1 **(a)** Describe, in terms of vibrations, the difference between a longitudinal and a transverse wave. Give one example of each wave.

....

....

....

....

....

....

.... **[4]**

(b) Fig. 6.1 shows a loudspeaker fixed near the end of a tube of length 0.6 m.

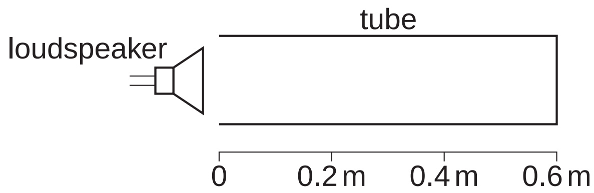


Fig. 6.1

The far end of the tube is closed. The frequency of the sound emitted from the loudspeaker is increased from zero. At a particular frequency a stationary wave is set up in the tube and the sound heard is much louder.

Explain how a stationary wave is formed in the tube.

In your answer, you should make clear how the stationary wave arises.

....

....

....

....

....

....

....

....

.... **[3]**

(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 $3f_0$.

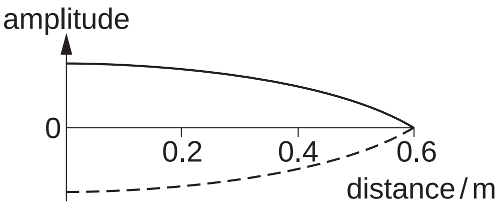


Fig. 6.2

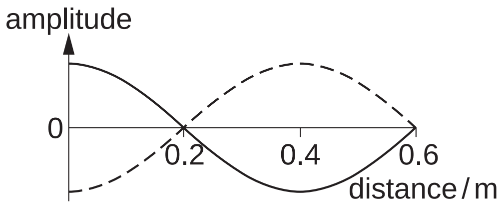


Fig. 6.3

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

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

....

....

.... **[2]**

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

....

....

.... **[2]**

(d) The end of the tube at 0.6 m 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]**

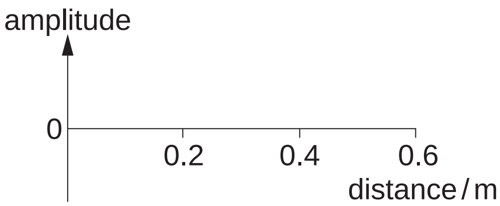


Fig. 6.4

(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

energy = ... J **[3]**

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

energy = ... 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.

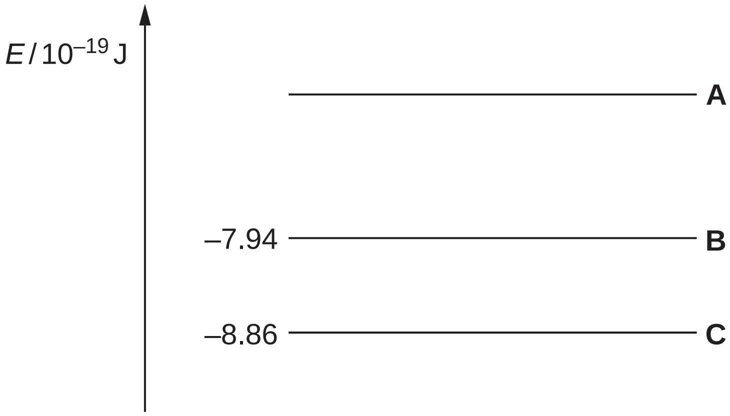


Fig. 7.1

(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 = ... 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 3.3×10^{-6} m.

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

angle = ... ° **[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.

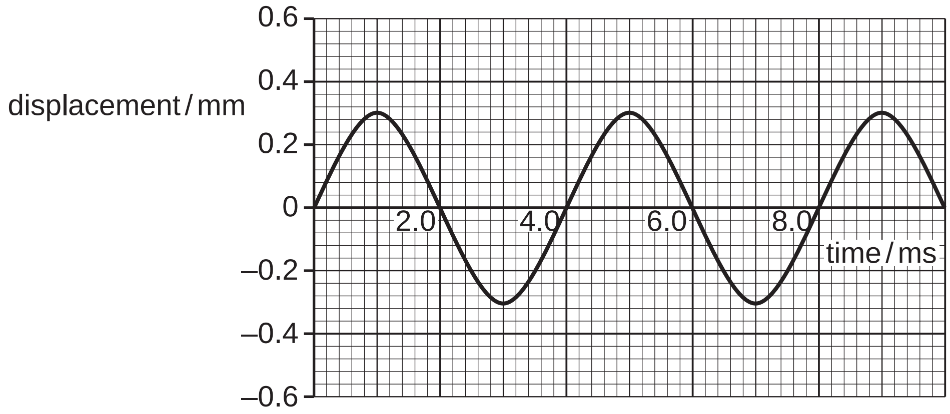


Fig. 4.1

(i) Use Fig. 4.1 to find

1 the amplitude of the air motion

amplitude = ... mm **[1]**

2 the frequency of the sound wave.

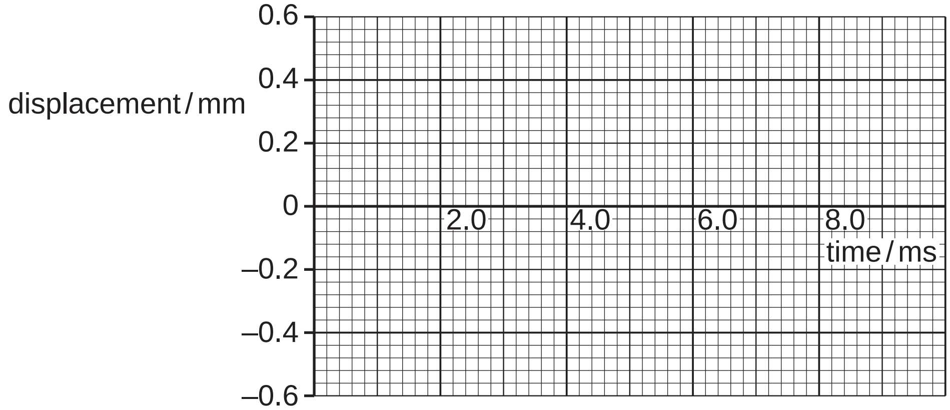
frequency = ... Hz **[2]**

(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]