THIS IS A NEW SPECIFICATION

ADVANCED SUBSIDIARY GCE

PHYSICS B (ADVANCING PHYSICS) G491

Physics in Action

Candidates answer on the question paper

OCR Supplied Materials:
- Data Formulae and Relationships Booklet

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

Thursday 21 May 2009
Afternoon

Duration: 1 hour

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 **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.

- The values of standard physics 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	**23**	
B	**37**	
TOTAL	**60**	

Answer **all** the questions.

Section A

1 Here is a list of electrical units:

A s **A V^{-1}** **C s^{-1}** **J s^{-1}** **J C^{-1}**

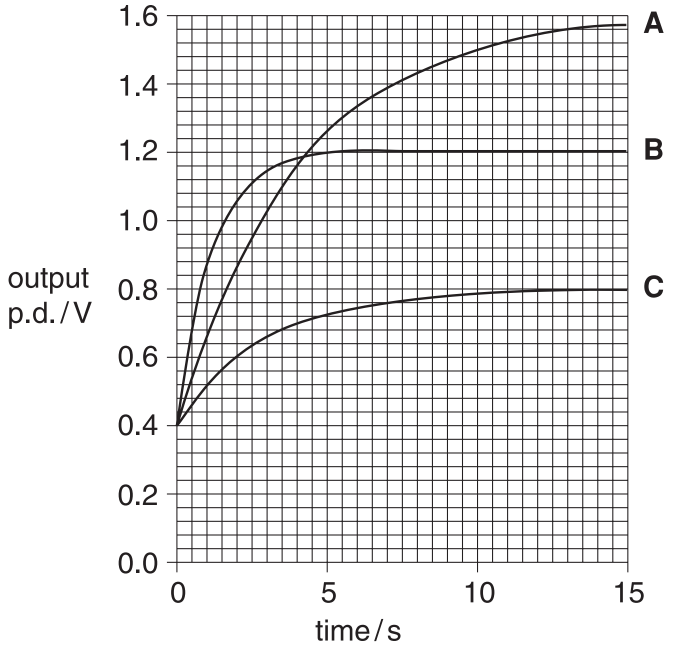
Choose the unit for

(a) electrical power ……………………….

(b) electric charge ……………………….

(c) conductance ………………………. **[3]**

2 Three temperature sensors **A, B** and **C** were plunged into hot water at the same moment, time $t = 0$. The graph below shows their responses.



(a) State the sensor with the **shortest** response time. ....**[1]**

(b) Estimate the response time of sensor **B**.

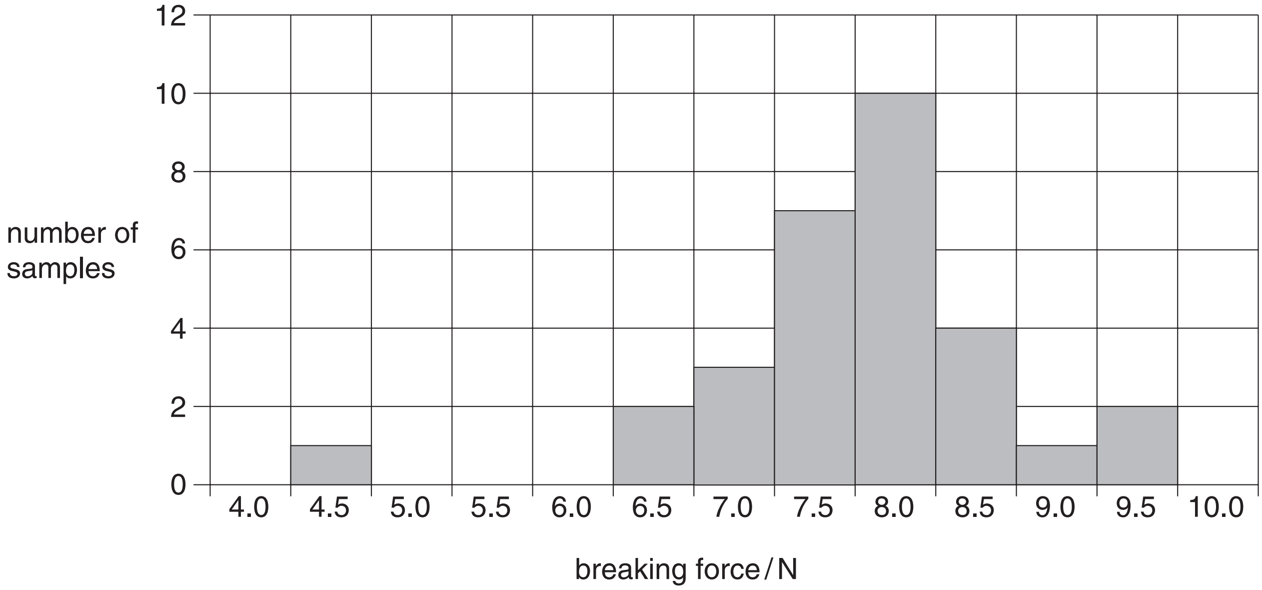
response time = ... s **[1]**

(c) The temperature rise of each sensor was 75 °C.

Calculate the average sensitivity of sensor **B** in this temperature range.
Make your method clear and give the units of sensitivity.

sensitivity = ... unit .... **[3]**

3 A class experiment sets out to investigate the force needed to break a strip of paper. 30 sample strips, all cut to the same width, were tested. The breaking force for each was measured to the nearest 0.5 N. The histogram below shows the number of samples at each measured breaking force.



(a) The class are discussing whether to ignore the low result at 4.5 N.

Suggest a possible reason for this low result.

[1]

(b) The result at 4.5 N was ignored. Estimate the breaking force of the paper. Estimate also the variability in the measurements for this set of samples.

Make your method for making the estimates clear.
Give your answers to a sensible number of significant figures.

breaking force = …………… ± …………… N **[3]**

4 Here are five mechanical properties of materials:

brittleness hardness toughness stiffness strength

For each of the following descriptions of mechanical properties of materials write down the property being described from the list.

the ratio stress/strain when a material is stretched elastically ....

the tendency to break by crack propagation .... **[2]**

5 The highest frequency in a film soundtrack is 6.0 kHz. The soundtrack is to be sampled and digitised. The sampling frequency should be at least 12 kHz.

(a) State one problem produced by sampling at less than 12 kHz.

[1]

(b) The soundtrack contains some random electrical noise. The variation of the noisy signal is 2000 times larger than the noise alone.

$$V_{total} / V_{noise} = 2000$$

Thus when the signal is digitised, there is no point distinguishing more than 2000 digital levels.

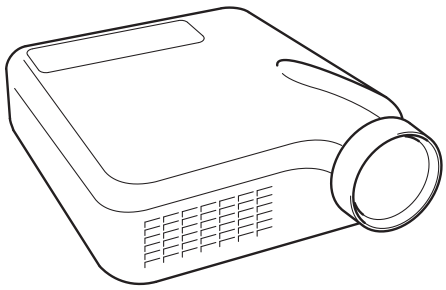
Show that it would be pointless to use more than 11 bits to digitise each sample.

[1]

(c) Estimate the rate of information transfer that this digitised soundtrack uses.

rate of information transfer = ... bit s^{-1} **[1]**

6 Inside a data projector the illuminated object display is 45 mm wide.
The focused real image on a distant screen is 1.35 m wide.



(a) Calculate the linear magnification of the image.

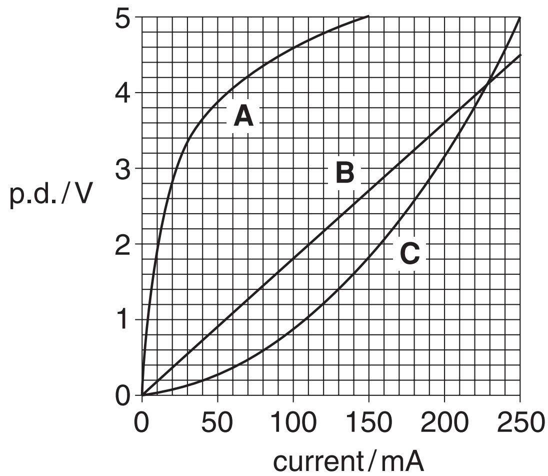
magnification = ... **[1]**

(b) The image distance *v* from the projector lens is 2.10 m.

Calculate the object distance *u* and hence show that the power of the projector lens is about 15 D.

[3]

7 The graph shows the characteristics of 3 different electrical conductors **A**, **B** and **C**.



(a) State which conductor obeys Ohm's Law. .... **[1]**

(b) State which graph shows decreasing resistance at higher current. .... **[1]**

[Section A Total: 23]

Section B

8 Fig. 8.1 shows an image of part of the South Atlantic seafloor.
The image is 480 pixels wide × 580 pixels high, and the resolution is 10 km pixel^{-1}.

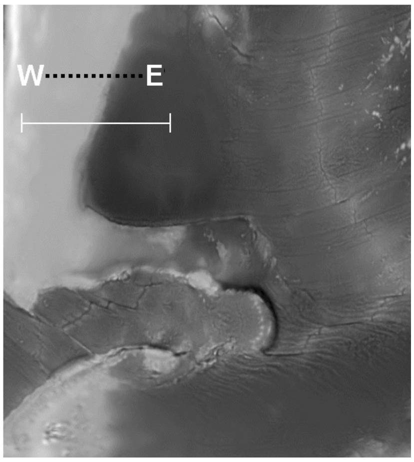


Fig. 8.1

(a) Calculate the area of seafloor that the image represents.

area = ... km^2 **[1]**

(b) Pixel values in the image represent a measurement of average sea depth.
These have been calibrated at 33 m depth per step of the grey scale from 0 (white) to 255 (black).

(i) Calculate the greatest depth that could be represented in the image.

greatest depth = ... m **[1]**

(ii) Explain why pixel values represent an **average** sea depth.

[1]

(c) Fig. 8.2 shows a West-East cross-section **W E** through part of the image data.

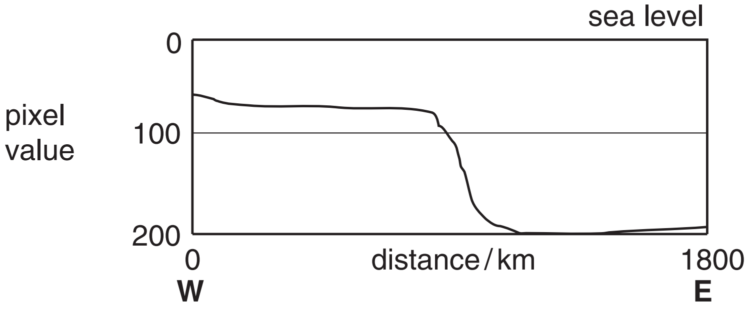


Fig. 8.2

Use numerical information from Fig. 8.2 to describe **two** features of the seafloor that this cross-section reveals.

[2]

(d) Fig. 8.3 shows the number of pixels in the whole image at each greyscale value.

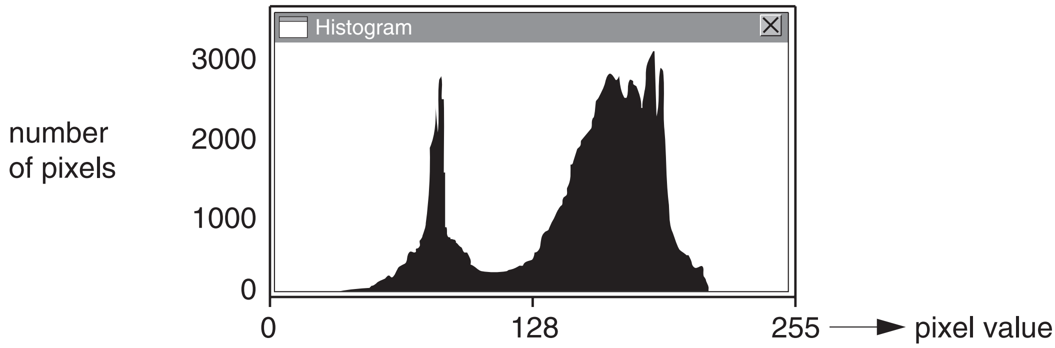


Fig. 8.3

Explain how you could use Fig. 8.3 to estimate the fraction of the area of the seafloor in the image that was less than 4 km deep.

In your answer, you should ensure that your explanation is clear with correct spelling and punctuation.

[2]

(e) The original image is processed by edge detection and the result is shown below in Fig. 8.4.

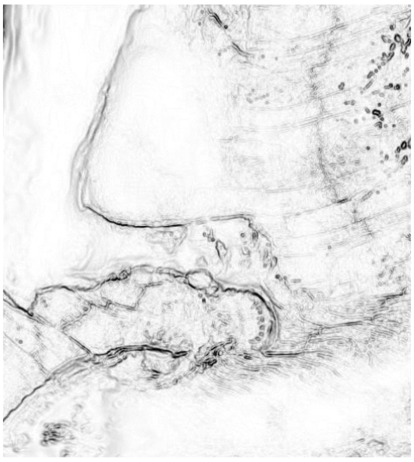


Fig. 8.4

Describe how this image process highlights details in the image.

[1]

[Total: 8]

9 Fig. 9.1 shows a cell with an emf ε of 1.55 V and an internal resistance r of 0.40 Ω. The cell delivers a current I of 250 mA into a constant load resistance R of 5.8 Ω.

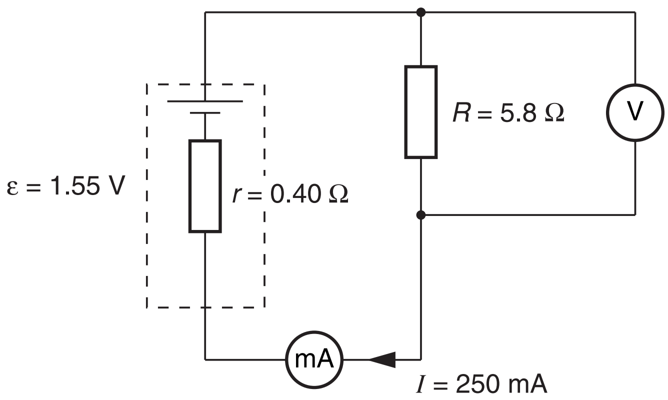


Fig. 9.1

(a) **(i)** Calculate the p.d. across the load resistance R.

p.d. = ... V **[2]**

(ii) Explain why the p.d. across the load resistance is less than the emf of the cell.

[1]

(b) The cell is left connected to the 5.8 Ω load resistance for several hours.
Fig. 9.2 shows how the current from the cell varies with time.

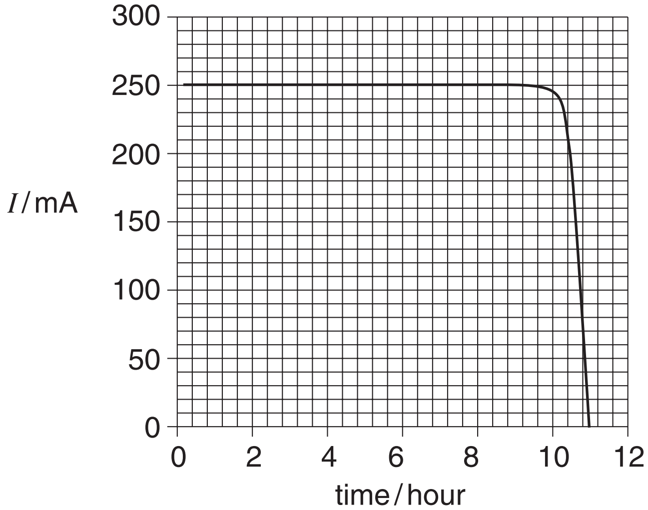


Fig. 9.2

(i) Describe how the current varies with time.

[2]

(ii) Suggest reasons why the current varies with time in this way.

[2]

(iii) Use Fig. 9.2 to estimate the total charge delivered by the cell.

Make your method clear.

charge = ... C **[3]**

[Total: 10]

10 A red LED starts conducting when the p.d. across it is greater than 1.6 V.
Fig. 10.1 shows the circuit used to run the LED from a 9.0 V battery of negligible internal resistance.

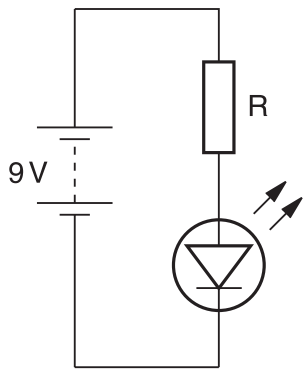


Fig. 10.1

(a) **(i)** State the purpose of the resistor R in this circuit.

[1]

(ii) When operating at its normal current of 25 mA the p.d. across the LED is 2.1 V.

Calculate the value of the resistor R for operation of the LED at 25 mA from the 9.0 V battery. Make your method clear.

resistance = ... Ω **[2]**

(iii) Calculate the power dissipated in the resistor R in this circuit.

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

(b) Fig. 10.2 shows how the p.d. across LEDs varies with current for a red and a green LED.

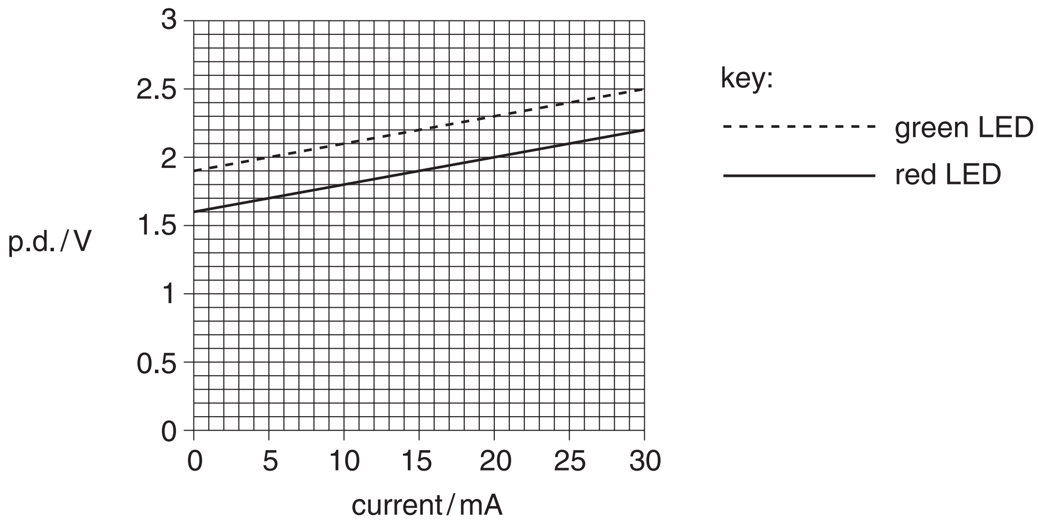


Fig. 10.2

(i) Describe a difference shown in the graphs between the behaviour of the red and green LEDs.

[1]

(ii) A red and a green LED are connected in parallel with a suitable series resistor to a supply of variable p.d. as in Fig. 10.3.

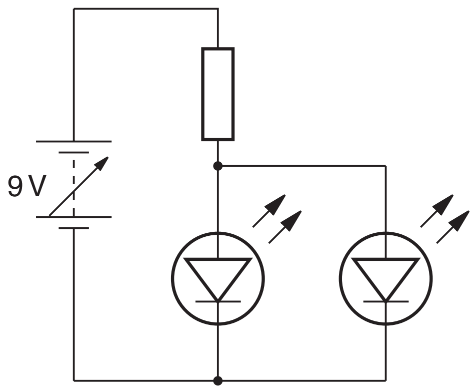


Fig. 10.3

State and explain what happens in the circuit when the p.d. across the diodes is gradually increased from 0 V to over 2.1 V.

[2]

(iii) The output of the variable supply is set to 7.0 V.
This makes a p.d. of 2.0 V across both LEDs. Use data from Fig. 10.2 to find the total conductance of the circuit at this setting.

Assume the variable supply has negligible internal resistance.

conductance = ... S **[2]**

[Total: 10]

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11 Fig. 11.1 shows the structure of glass.

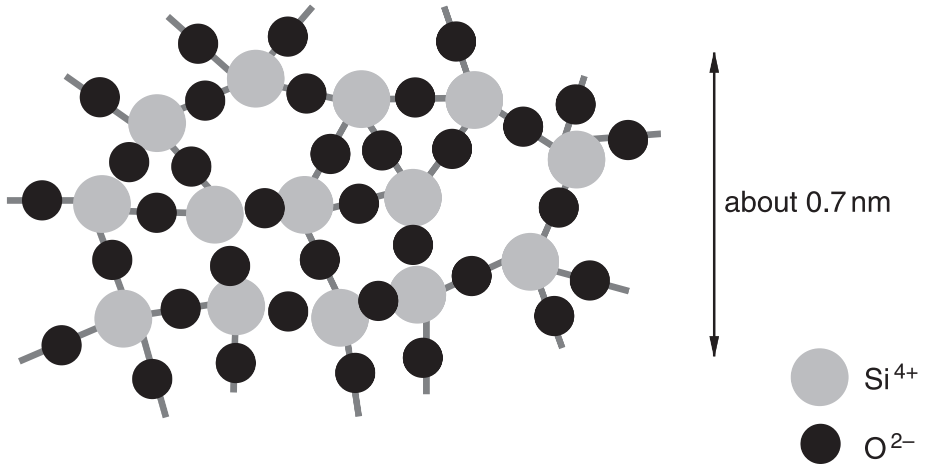

Fig. 11.1

The bonding is strong, stiff and directional within groups of ions, but with random orientations between neighbouring groups. There is little short range order in the structure.

Use features of this micro-structure of glass to suggest **explanations** for the following macroscopic properties of glass.

(a) Glass fibres are strong but show no plastic deformation before fracture.

[3]

(b) A sheet of glass can be broken cleanly and accurately into two pieces, if a scratch is drawn across its surface and the glass is slightly bent.

In your answer, you should use appropriate technical terms, spelt correctly.

[3]

(c) Solid glass at room temperature is a good electrical insulator, but when heated near its melting temperature it can conduct electricity.

[3]

[Total: 9]

[Section B Total: 37]

END OF QUESTION PAPER

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