OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS B (Advancing Physics) 2860
Physics in Action

Tuesday **18 January 2001** 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

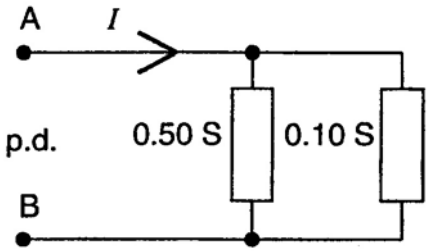
- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above. .Answer all the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Show clearly the working in all calculations, and round answers to only a justifiable number of significant figures.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- 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.
- You are advised to spend about 20 minutes on Section A, 40 minutes on Section B and 30 minutes on Section C. You will be awarded marks for the quality of written communication in Section C.

Section A

1 Two conductors of conductance 0.10 S and 0.50 S are connected in parallel as shown in Fig. 1.



(a) What is the conductance of the parallel combination?

conductance = ...S [1]

The p.d. across terminals A B in Fig. 1 is 1.5 V.

(b) Calculate the current *I* passing through the combination.

current I = ...A [2]

2 Here is a magnified image of part of the surface of Mercury, Fig. 2.1 .

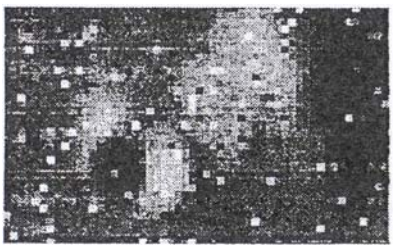


Fig. 2.1

(a) The image suffers from random noise. What feature of the image shows that random noise is present?

(b) The image, shown in Fig. 2.2, has been processed to reduce the effect of noise.

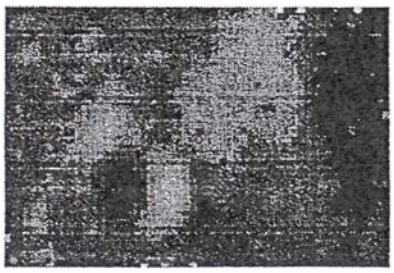


Fig. 2.2

(i) What process could have been used to reduce the effect of noise in this way?

(ii) What effects does this process have on the remainder of the image?

[3]

3 A scanning tunnelling electron microscope (STM), measures a tiny electrical current tunnelling out of the surface of a crystal. The current is 0.30pA (0.30×10^{-12}A).

Calculate the number of electrons per second leaving the surface of the crystal.

number of electrons per second = …… [2]

4 Lisa is pregnant and goes for an ultrasound scan to see her baby. The speed ultrasound in soft tissue is 1500 m s^{-1}.
The wavelength of the ultrasound required in this tissue is 0.50 mm.

(a) Calculate the frequency of the ultrasound.

frequency = ...Hz [2]

(b) The wavelength in part **(a)** gives an image resolution of about 0.50 mm.
Explain the meaning of the term *resolution* in this case.

[1]

5 An atom is about 0.10 nm (0.10×10^{-9} m) across. How many atoms are there, across the width of a human hair that is 0.040 mm wide?

number of atoms = ... [2]

6 A motor bike battery delivers a current of 2.5 A for two hours.

(a) Show that the total charge flowing is 18 kC.

[1]

(b) This charge transfers 108 kJ of electrical energy. Calculate the emf of the battery.

emf of battery = …… V [2]

7 Fig. 7 shows the frequency spectrum of a musical note.

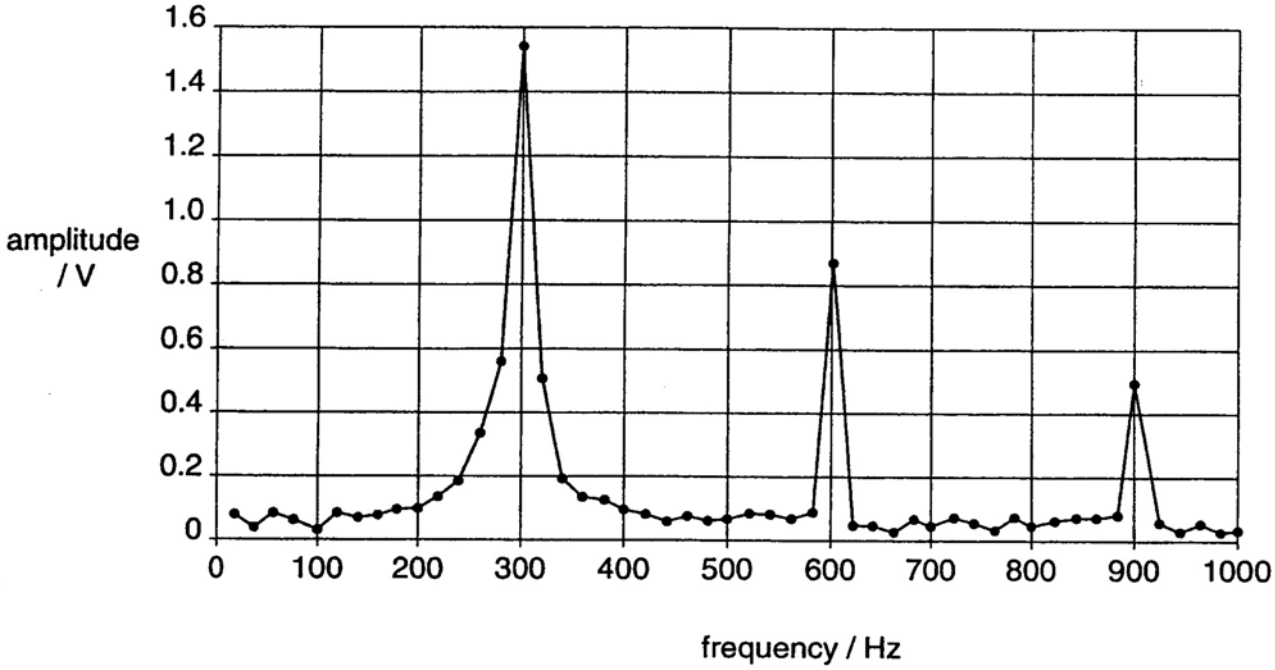


Fig. 7

(a) What does this frequency spectrum show?

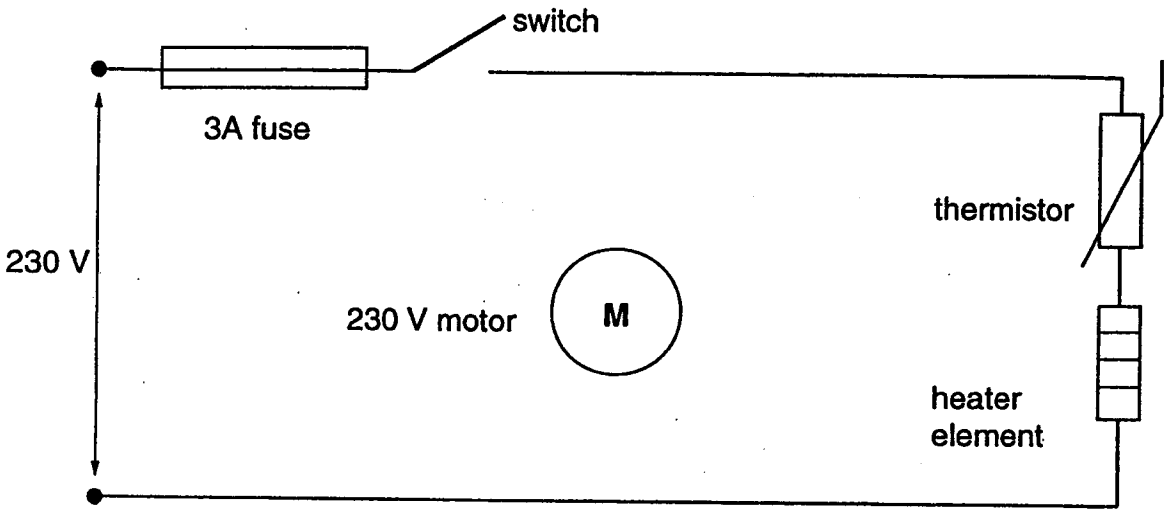
[2]

(b) Identify the fundamental frequency of the note.

fundamental frequency = ... Hz [1]

Section B

8 Part of the circuit for a hair dryer is shown in Fig. 8.1.
The hair dryer has a 230 V motor.
A thermistor is close to the heater element in the hot air stream.



(a) Draw on Fig. 8.1 to show how the motor should be connected.

(b) The resistance of the heater element changes during the first few seconds of operation as shown in Fig. 8.2.

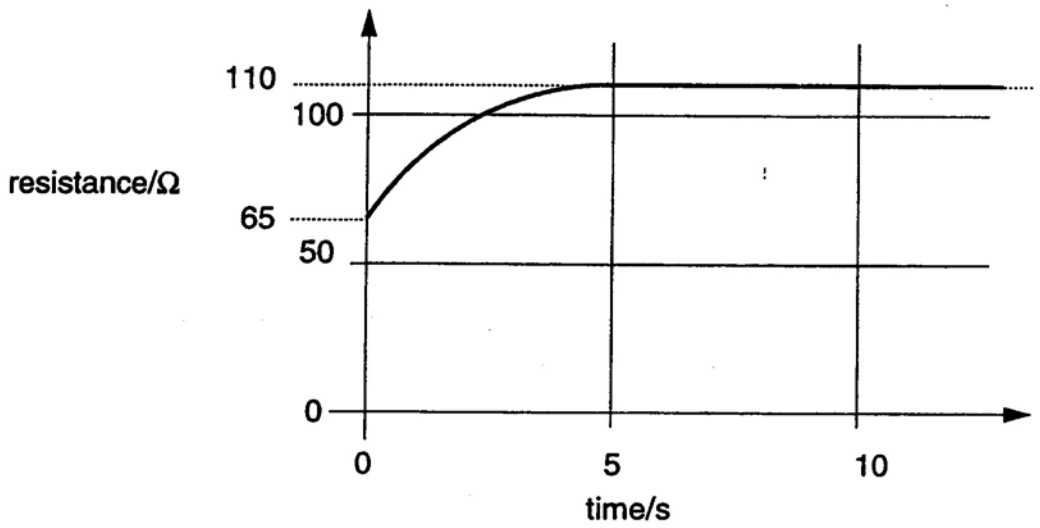


Fig. 8.2

(i) Describe how the resistance of the heater element changes with time.

[2]

(ii) Give one reason why the resistance changes when the dryer is first turned on.

[1]

(c) A thermistor is in the hot air stream, close to the heater element.
The thermistor is chosen to maintain a constant current of 2.0 A in the heater circuit.

(i) Describe how the resistance of the thermistor needs to change during the first few seconds.

[1]

(ii) After the first few seconds, the resistance of the heater element is 110Ω, and the current in the heater circuit is 2.0 A.
Show that the resistance of the thermistor at this time is 5.0Ω.

[3]

(iii) On the graph, Fig. 8.2, show how the resistance of the thermistor changes.

[2]

9 A slide projector produces a magnified focused image of a slide as shown in Fig. 9.

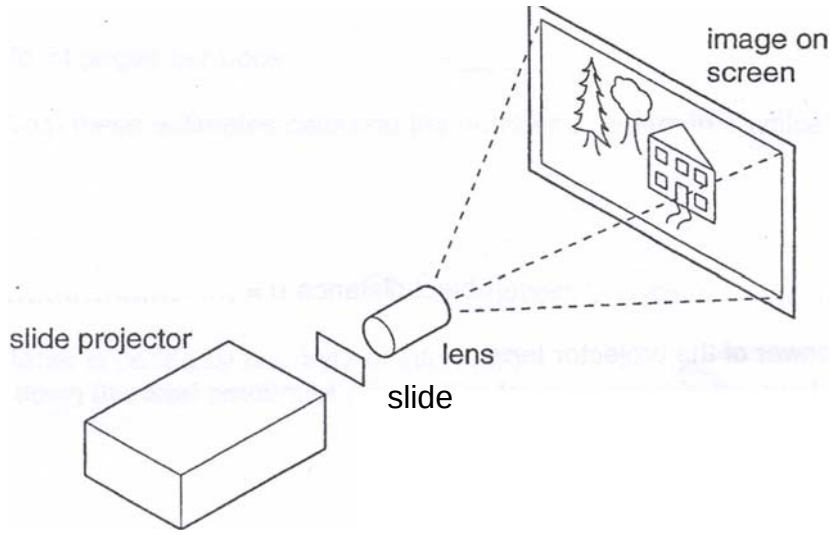


Fig. 9

(a) State the type of lens required for the projector.

[1]

(b) The image on the screen is projected the correct way up.
How must the slide be placed in the projector to achieve this?

[1]

(c) The width of the slide is 35 mm. If the image on the screen is to be 1.75 m wide, what is the magnification?

magnification = ……[2]

(d) The image is 4.0 m from the projector lens.
Calculate the object distance u from the slide to the lens.

object distance u = ……[2]

(e) Calculate the power of the projector lens.

power of lens = ... D [3]

(f) The screen is moved further away from the projector.
What adjustment to the lens position is needed to keep the image in focus?

[1]

10 This question is about some aspects of the design of a book in electronic form that might replace paper print in the future.

(a) (i) Complete the following list of estimates for a typical paperback book.

No. of letters per word = 6

No. of words per line = _____

No. of lines per page = 40

No. of pages per book = _____

[2]

(ii) From these estimates calculate the number of letters in a typical paperback book.

letters in book =..... [1]

(b) Each letter is coded by one byte of information.
Write down the total amount of information for the letters in the book.

information in book = ... bytes [1]

(d) (i) Books will be available on credit-card sized memory chips, having storage capacity of 8 Mbytes.
How many books of this size could be stored on one chip?

books stored per chip = ... [2]

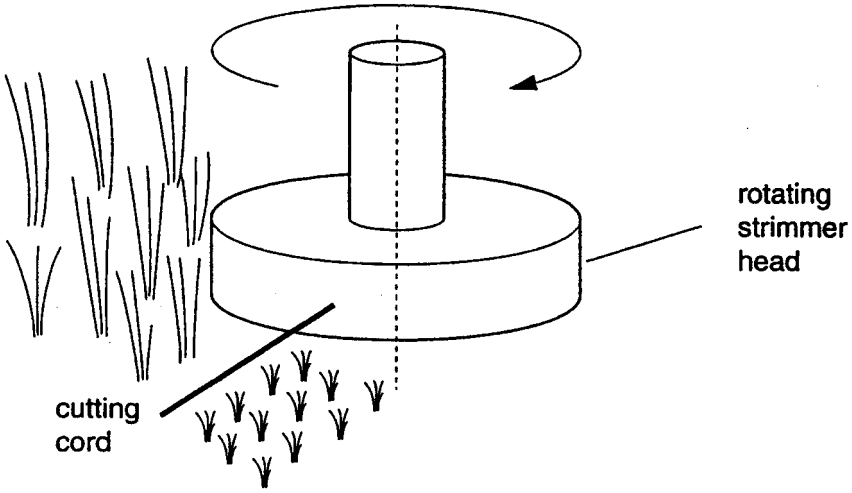
(ii) Books could also be downloaded to memory from the Internet. . The average information transfer rate is 14 kbits per second.
How long will it take to download one book from the Internet?

time to download one book = ... s [3]

(e) Suggest one consequence of having books available on portable cards, able to be read by computer, and downloadable from the Internet.

[1]

11 This question is about choosing a material, to be used as the cutting cord of a motorised lawn cutter (strimmer). This is illustrated in Fig. 11.1.



The strimmer head is rotated at high speed and the taut plastic cord slices the grass.

Fig. 11.1

(a) Suggest one reason why the material of the cord needs to be tough.

[1]

The table, Fig. 11.2, shows mechanical properties for three different polymers.

Polymer	density / kg m^{-3}	Young modulus / GPa	toughness / J m^{-2}	yield stress / MPa	hardness / MPa
Nylon 6	1200	1.8	2600	48	130
Polypropylene	900	1.3	2800	26	77
Polystyrene	1100	2.6	370	35	110

Fig. 11.2

(b) (i) Explain the terms: toughness, yield stress and hardness.

Toughness:

Yield stress:

Hardness:

[3]

(ii) Which of the three materials in Fig. 11.2 would be the best choice for the strimming cord?

[1]

(iii) Give three reasons for your choice of material.

[3]

(iv) Rapid rotation of the strimmer sets up tensile stress in the cord. The tensile stress is kept below half the yield stress.
Calculate the maximum strain on the cord.
Use data for the material you selected in (b)(i).

maximum strain =..... [2]

Section C

In this section of the paper you have the opportunity to write about some of the physics you have studied independently.

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 written communication.

12 This question is about devising an electrical/electronic sensor system for a particular purpose.

(a) (i) Describe the purpose for which the sensor system is intended.

[2]

(ii) Write down a suitable sensor for the purpose.

[1]

(c) State what physical change the sensor detects. How does it detect and measure this change?

[3]

(d) State a typical response time for your sensor, explaining any implications for your system.

[2]

(f) Draw a circuit diagram showing how a suitable electrical output signal can be obtained from the sensor.

[3]

(e) Describe how the circuit works.

[2]

13 You are asked to choose and discuss a practical example of a system in which signals transmit information.

(a) (i) State the example of a signal transmission system that you have chosen, naming the kind of information to be transmitted.

(ii) Show with a diagram how the signal information is produced, transmitted and delivered to the receiver.

[5]

(b) (i) At approximately what speed do the signals travel?

(ii) Make an estimate of the time the signals typically take to travel from sender to receiver.

[4]

(c) (i) State two factors which affect the rate of information transfer of your signalling system.

(ii) Estimate a typical rate of information transfer in your system

[4]

Quality of written communication [4]