

Wave Basics

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Electrons , waves and photons
Sub-Topic	Wave Basics
Booklet	Question Paper 4

Time Allowed: 53 minutes

Score: / 44

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

- (c) Figs. 6.2 and 6.3 show stationary wave patterns of amplitude against position along the tube at the fundamental frequency f_0 and the next possible harmonic at frequency $3f_0$.

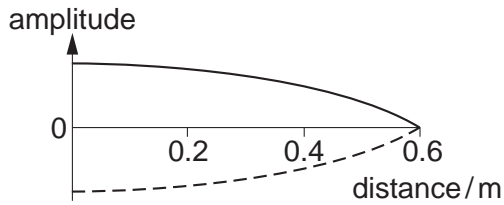


Fig. 6.2

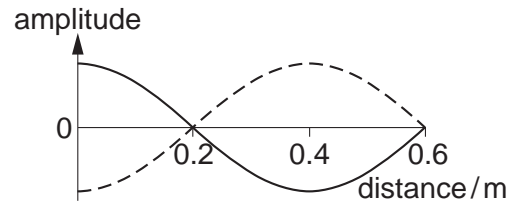


Fig. 6.3

Describe the motion of the air in the tube containing the stationary wave

- (i) at points 0m, 0.2m and 0.6m in Fig. 6.2

.....

 [2]

- (ii) at points 0m, 0.2m and 0.4m in Fig. 6.3.

.....

 [2]

- (d) The end of the tube at 0.6m from the loudspeaker is now opened.

- (i) On Fig. 6.4 sketch the stationary wave pattern of amplitude against position along the tube at the new fundamental frequency. [2]

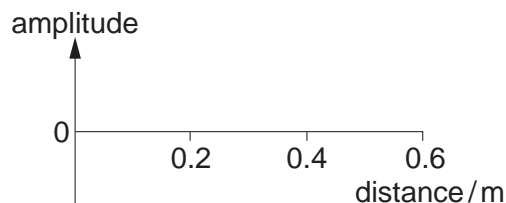


Fig. 6.4

- (ii) State how the frequency of this stationary wave is related to the frequency f_0 of Fig. 6.2.

..... [1]

[Total: 14]

2 (a) When a glowing gas discharge tube is viewed through a diffraction grating an emission line spectrum is observed.

(i) Explain what is meant by a *line spectrum*.

.....
.....
..... [2]

(ii) Describe how an absorption line spectrum differs from an emission line spectrum.

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

(b) A fluorescent tube used for commercial lighting contains excited mercury atoms. Two bright lines in the visible spectrum of mercury are at wavelengths 436 nm and 546 nm.

$$1 \text{ nm} = 10^{-9} \text{ m}$$

Calculate

(i) the energy of a photon of violet light of wavelength 436 nm

$$\text{energy} = \dots\dots\dots \text{ J [3]}$$

(ii) the energy of a photon of green light of wavelength 546 nm.

$$\text{energy} = \dots\dots\dots \text{ J [1]}$$

- (c) Electron transitions between the three levels **A**, **B** and **C** in the energy level diagram for a mercury atom (Fig. 7.1) produce photons at 436 nm and 546 nm. The energy E of an electron bound to an atom is negative. The ionisation level, not shown on the diagram, defines the zero of the vertical energy scale.

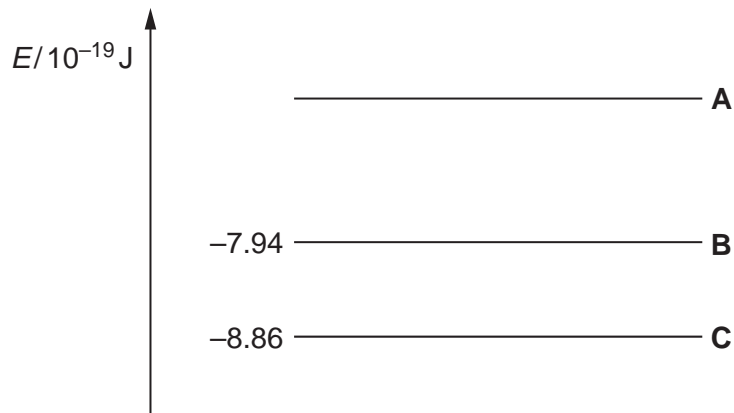


Fig. 7.1

- (i) Draw two arrows on Fig. 7.1 to represent the transitions which give rise to these photons. Label each arrow with its emitted photon wavelength. [3]
- (ii) Use your values for the energy of the photons from (b) to calculate the value of the energy level **A**.

$$E = \dots\dots\dots \text{ J [2]}$$

- (d) The light from a distant fluorescent tube is viewed through a diffraction grating aligned so that the tube and the lines on the grating are parallel. The light from the tube is incident as a parallel beam at right angles to the diffraction grating.

The line separation on the grating is $3.3 \times 10^{-6} \text{ m}$.

Calculate the angle to the straight through direction of the first order green (546 nm) image of the tube seen through the grating.

$$\text{angle} = \dots\dots\dots^\circ \text{ [3]}$$

[Total: 15]

3 (a) (i) Both electromagnetic waves and sound waves can be **reflected**. State **two** other wave

phenomena that apply to both electromagnetic waves and sound waves.

- 1.
- 2. **[2]**

(ii) Explain why electromagnetic waves can be polarised but sound waves cannot be polarised.

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

(iii) Describe briefly an experiment to demonstrate the polarisation of microwaves in the laboratory.



In your answer you should make clear how your observations demonstrate polarisation.

.....
.....
.....
..... **[4]**

- (b) A sound wave emitted by a loudspeaker consists of a single frequency. Fig. 4.1 shows the displacement against time graph of the air at a point **P** in front of the speaker.

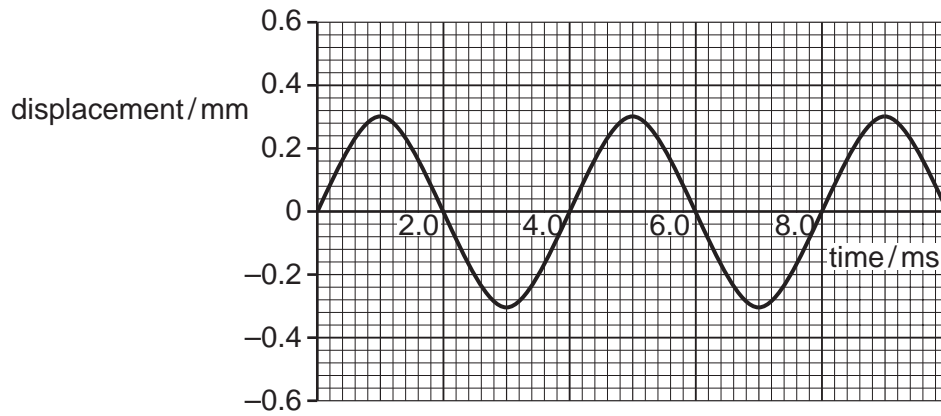


Fig. 4.1

- (i) Use Fig. 4.1 to find

- 1 the amplitude of the air motion

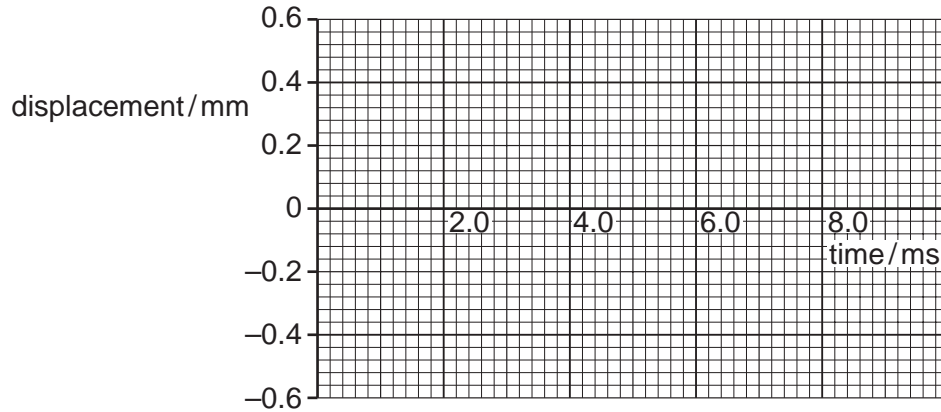
amplitude = mm [1]

- 2 the frequency of the sound wave.

frequency = Hz [2]

- (ii) The sound generator is adjusted so that the loudspeaker emits a sound at the original frequency and twice the **intensity**. Sketch on Fig. 4.2 the new displacement against time graph at point **P**. Explain your reasoning.

.....



[3]

Fig. 4.2

- (iii) Suggest, with reasons, the apparatus that you would choose to detect and measure the frequency of the sound wave at **P**.

.....

 [2]

[Total: 15]