THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

PHYSICS B (ADVANCING PHYSICS) 2860

Physics in Action

*C U P / T 5 0 1 1 0 *

Candidates answer on the question paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Protractor
- Ruler (cm/mm)

Tuesday 13 January 2009
Afternoon

Duration: 1 hour 30 minutes

2860

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- 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.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

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 **90**.
- You are advised to spend about 20 minutes on Section A, 40 minutes on Section B and 30 minutes on Section C.
- 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.
- This document consists of **20** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Section	**Max.**	**Mark**
A	**19**	
B	**41**	
C	**30**	
TOTAL	**90**	

Answer **all** the questions.

Section A

1 Here is a list of units

$$\mathbf{J\,m^{-2}} \qquad \mathbf{kg\,m^{-3}} \qquad \mathbf{N\,m^{-1}} \qquad \mathbf{N\,m^{-2}}$$

Choose the correct unit for the following quantities

(a) density .....

(b) Young modulus .....

(c) toughness. ..... **[3]**

2 Three image processing techniques that can be used to process images are

A replacing each pixel value with the average of the surrounding pixel values

B replacing each pixel value with the median of the surrounding pixel values

C replacing each pixel value with a weighted difference between its value and that of the surrounding pixels.

State the method that would be most suitable for

(a) removing specks of random noise from an image from a satellite camera .....

(b) identifying the edges of craters on an image of the moon. .....

[2]

3 A musical note is recorded. Fig. 3.1 shows the waveform over a time interval of 10 ms displayed on a computer screen.

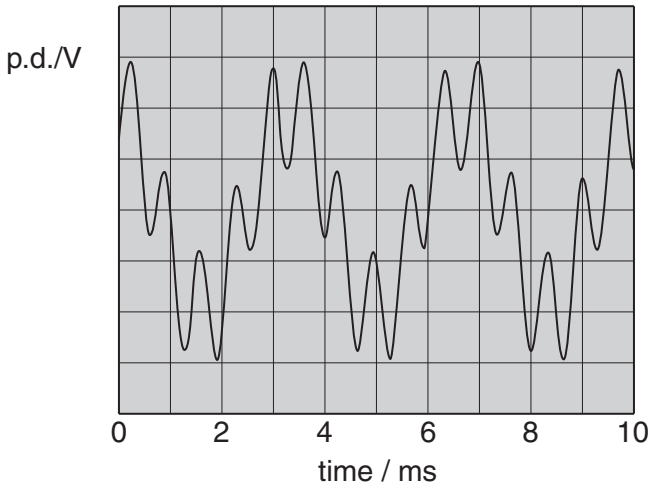


Fig. 3.1

(a) Estimate the **highest** frequency present in the waveform.

Make your method clear.

highest frequency = ... Hz **[2]**

(b) Fig. 3.2 represents part of the frequency spectrum of this musical note. It shows only the **lowest** frequency component.

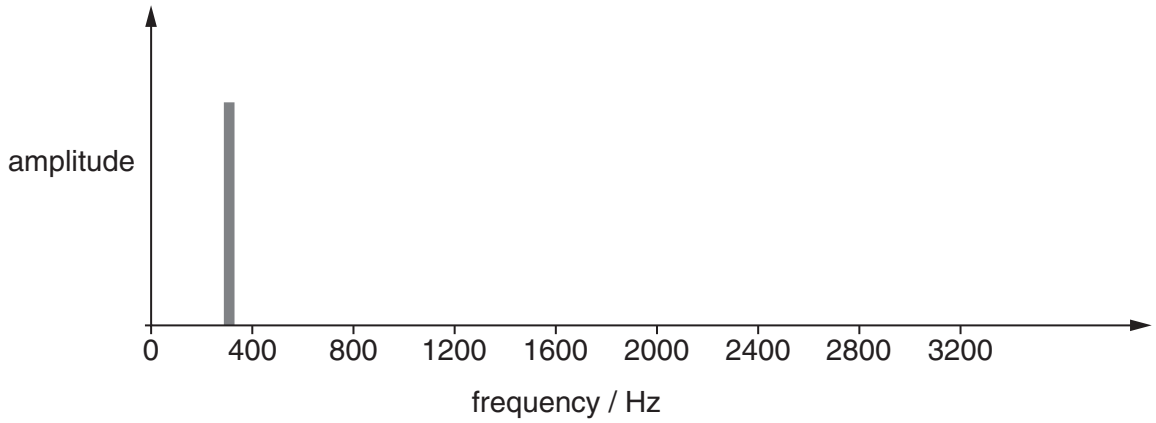


Fig. 3.2

Draw on Fig. 3.2 the highest frequency component you estimated in **(a)**. **[2]**

4 Fig. 4.1 shows the result of plane wavefronts passing through a converging lens.

The lens is replaced with one of the same shape and dimensions, made from a material with a **higher** refractive index.

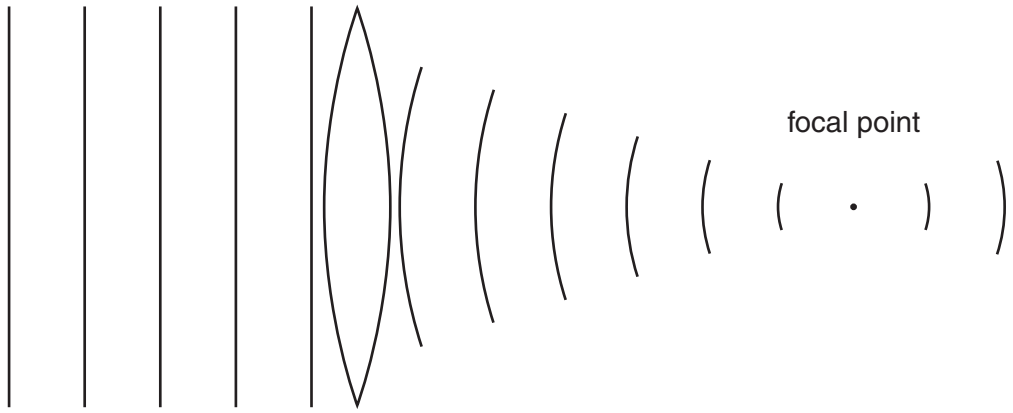


Fig. 4.1 (not to scale)

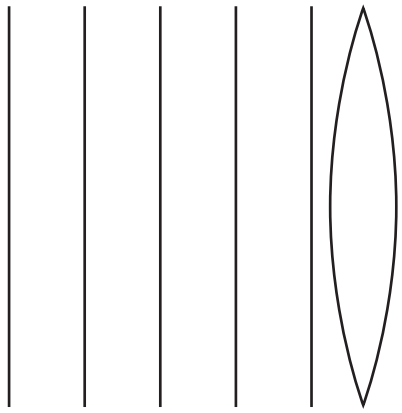


Fig. 4.2 (**higher** refractive index)

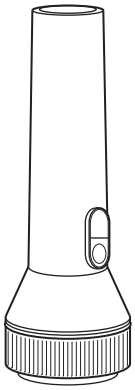
(a) Complete Fig. 4.2 to show the wavefronts to the right of the lens with the **higher** refractive index.

[2]

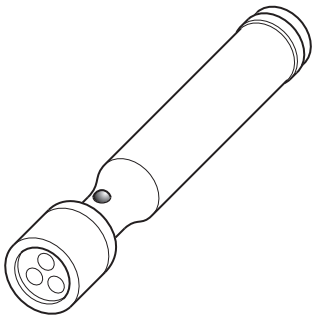
(b) State with a reason whether the power of this lens is larger, smaller or the same as that of the original lens.

[1]

5 Two torches produce similar intensities of illumination using different light sources.



filament lamp torch



LED torch

Each torch has an identical rechargeable cell which can store 14 000 J of energy.
The cell in the filament lamp torch draws power from its cell at 0.80 W and the LED torch at 0.10 W

(a) Calculate the maximum time in hours the cell can run the filament lamp.

maximum time = ... hours **[2]**

(b) Suggest one advantage of using LEDs rather than the filament lamp in a torch.

[1]

6 Figs. 6.1 and 6.2 show two digital CCD images of the same region of the surface of Mars. Fig. 6.1 was taken 20 years ago.
Fig. 6.2 was taken recently with an improved satellite camera.

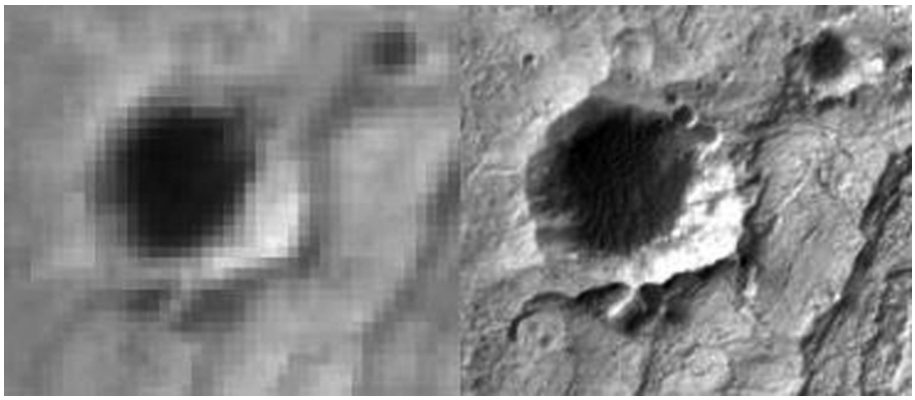


Fig. 6.1 **Fig. 6.2**

(a) State **one** significant improvement in the more recent image Fig. 6.2.

[1]

(b) Suggest a difference in the two satellite cameras that could account for this improvement.

[1]

7 Two samples of similar size and shape of different polymers are stretched to test their stiffness. Figs. 7.1 and 7.2 show diagrams of their internal structure.

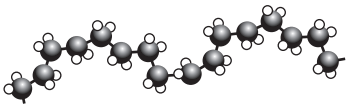


Fig. 7.1 Polythene

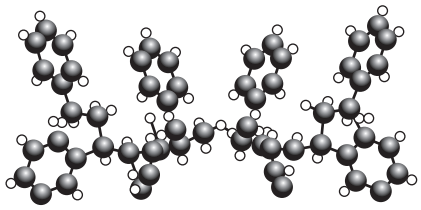


Fig. 7.2 polystyrene

Fig. 7.1 shows Polythene. It has long chain molecules which can be folded up. The bonds in the chain can rotate freely.

Fig. 7.2 shows polystyrene. It has long chain molecules which have bulky side rings. The rings make it difficult for the bonds in the chain to rotate freely.

(a) State **one** difference you would expect to find in the mechanical properties of the samples of the two polymers.

[1]

(b) Suggest a reason for this difference using the information given about the two different polymers.

[1]

[Section A Total: 19]

Section B

8 This question is about the properties of mild steel bars.

A sample of mild steel is tested in the laboratory. Fig. 8.1 shows the stress versus strain graph obtained when a bar is stretched in a tensile testing machine.

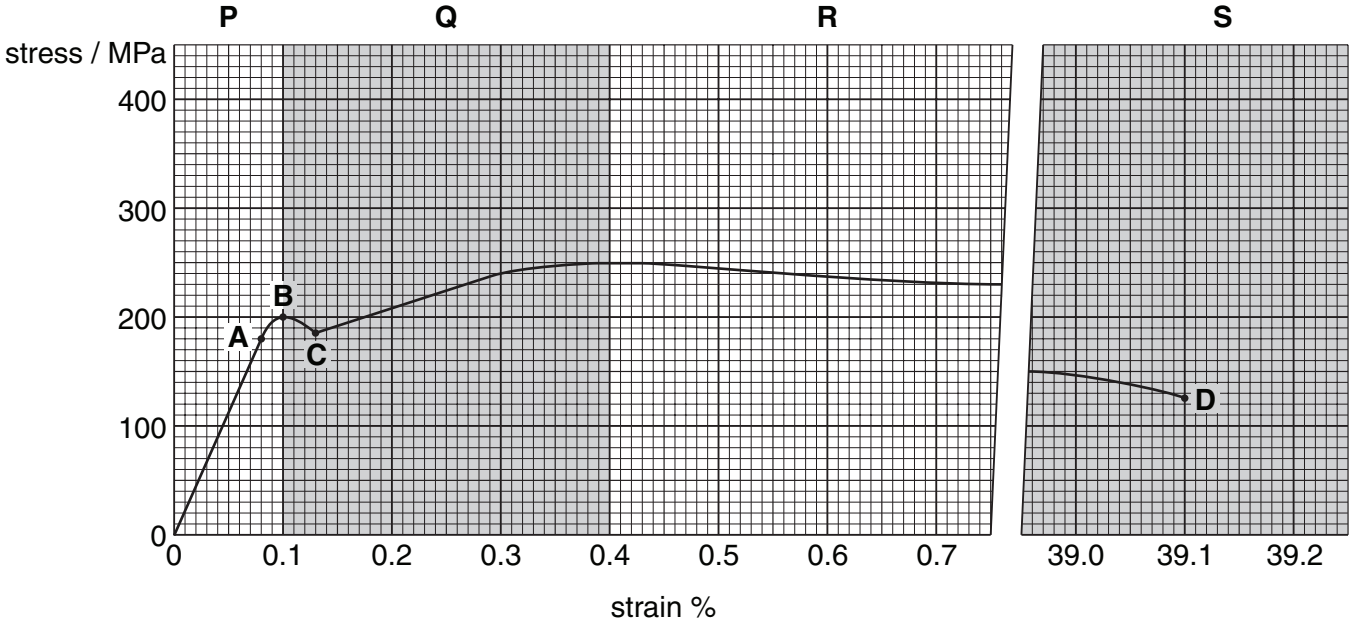


Fig. 8.1

(a) State which of the points on the graph **A**, **B**, **C** or **D** correspond to

(i) the breaking point .....

(ii) the limit of proportionality .....

and which of the shaded regions **P**, **Q**, **R** or **S** corresponds to

(iii) the region where the Young modulus can be defined. ..... **[3]**

(b) Use the graph to obtain an estimate for the Young modulus of mild steel. Make your method clear.

Young modulus = ... Pa **[2]**

(c) The test is repeated using another bar of the **same material** but the tensile test is stopped when the bar reaches point **C** on the graph, and the tensile force is removed.

(i) Draw on the axes of Fig. 8.1 a line that helps you to estimate the permanent strain of the mild steel bar after the stress is removed.

[1]

(ii) State your estimate for the permanent strain.

permanent strain = ... **[1]**

(d) Alloys are often made from a pure metal with a small fraction of impurity atoms of a different size added to them.

Suggest and explain **one** improvement in mechanical properties that an alloy can have compared to the pure metal from which it is made.

[2]

[Total: 9]

9 This question is about a mobile phone camera with video capability.

(a) The images taken by the phone consist of 800×600 colour pixels, requiring 24 bits per pixel. In video mode the camera can record and send 15 full colour images per second.

Show that the rate at which information is transmitted when sending the uncompressed video is greater than $150\,\text{Mbit}\,\text{s}^{-1}$.

[1]

(b) Fig. 9.1 shows how this phone operates, by turning a carrier wave frequency on for 40 complete cycles to represent a 1, and off for 40 cycles to represent a 0.

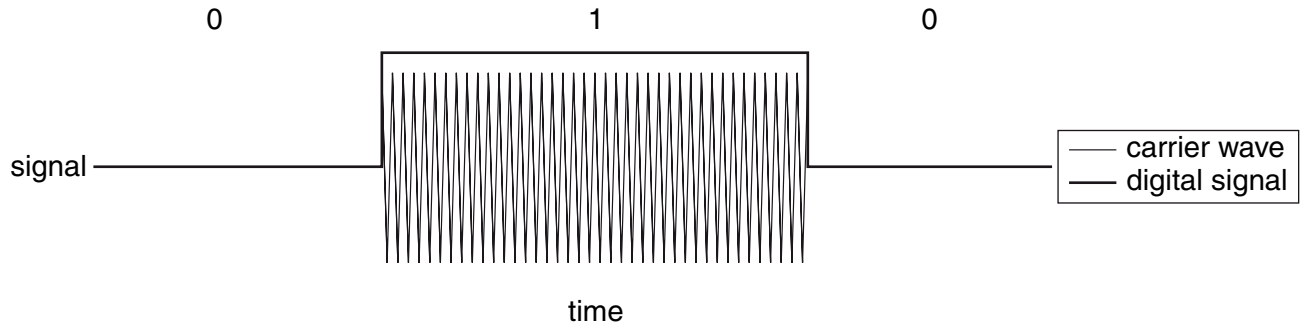


Fig. 9.1

Estimate a minimum suitable carrier frequency for the phone to transmit video information, at the rate in **(a)**.

minimum carrier frequency = ... Hz **[1]**

(c) The mobile phone camera also records sound.
The sound signal is sampled at 20 000 samples per second using 12 bits per sample.

(i) Show that the extra bit rate required for the sound information is negligible compared to that needed by the video image data.

[2]

(ii) State the maximum sound frequency that this system can sample successfully, and explain why this is the case.
You may wish to use a diagram in your answer.

maximum frequency = ... Hz **[2]**

(d) The camera of the video phone takes a focused image of the owner's face when 0.25 m from the fixed focus camera lens.

(i) State the curvature of waves arriving at the lens from an object at 0.25 m.

curvature = − ..... D **[1]**

(ii) The power of the lens in this camera is + 250 D.

Calculate how far this focused image is from the **focal point** of the lens.

distance of image from the focal point = ... m **[3]**

[Total: 10]

10 A student is trying to understand some aspects of how spherical raindrops can form a rainbow. She realises that light rays from the Sun are incident on the surface of the drop at all angles of incidence from 0 to 90°.

Fig. 10.1 shows two incident rays **A** and **B** from the Sun.
The dotted lines are normals to the surface of the drop at the points of contact.

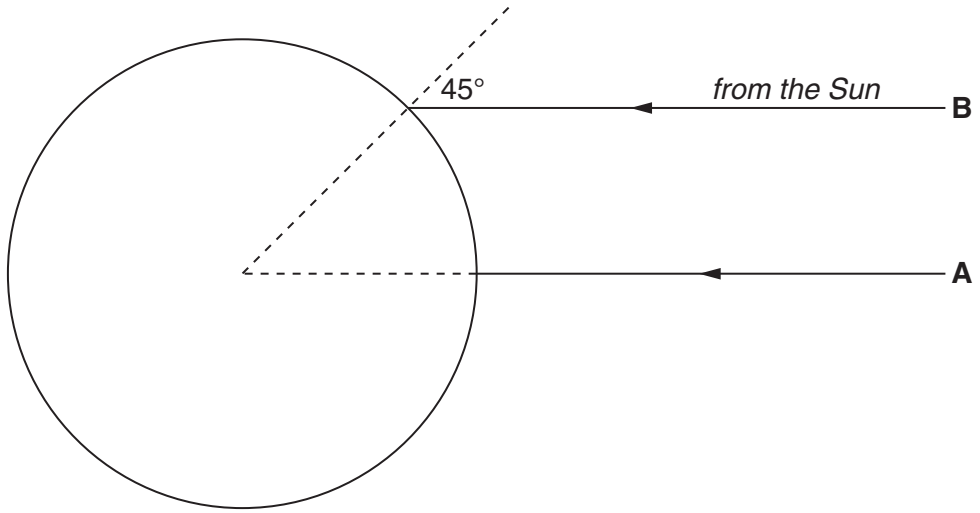


Fig. 10.1

(a) On Fig. 10.1 draw the path of ray **A** as it travels through the drop. **[1]**

(b) **(i)** Ray **B** is incident at 45° to the normal at the surface of the drop.

Calculate the angle of refraction *r* of the ray at the surface.

refractive index for water $n = 1.33$

$r =$ ..... ° **[3]**

(ii) Draw a line on Fig. 10.1 to show the path of ray **B** across the drop. **[1]**

(iii) Use geometry to show that the angle of incidence *i* for this ray at the water-air boundary at the back of the drop is equal to the angle *r* in part **(i)** above.

[1]

(c) (i) Calculate the critical angle *C* for water.

C = ... ° **[2]**

(ii) Describe carefully what happens to the light travelling along ray **B** when it meets the water-air boundary.

[2]

(iii) Sunlight consists of many wavelengths of light.

Suggest a reason why all wavelengths within ray **B** do not follow the same path through the drop.

[1]

[Total: 11]

11 Three lamps **A**, **B** and **C** are all rated at 12V and 24W but take the following currents when operating at 12V.

lamp	**A**	**B**	**C**
current/A	2.0	2.0	2.1

(a) (i) Calculate the working resistance of lamp **A** when operating at 12V.

working resistance = ... Ω **[1]**

(ii) Lamp filaments are made from long thin uniform coiled wires of tungsten as shown in Fig. 11.1.

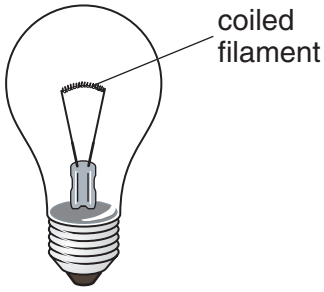


Fig. 11.1

In operating conditions the wire used has a resistance of 300Ω per metre length.

Calculate the length of wire needed to construct the filament of lamp **A**.

length = ... unit ..... **[1]**

(iii) Manufactured lamps labelled with the same power rating vary in their actual power, due to small differences in filament dimensions.

State **two** possible differences in the dimensions of the filament wire of lamp **C** that would result in it operating at more power than 24W at 12V.

[2]

(b) Fig. 11.2 shows the p.d. versus current graph for the identical lamps **A** and **B**.

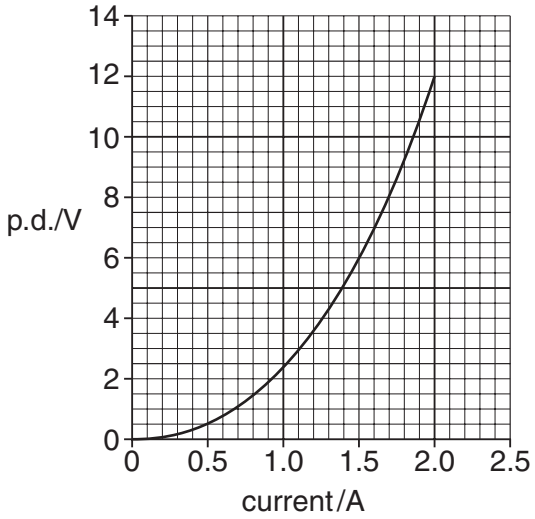


Fig. 11.2

(i) State and explain what the graph shows about the resistance of the lamps as the current increases.

[2]

(ii) Identical lamps **A** and **B** are connected in series with the 12V supply.
Use data from Fig. 11.2 to predict the total power of the two lamps in series.
Explain your reasoning.

total power = ... W **[2]**

(iii) On Fig. 11.2 sketch the graph you would expect for lamp **C** in **(a)**. **[1]**

(iv) Lamps **A** and **C** are now connected in series with the 12V supply.
State and explain which lamp will have the greater voltage across it.

[2]

[Total: 11]

[Section B Total: 41]

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. Up to four marks in this section will be awarded for the quality of written communication.

12 In this question, you are asked to describe the operation of an electrical sensor system of your choice.

(a) (i) State the physical variable your system is designed to monitor or measure.

..... **[1]**

(ii) Draw and label a circuit diagram for your electrical sensor system.

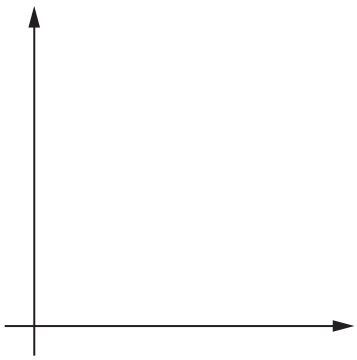
[3]

(iii) Explain how the circuit operates.

[3]

(b) (i) Explain how you could **calibrate** your sensor system.

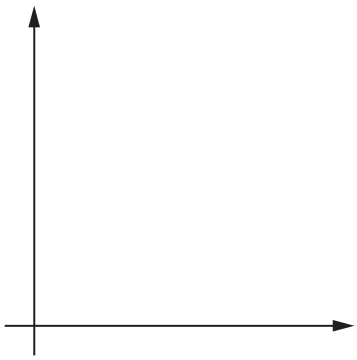
You are encouraged to use sketch graphs or further diagrams to help your answer.



[4]

(ii) Explain how you could estimate the **uncertainty** that your sensor system could achieve in measuring the physical variable.

You are encouraged to use sketch graphs or further diagrams to help your answer.



[3]

[Total: 14]

13 Materials are chosen or can be designed with properties suitable for a particular application. You are asked to illustrate this with your own example.

(a) (i) State your choice of material and the application.

material .....

application ..... **[1]**

(ii) State **two** physical properties of the material that are important in the application.

Explain the **exact meaning** of each physical property including its unit of measurement.

first property .....

definition of property with unit

[3]

second property .....

definition of property with unit

[3]

(iii) Explain in detail why **one** of these properties is important in the application you have chosen.

Make clear which property you are considering.

[2]

(b) Materials have internal structure, which can help us to understand their physical properties.

Describe the internal structure of your material.

Explain **one** of the properties you chose in **(a)** in terms of the structure.

Use a labelled diagram(s), indicating how the structure helps to explain your chosen property.

structure

explanation

[3]

[Total: 12]

[Quality of Written Communication: 4]

[Section C Total: 30]

END OF QUESTION PAPER

PLEASE DO NOT WRITE ON THIS PAGE