



OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE
PHYSICS B (ADVANCING
PHYSICS)



2861

Understanding Processes

Monday **14 JUNE 2004** Afternoon 1 hour 30 minutes

Candidates answer on the question paper.

Additional materials:

- Data, Formulae and Relationships Booklet
- Electronic calculator
- Protractor
- Ruler

Candidate Name

Centre Number

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Candidate Number

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TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
DO NOT ANSWER IN PENCIL. DO NOT WRITE IN THE BARCODE. DO NOT WRITE IN THE GREY AREAS BETWEEN THE PAGES.
- 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 give 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.
- You will be awarded 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	41	
C	29	
TOTAL	90	

This question paper consists of 20 printed pages.



Section A

Answer all the questions.

For
Examiner's
Use

1 Here is a list of numbers.

- 500 5 5×10^{-2} 5×10^{-4}

Select from the list the number which is the best estimate for

(a) the diameter of a hair in m

diameter =m

(b) the wavelength of visible light in nm.

wavelength =nm
[2]

2 Photons from a source reach the point X on the screen by the two possible paths shown in Fig. 2.1. The resultant phasor amplitude at X for these two paths is 3.0.
At another point Y on the same screen (Fig. 2.2), the resultant phasor amplitude is 1.5.

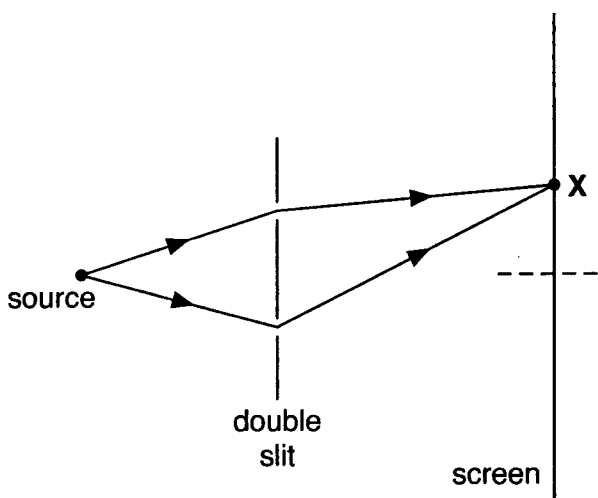


Fig. 2.1

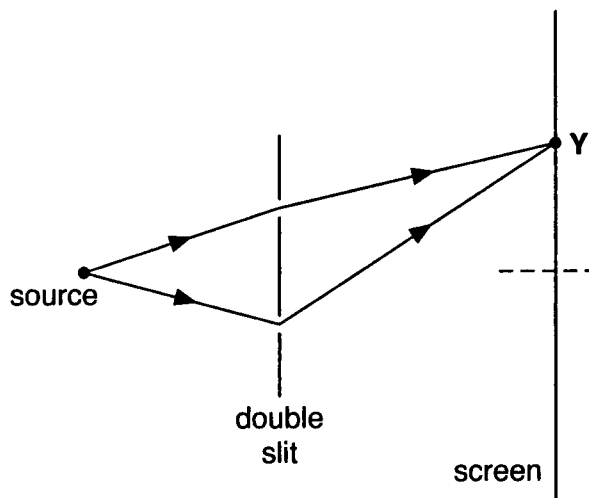


Fig. 2.2

Calculate the ratio, $P = \frac{\text{probability of photons arriving at point X}}{\text{probability of photons arriving at point Y}}$

$P = \dots\dots\dots$ [2]



3 A car travels a distance s in a time t with constant acceleration a . In this time, the velocity of the car increases from an initial velocity u to a final velocity v .

The equations below model the motion.

$$s = \frac{(u + v)t}{2} \quad \text{equation 1}$$

$$v = u + at \quad \text{equation 2}$$

(a) Rearrange each of these equations to make t the subject of the equation.

equation 1

equation 2

$t =$

$t =$

[2]

(b) Equate the two expressions for t and hence show that

$$v^2 = u^2 + 2as.$$

[1]





4

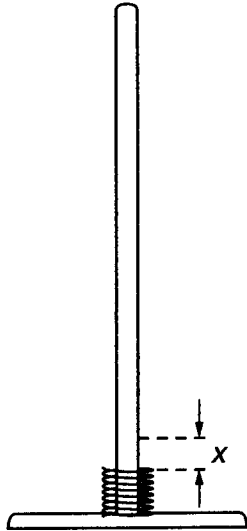


Fig. 4.1(a)

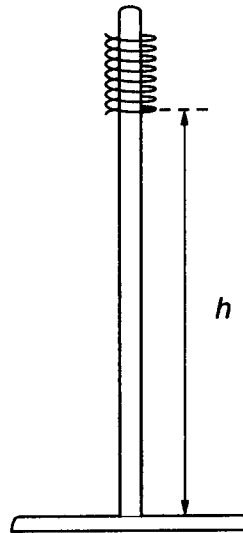


Fig. 4.1(b)

In Fig. 4.1(a), an open-wound spring is compressed a distance x . When released, the spring rises by a height h as shown in Fig. 4.1(b). The maximum possible value of h is given by

$$h = 500x^2.$$

On Fig. 4.2, the point for $x = 0.02$ m is already plotted.

Plot **three** further points and draw the graph to show how h varies with x .

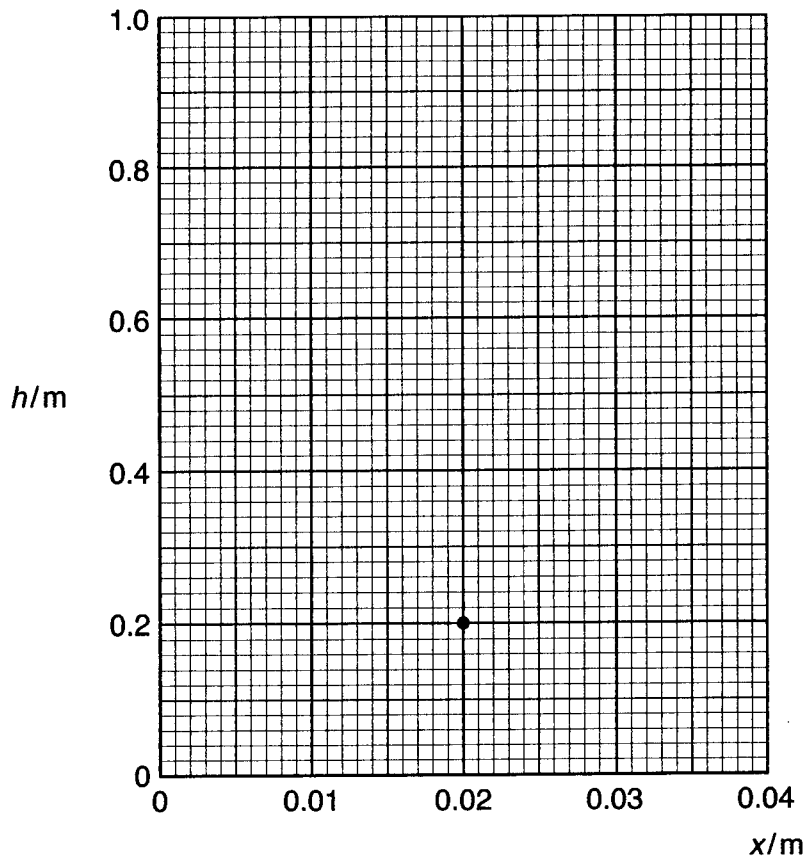


Fig. 4.2

[3]



- 5 A metal surface is illuminated with light. An electron in the metal surface requires a minimum amount of energy to escape from the surface.

The frequency of the light is changed and the maximum kinetic energy of the electrons emitted is measured for each frequency.

Fig. 5.1 shows a graph drawn using the measurements.

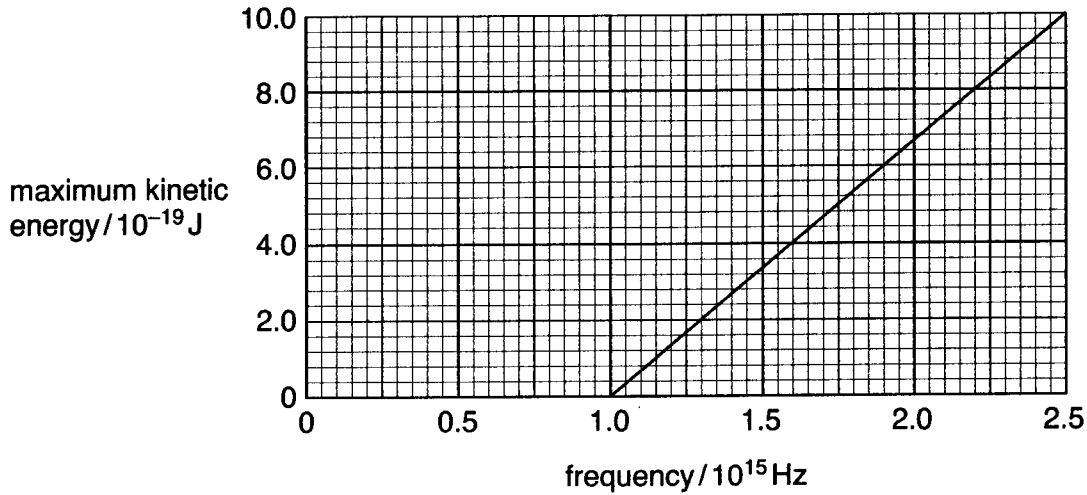


Fig. 5.1

- (a) Use the graph to determine the **minimum** frequency of light required for an electron to escape from the metal surface.

frequency =Hz [1]

- (b) Explain how the graph suggests that a minimum amount of **energy** is required for an electron to escape from the metal.

[2]

- (c) Calculate the gradient of the graph.

gradient =Js [1]





- 6 Fig. 6.1 shows the distance–time graph for an underground train travelling between two stations.

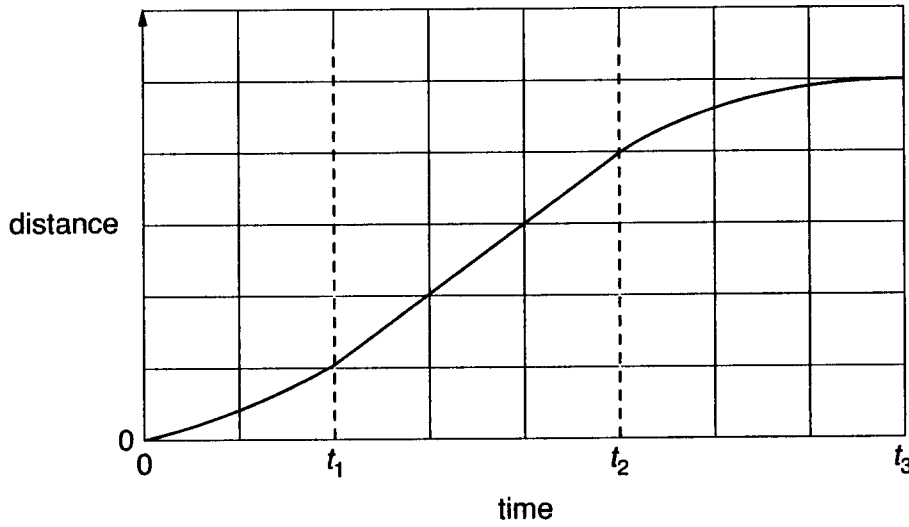


Fig. 6.1

On Fig. 6.2, sketch a graph to show how the **speed** of the train varies with time t during the journey.
The train starts from rest at $t = 0$.

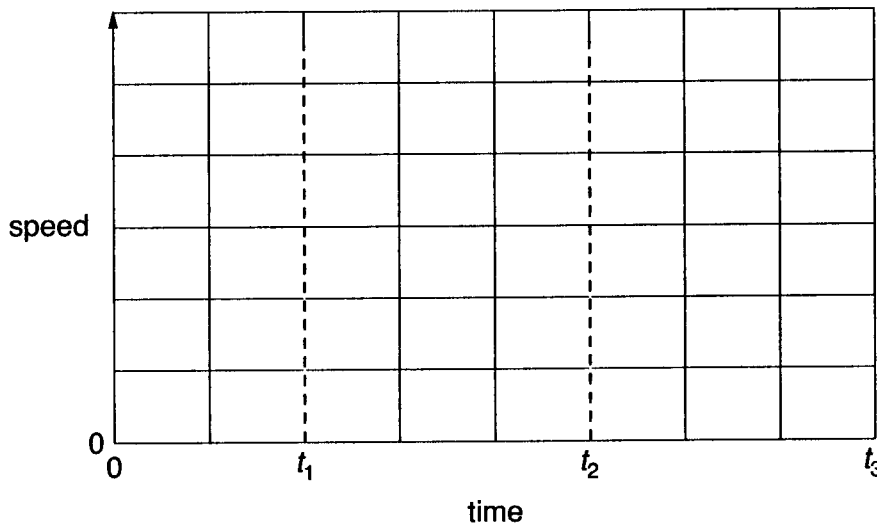


Fig. 6.2

[3]





For
Examiner's
Use

7 Fig. 7.1 shows a graph of two oscillations **A** and **B**.

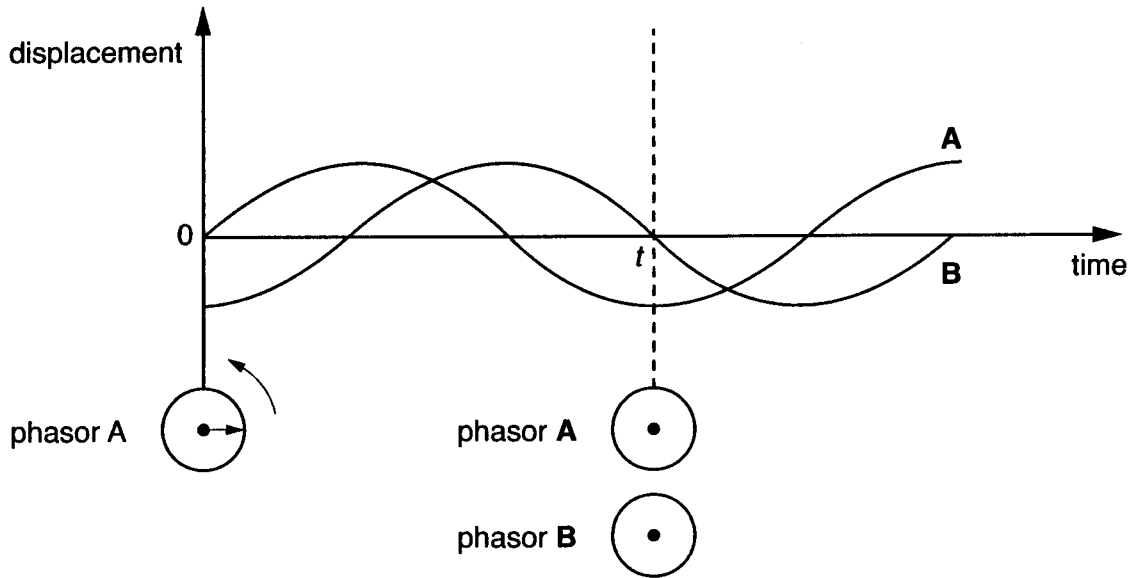


Fig. 7.1

(a) State the phase difference between the two oscillations **A** and **B**.

phase difference =[1]

(b) Draw, in the circles provided on Fig. 7.1, phasors to represent **A** and **B** at time t . Assume that the phasors rotate in an anticlockwise direction. [2]

[Section A Total: 20]





Section B

8 This question is about an investigation of standing waves in a pipe.

- (a) Sound waves are sent into a long pipe containing water, from a loudspeaker positioned above the pipe. The waves are reflected by the water surface. The water level is lowered until a standing wave is set up in the air in the pipe (Fig. 8.1). A loud note is heard. The water level is then lowered further until a loud sound is again obtained from the air in the pipe (Fig. 8.2).

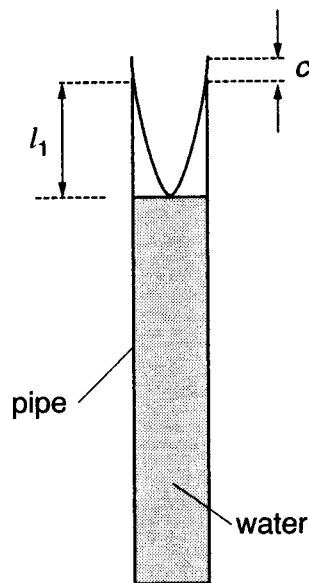


Fig. 8.1

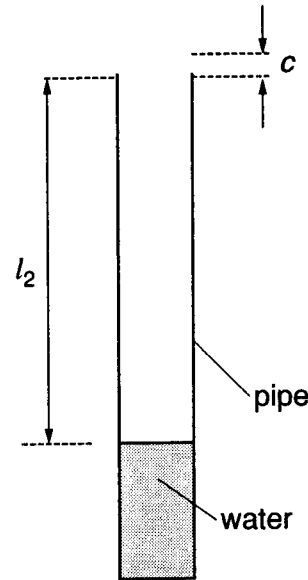


Fig. 8.2

The air at the open end of the pipe is free to move and this means that the displacement antinode of the standing wave is actually a small distance c beyond the open end. This distance is called the end correction.

A student writes down the following equations relating to the two situations shown.

$$l_1 + c = \frac{\lambda}{4} \qquad l_2 + c = \frac{3\lambda}{4}$$

- (i) Draw the standing wave in the pipe shown in Fig. 8.2 which corresponds to the equation $l_2 + c = \frac{3\lambda}{4}$.

On your diagram, label the positions of any displacement nodes and antinodes with the letters **N** and **A** respectively. [2]

- (ii) Use the two equations to show that $l_2 - l_1 = \frac{\lambda}{2}$.

[1]



(iii) The following results were recorded in this experiment.

frequency of sound = 500 Hz $l_1 = 0.170$ m $l_2 = 0.506$ m

Calculate

1. the wavelength λ of the sound wave

$\lambda = \dots\dots\dots\text{m}$ [2]

2. the speed of sound v in the pipe.

$v = \dots\dots\dots\text{ms}^{-1}$ [2]

(b) The student repeats the experiment, but sets the frequency of the sound from the speaker at 5000 Hz.

Suggest and explain why these results are likely to give a far less accurate value for the speed of sound v than those obtained in the first experiment.

[3]

[Total: 10]





- 9 This question is about an orange light-emitting diode (LED).

Light emerging from the orange LED passes through a diffraction grating and the pattern of coloured dots, shown in Fig. 9.1, is produced on a screen beyond the grating. Fig. 9.2 shows the intensity distribution in the pattern.

For
Examiner's
Use

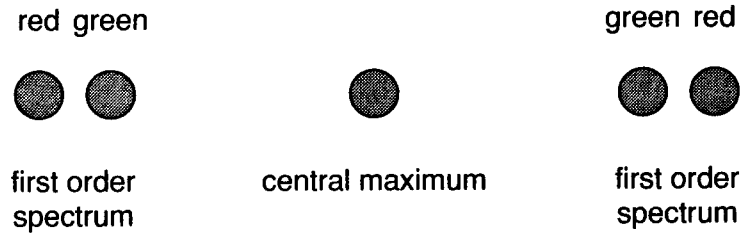


Fig. 9.1

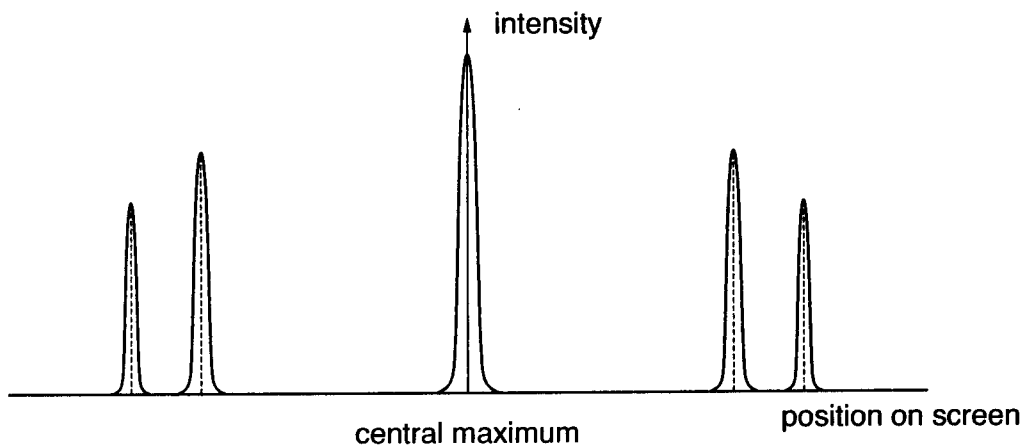


Fig. 9.2

- (a) (i) State **two** ways in which the central maximum differs in **appearance** from the first order spectrum either side of the central maximum.

[2]

- (ii) What does the presence of just two dots, green and red, in the first order spectrum, tell you about the light waves coming from the LED?

[1]



(iii) Explain why the green dots are closer than the red dots to the central maximum of the diffraction pattern.

[2]

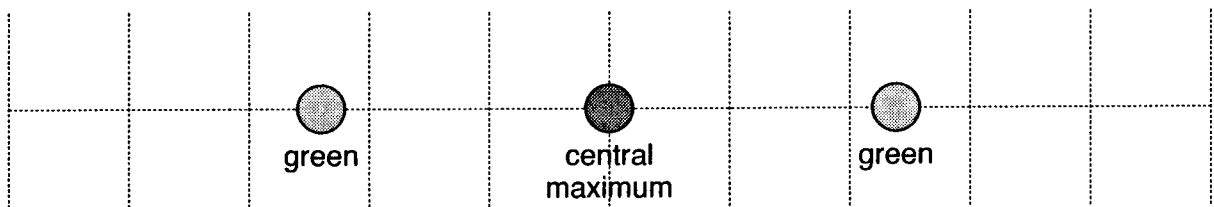
(iv) Give **one** reason why the intensity of the central maximum is greater than the intensity of either the green or red dots in the first order spectrum.

[1]

(b) The diffraction grating is removed and replaced by another with **twice** the number of lines per mm.

(i) In Fig. 9.3, the positions of the central maximum and the green dots in the first order spectrum of the **original** pattern are shown.

Draw on this diagram the positions of the green dots in the first order spectrum produced by the grating with twice the number of lines per mm.



[2]

Fig. 9.3

(ii) Explain your reasoning.

[2]

[Total: 10]

[Turn over