OCR
RECOGNISING ACHIEVEMENT

Monday 20 May 2013 – Afternoon

AS GCE PHYSICS B (ADVANCING PHYSICS)

G491/01 Physics in Action

Candidates answer on the Question Paper.

OCR supplied materials:
- Data, Formulae and Relationships Booklet (sent with general stationery)

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Duration: 1 hour

G491 0 1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. 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.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

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.
- 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.
- 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 when appropriate.
- This document consists of **16** pages. Any blank pages are indicated.

Answer **all** the questions.

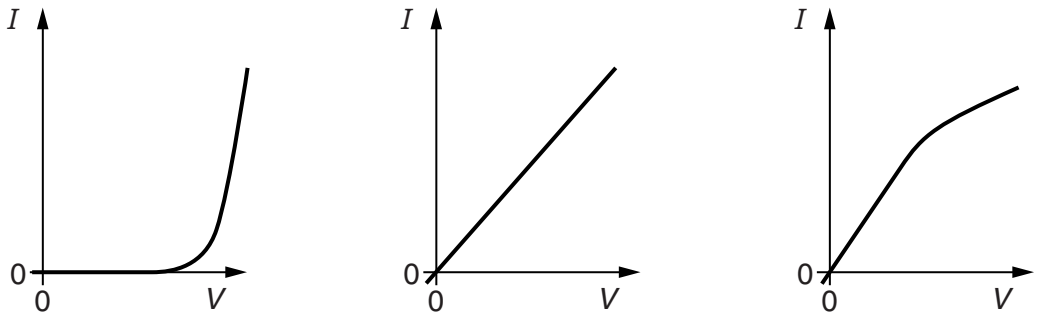
SECTION A

1 Fig. 1.1 shows the *I*-*V* characteristics for three electric circuit components:

a fixed resistor **R**

a filament lamp **L**

a light emitting diode (LED) **D**.



....

Fig. 1.1

Write the correct component labels **R**, **L** or **D** on the line under each graph. **[2]**

2 A camera lens has a focal length of 0.20 m.

(a) Calculate the power of the lens in dioptres. Make your method clear.

power of lens = ... D **[2]**

(b) Light waves with a curvature of –0.4 dioptres are incident on this lens.

Calculate the curvature of the waves leaving the lens.

Make your method clear.

curvature of waves leaving lens = ... D **[2]**

3 Dolphins emit clicks, short pulses of high frequency sound.

Fig. 3.1 shows the waveform and frequency spectrum of a click.

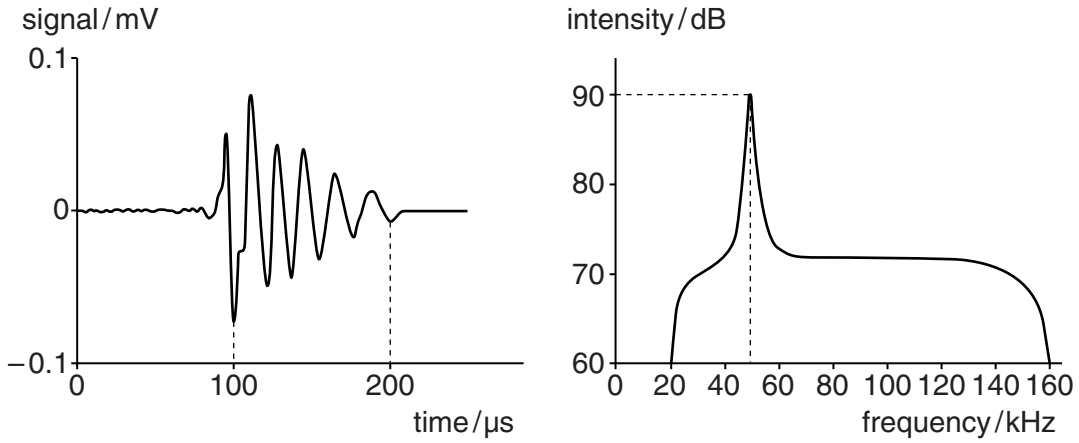


Fig. 3.1

(a) Estimate the time period of the major frequency component of the click.

Make your method clear.

time period = ... s **[2]**

(b) State the bandwidth of the click sound.

bandwidth = ... kHz **[1]**

(c) The scale in dB on the intensity axis of the frequency spectrum is logarithmic.

This means that for each increase of 10 dB the intensity is 10 times greater.

State the ratio of the peak intensity to the intensity recorded at 20 kHz.

peak intensity / intensity at 20 kHz = ... **[1]**

4 Fig. 4.1 shows an axe with a head made of steel.

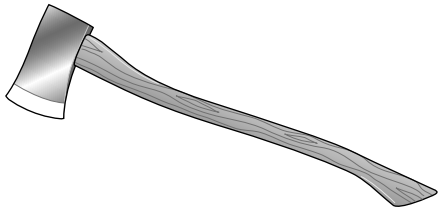


Fig. 4.1

The cutting edge of the axe head is heat-treated to harden it.

(a) State the meaning of the term *hard*.

[1]

(b) Explain why it is an advantage for an axe head to have a hardened edge.

[1]

(c) Other physical properties of steel such as high density make it a good material for making axe heads.

State **one** other useful physical property and explain why it is useful.

[2]

5 A rechargeable battery for a toy helicopter delivers a charge of 2900 C at a p.d. of 3.7 V.

(a) Calculate the energy delivered by the battery.

energy = ... J **[2]**

(b) The energy is delivered in 9.0 minutes.

Calculate the mean power output of the battery.

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

6 **(a)** A circuit of total conductance 45 mS is connected to a 3.0 V battery of negligible internal resistance.

Calculate the current in the circuit.

current = ... A **[2]**

(b) Three conductors are connected as shown in Fig. 6.1.
Their conductance values are shown on the diagram.

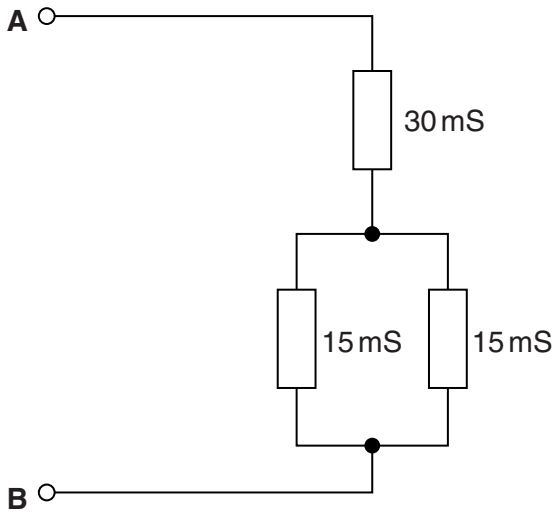


Fig. 6.1

Here are four possible values for the total conductance between points **A** and **B**.

15 mS 30 mS 37.5 mS 60 mS

Put a (ring) around the correct answer. **[1]**

7 Fig. 7.1 shows an original image and a digitally processed version of it.

original **processed**

Fig. 7.1

(a) The pixels of the original image are in the range 80 to 200 in greyscale values.

The image processing applied the following numerical operation to the value of each pixel:

$$\text{new pixel value} = (\text{original pixel value} - 80) \times 2.1$$

Complete the following table.

New pixel value	Original pixel value
	80
147	150
	200

[2]

(b) Describe how this numerical image processing has improved the original image.

[1]

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Question 8 begins on page 8

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SECTION B

8 This question is about a pressure sensor. Fig. 8.1 shows the output p.d. in mV against pressure in mmHg (mm of mercury) for a pressure sensor.

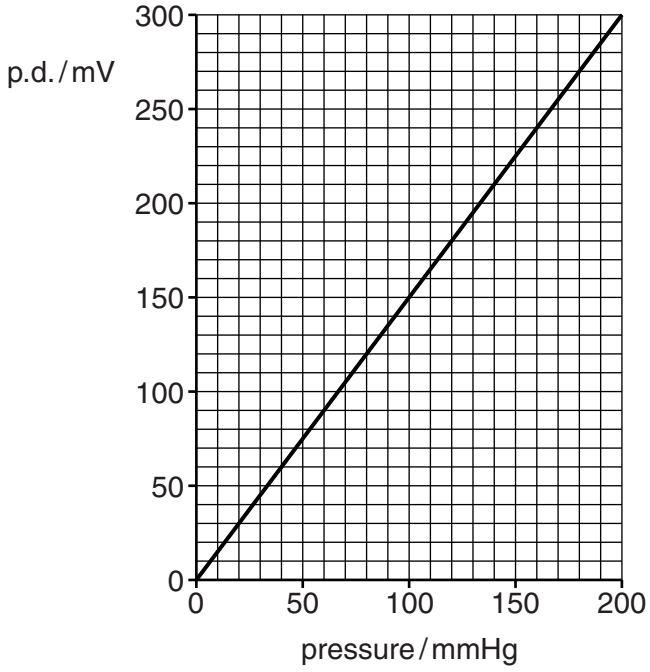

Fig. 8.1

(a) (i) Describe the relationship between the output p.d. and pressure for this sensor.

[1]

(ii) Calculate the sensitivity of the sensor.

Make your method clear.

sensitivity = ... mV / mmHg **[2]**

(b) The pressure sensor is part of a human blood pressure monitor.
Fig. 8.2 shows a visual display of data logged by the monitor during 15 seconds.

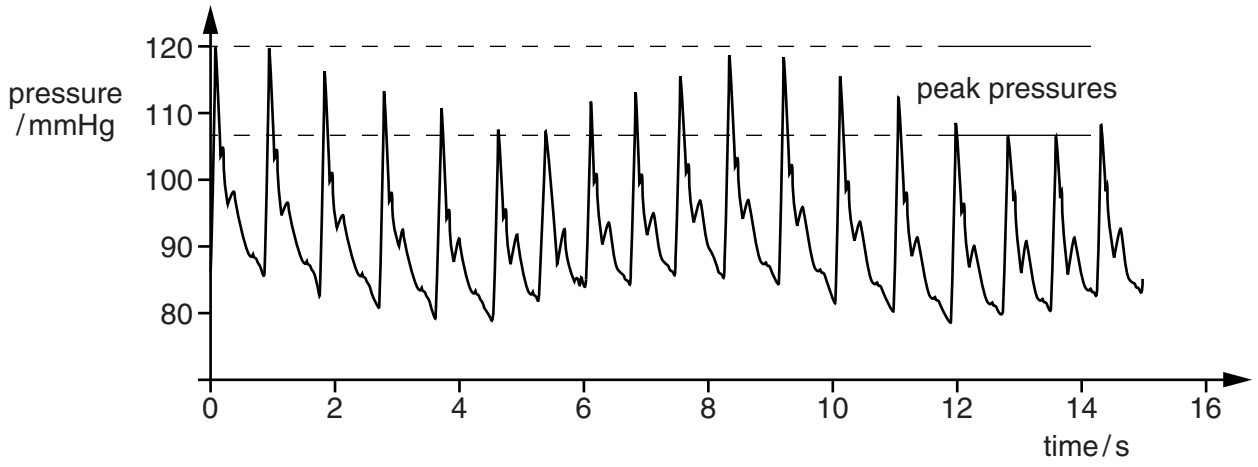

Fig. 8.2

(i) Using data in Fig. 8.2, and making your method clear, estimate the **mean** values of

1 heart rate in beats per minute

rate = ... beats min^{-1}

2 peak pressure in mmHg.

pressure = ... mmHg
[4]

(ii) Describe **two** other features shown by the data in Fig. 8.2.

1

2

[2]

(c) The sensor measures pressure from 0 to 200 mmHg and has a resolution of 0.5 mmHg. The signal is to be digitised.

Calculate the number of bits needed to code for this number of pressure levels.

number of bits = ... **[2]**

[Total: 11]

9 The designers of an e-book, a device used for reading books electronically, claim that it can store the information from up to 3500 paper books in its 3 Gbyte memory.

(a) (i) Show that this claim means that the average information required per paper book is less than 1 Mbyte.

[1]

(ii) Each text character of the book can be coded by **one byte** of information.

Complete the table of estimates below for a typical paper book and calculate your estimate for the amount of information in it.

Pages per book	Lines per page	Words per line	Characters per word
	30		6

information estimate = ... bytes **[2]**

(b) (i) The makers claim that the Wi-Fi link for the e-book is able to download a typical book in under one minute.

Calculate the lowest information transfer rate in bits per second that can achieve this, using your answer to **(a)(i)**.

information transfer rate = ... bit s^{-1} **[2]**

(ii) The Wi-Fi link transmits radio waves with a wavelength of 0.36 m.

Calculate the frequency of these radio waves.

speed of light = $3.0 \times 10^8 \, m \, s^{-1}$

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

(iii) State and explain whether this frequency is high enough to cope with the bit rate calculated in **(b)(i)**.

[2]

(c) State clearly reasons why there can be both advantage and disadvantage to **society as a whole** of using e-books rather than traditional paper based books.

Ensure your text is legible and that spelling, punctuation and grammar are accurate.

advantage

disadvantage

[2]

[Total: 11]

10 Fig. 10.1 shows the cut and polished surface of 2 cm^2 of a concrete tile.

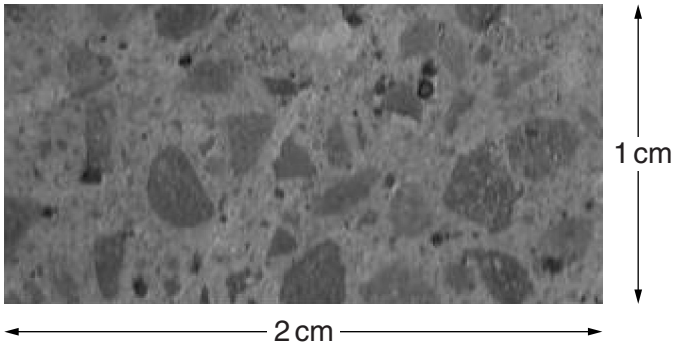

Fig. 10.1

(a) (i) Explain why concrete can be described as a composite material. You may use evidence from the image of Fig. 10.1.

[2]

(ii) Concrete is a material which can suffer brittle fracture. Explain why concrete is strong under compressive stress but much weaker under tension.

In your answer, you should organise information clearly and coherently, using specialist vocabulary when appropriate. You may wish to use labelled diagrams in your answer.

[4]

(b) Fig. 10.2 shows the stress-strain graphs for concrete (to breaking) and steel (to just beyond the elastic limit) for tension and compression.

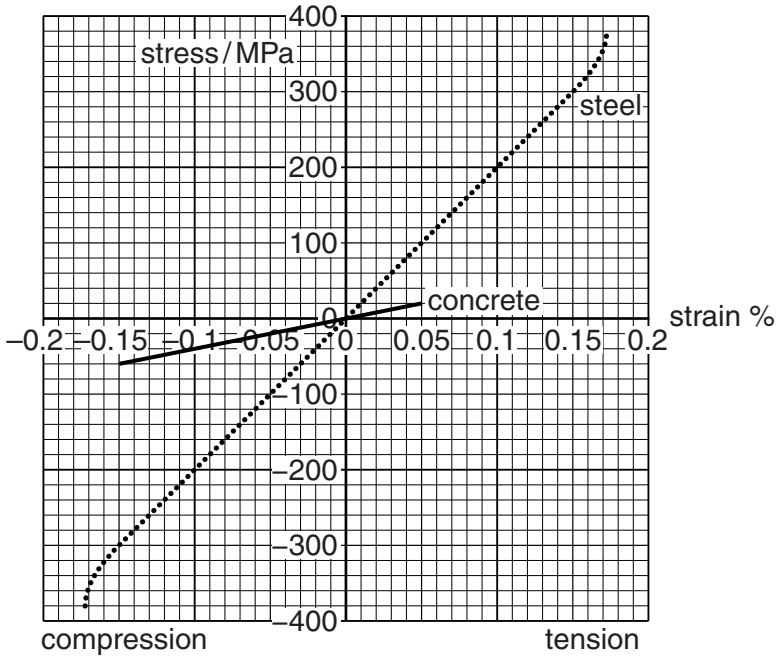

Fig. 10.2

(i) Calculate how many times stiffer steel is than concrete.

Make your method clear.

times stiffer = ... **[3]**

(ii) Calculate how many times stronger concrete is in compression than in tension.

Make your method clear.

times stronger = ... **[2]**

(c) One type of steel-reinforced concrete beam is made by setting a steel cable covered by a plastic sleeve into the beam. This allows the cable to move within the concrete beam. Compression of the concrete is achieved, after it is set, by the steel cable being tensioned against steel anchors embedded in the ends of the beam.

This is illustrated in Fig. 10.3 where arrows represent the forces on the anchors from cable and beam.

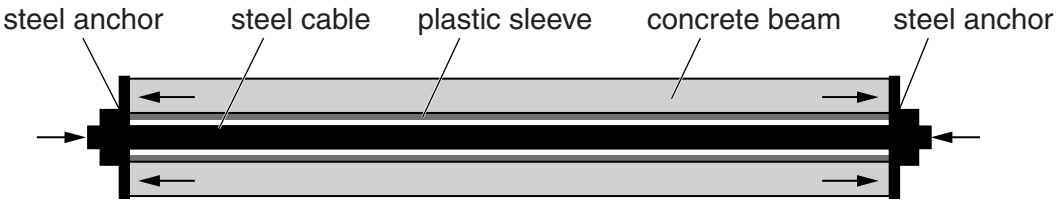

Fig. 10.3

(i) The cross-sectional area of the concrete in the beam is 5 times larger than that of the steel cable.

Give complete reasoning to explain why this means that the stress in the concrete is one fifth of that in the steel.

[2]

(ii) The concrete in the beam is compressed to a strain of 0.075%.

Use the graphs of Fig. 10.2 to find the tensile stress in the steel.

tensile stress = ... Pa **[1]**

[Total: 14]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined pages. The question number(s) must be clearly shown in the margins.

ADDITIONAL ANSWER SPACE