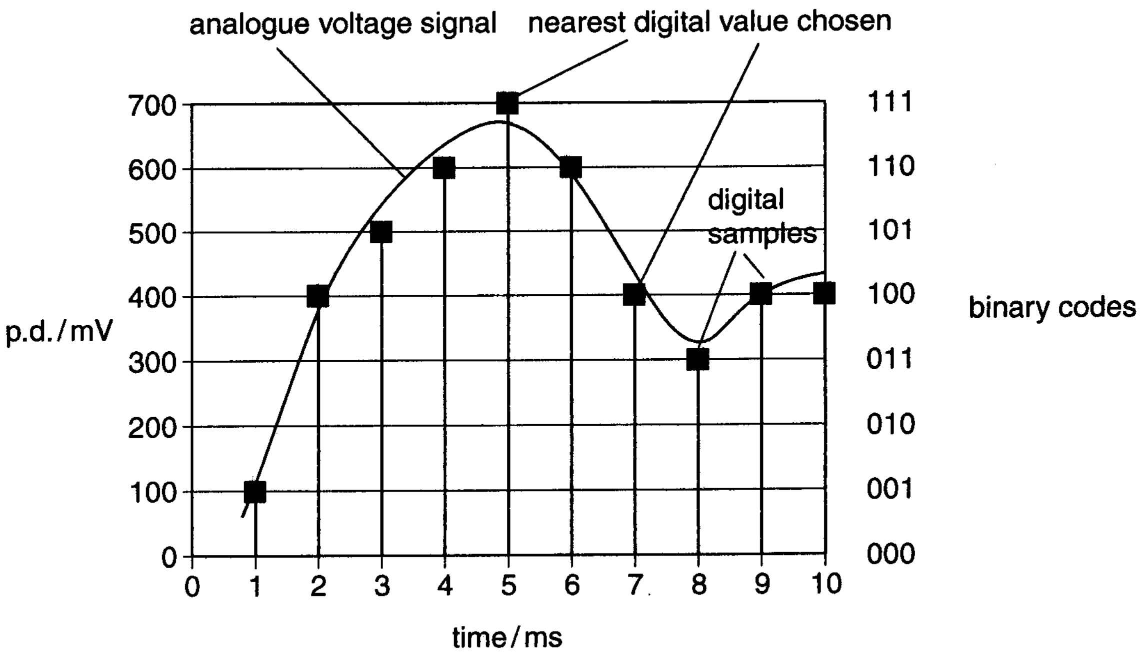


Fig. 5.1

(a) (i) State the number of bits used for the binary code of each sample in Fig. 5.1.

number of bits per sample = ... [1]

(ii) State the number of different signal levels defined by this number of bits.

number of signal levels = ... [1]

(b) Fig. 5.1 illustrates that the digital signals, introduced during digital sampling, can differ from the analogue signal.

(i) State the largest difference (measured in mV) that could be introduced in this example.

largest difference = ... mV [1]

(ii) Suggest **one** way in which these differences could be reduced to make the sampling more accurate.

[1]

[Turn over

For Examiner's Use

6 The electrical power P dissipated in a resistor R, with a potential difference V across it, can be calculated using

$$P = \frac{V^2}{R}.$$

Here is a list of multiplying factors.

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

Choose the factor that best completes each of the two statements given below.

(a) When resistance R is kept constant, and the p.d. V is halved,

the power P will be multiplied by .... [1]

(b) When p.d. V is kept constant, and the resistance R is halved,

the power P will be multiplied by .... [1]

7 A spectrum analyser displays the intensity of sound in five ranges from low (bass) to high (treble). Fig. 7.1 shows the display.

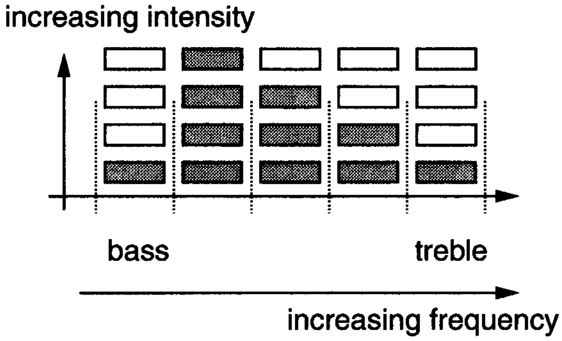


Fig. 7.1

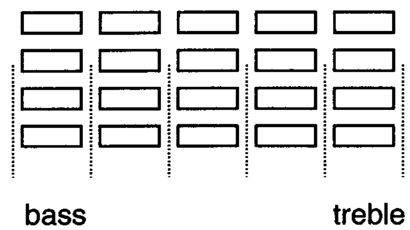


Fig. 7.2

More bars on the display shown in Fig. 7.1 light up when the sound in that frequency range is more intense. The lit up bars are shown as shaded.

Fig. 7.1 shows the display at one instant during the playback of a song on an audio system.

The listener then **boosts the bass** and **filters out the treble**.

Sketch on Fig. 7.2 a possible appearance of the spectrum analyser after this change, at the same instant of the new playback of the song.

[2]

[Section A Total: 20]

For Examiner's Use

Section B

8 Fig. 8.1 shows how the resistance of a thermistor varies with temperature.

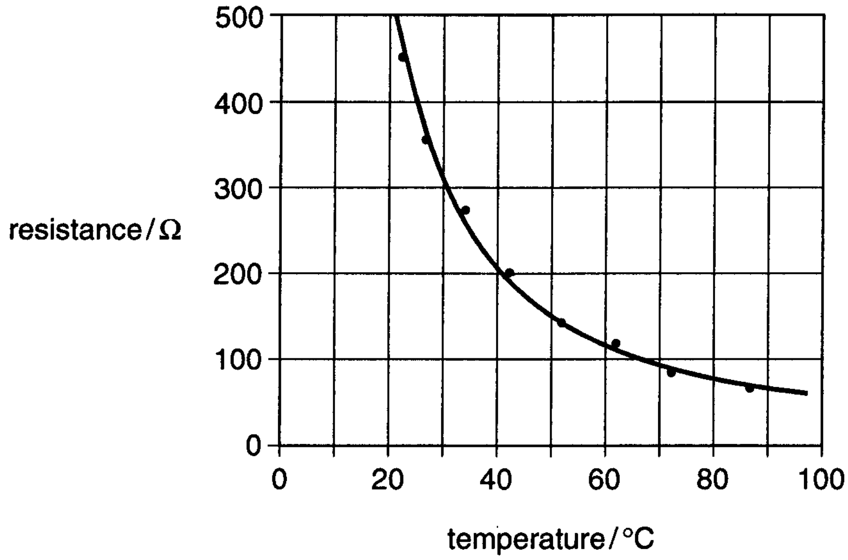


Fig. 8.1

(a) Complete the following description of the graph.

As the temperature of the thermistor rises, its resistance ....

The change in resistance between 80 °C and 90 °C is about 15 Ω, the change in resistance between 30 °C and 40 °C is about .... Ω.

On Fig. 8.1, the thermistor shows **greatest** sensitivity to temperature change when the temperature is .... [3]

(b) Fig. 8.2 shows this thermistor together with a resistor in a temperature sensing potential divider circuit.

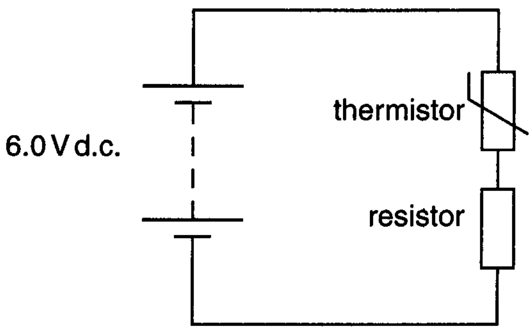


Fig. 8.2

(i) A voltmeter is to be connected to the circuit to indicate an **increasing** p.d. when the sensor detects an increasing temperature.

On Fig. 8.2, draw the circuit connections for a voltmeter to measure a p.d. that **rises** with increasing temperature. [1]

For Examiner's Use

(ii) The value of the resistor in Fig. 8.2 is 200 Ω. The thermistor is at 65 °C.

Show that the current drawn from the 6.0 V supply is about 0.02 A.
Use data from Fig. 8.1.

[3]

(iii) Calculate the p.d. across the 200 Ω resistor at 65 °C.

p.d. across resistor = ... V [1]

(c) The graphs **X, Y** and **Z** in Fig. 8.3 show how the p.d. across the resistor varies with temperature, for three different values of the resistor.

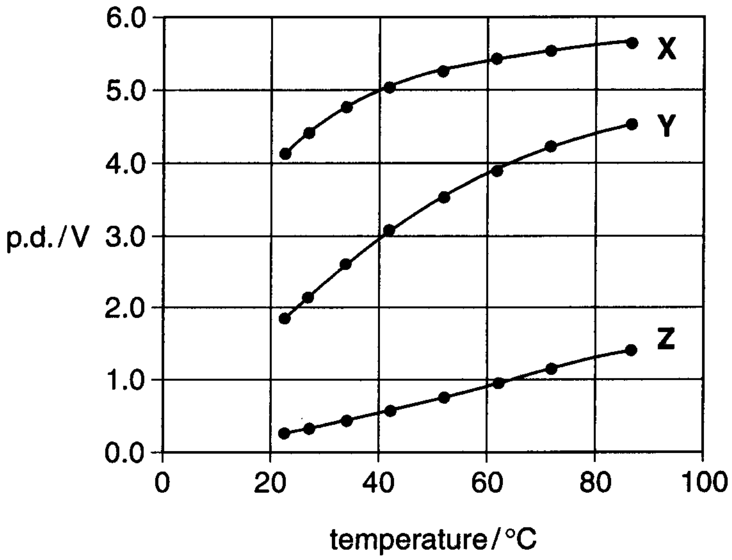


Fig. 8.3

(i) The values of resistance used are 20 Ω, 200 Ω and 1000 Ω.

State which graph, **X, Y** or **Z**, is the curve for the 1000 Ω resistor. .... [1]

(ii) State **one** advantage and **one** disadvantage of using output **Z** for the temperature sensing circuit.

advantage

disadvantage

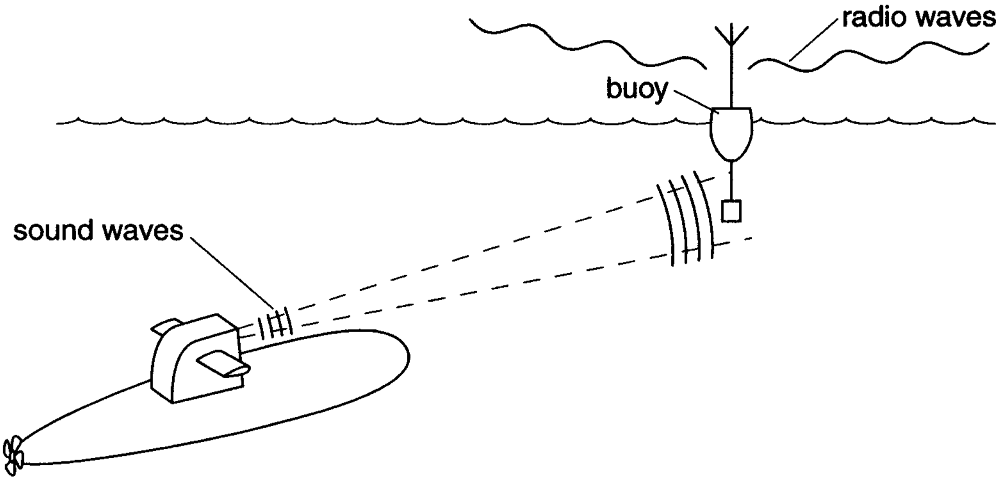
[2]

[Total: 11]

[Turn over

For Examiner's Use

9 Radio waves cannot be transmitted through water, but submarines can now transmit and receive e-mails, without having to surface.



An 'acoustic modem' on the submarine transmits sound waves through water, at a frequency of 8.0 kHz. The waves carry information at 2.4 kbit s^{-1} to a radio buoy. The information is relayed from the buoy to shore by radio waves. The buoy can also receive radio signals, and transmit the information as sound waves back to the submarine.

(a) Show that the wavelength of the 8.0 kHz sound waves in sea water is about 0.2 m.

speed of sound in sea water = 1500 m s^{-1}

[3]

(b) The sound waves travel 5.0 km from the submarine to the buoy.

Calculate the time taken for the sound waves to travel this distance.

time taken = ... s [2]

For Examiner's Use

(c) A typical e-mail message contains 1500 bytes of information.

Calculate the time taken to transmit the e-mail at 2.4 kbit s^{-1}.

time to transmit = ...s [2]

(d) Suggest and explain reasons why a live two-way video picture link **cannot** be supported by this underwater signalling system, although still pictures **can** be transmitted.

[3]

[Total: 10]

For Examiner's Use

10 This question is about materials that have been used to build railway tracks.

Railway tracks must withstand the effects of metal train wheels running along them. The first metal tracks, which were made of cast iron, were **hard** but also **brittle** and often broke. These were replaced by wrought iron, which is **stronger** and **tougher**.

(a) State what is meant by the following words from the passage.

brittle

hard

strong

tough

[4]

For Examiner's Use

(b) More recently, steel has replaced wrought iron as the material for railway tracks. The table gives data for wrought iron and steel.

material	toughness / J m^{-2}	strength / MN m^{-2}
wrought iron	4000	350
steel	16000	430

(i) Look at the data in the table.

State the **main** reason why steel replaced wrought iron as the preferred material for railway tracks.

[1]

(ii) Suggest why toughness is measured in units J m^{-2}.

[2]

(c) Fig. 10.1 shows how stress varies with strain for the three materials, cast iron, wrought iron and steel.

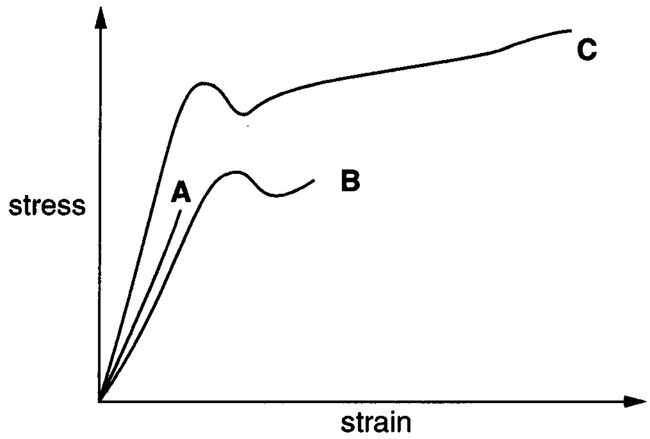


Fig. 10.1

(i) State which graph, **A, B** or **C**, best represents wrought iron .... [1]

(ii) Explain your choice of graph.

[1]

[Total: 9]

For Examiner's Use

11 Fig. 11.1 shows the illumination system of an overhead projector used to illuminate the transparency uniformly.

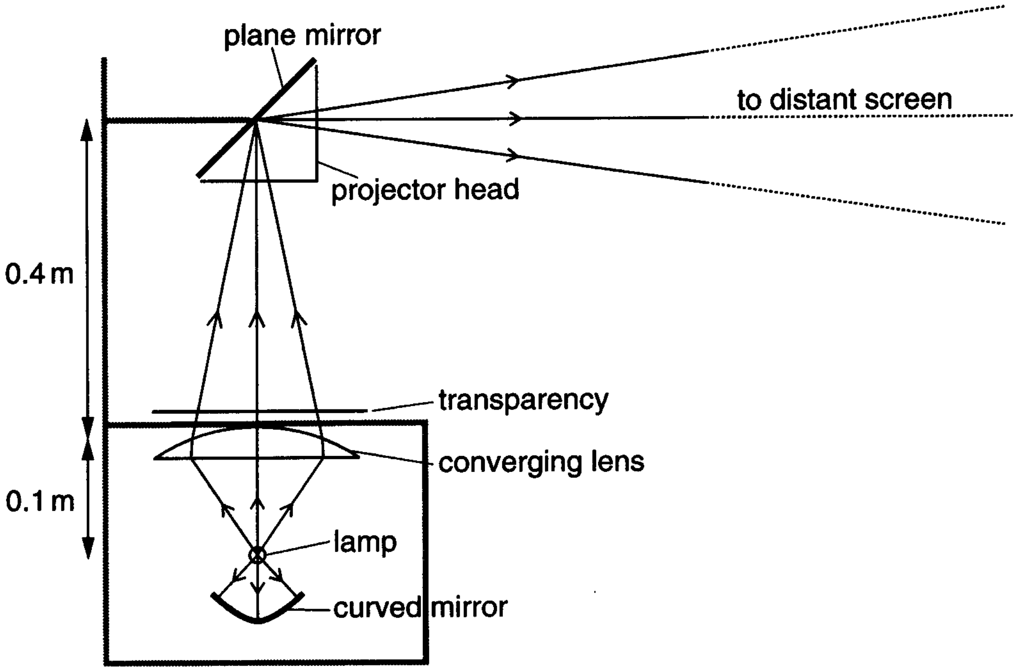


Fig. 11.1

The questions below consider the effects of only the lamp, curved mirror, and converging lens below the transparency. (Effects of lenses in the projector head, which focus an image of the transparency can be ignored.)

(a) The lamp emits light in all directions.

Suggest and explain a purpose for the curved mirror that is placed below the lamp.

[2]

(b) A real image of the lamp is focused onto the plane mirror.
The lamp (object) is 0.1 m below the lens and the centre of the plane mirror (image position) is 0.4 m above the lens.

Calculate the power of the converging lens needed to achieve this.

power of lens = ... unit .... [4]

For Examiner's Use

(c) A conventional glass lens, as drawn in Fig. 11.1 would need to be quite thick in the middle to achieve this power. It would also be very heavy.

In reality the lens is made from a thin layer of material with curvatures impressed on the top surface as shown in Fig. 11.2 (this is called a Fresnel lens). These have the same refracting effect as a conventional converging lens of glass.

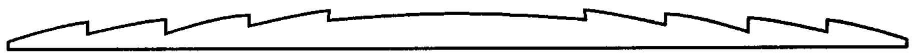


Fig. 11.2

A designer is considering different materials from which this Fresnel lens might be made.

Suggest and explain **two** important **physical** properties that this material should possess.

first property

explanation

second property

explanation

[4]

[Total: 10]

[Section B Total: 40]

Section C

In this section, you will choose the context in which you give your answers.

Use diagrams to help your explanations and take particular care with your written English. In this section, four marks are available for the quality of written communication.

12 This question is about an experiment to measure

either the Young modulus **or** the electrical conductivity

of a material of your choice.

(a) (i) State the material and circle the physical property above that you have chosen.

material ....

(ii) Describe with the aid of a diagram, the shape required for the sample of material.

[1]

(iii) Justify the shape of the sample of material you have chosen to use.

[1]

(iv) Add estimates of important linear dimensions to your diagram in **(a)(ii)**.

[2]

(v) State the instrument you would choose to measure the smallest of these linear dimensions, justifying your choice.

instrument ....

justification

[2]

For Examiner's Use

(b) **(i)** Suggest an experimental difficulty, other than measuring linear dimensions, that needs to be overcome in making a good measurement of your chosen physical property.

[1]

(ii) Describe how this difficulty can be overcome in practice.

[2]

(c) **(i)** State the quantities, in addition to specimen dimensions, that you need to measure, to complete your calculation of the value of the physical property.

[2]

(ii) Write down using words or symbols the equation you would use to calculate the physical property.

[2]

[Total: 13]

For Examiner's Use

13 This question is about an imaging system, producing data that can be stored and displayed by a computer.

(a) (i) State your own example of such an imaging system.

(ii) Describe **three** uses of the images produced by this imaging system.

[4]

(b) (i) State the kind of waves or radiation used in obtaining the image.

[1]

(ii) Describe how the data for the image are obtained.
You may find it useful to use a labelled diagram.

[3]

(c) **(i)** Explain the meaning of the term **resolution** of an image.

[1]

(ii) Estimate the resolution of the image that you have chosen.

resolution = ... [1]

(d) State and explain **one** way in which your image could be enhanced by image processing.

[3]
[Total: 13]

Quality of Written Communication [4]

[Section C Total: 30]