A Level H2 Physics Tutorial 11: Wave Motion

Syllabus :
(a) show an understanding of and use the terms displacement, amplitude, period, frequency, phase difference, wavelength and speed .

1.

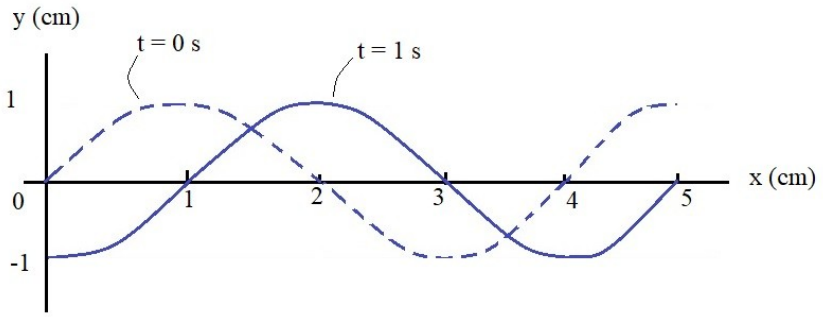

Figure 11-1(a)

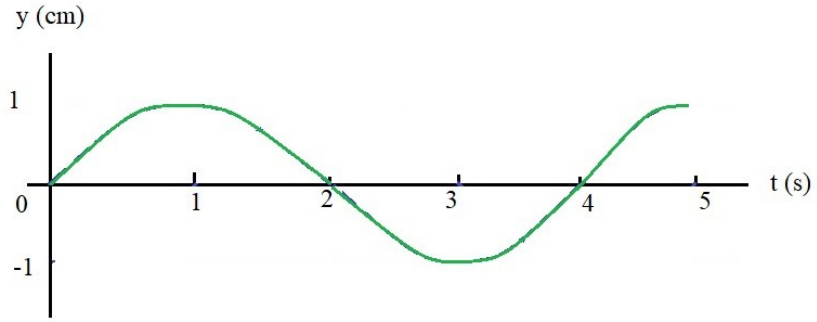

Figure 11-1(b)

A student holds one end of a rope and shakes it up and down repeatedly. Figure 11-1 (a) shows snapshots of the rope at time t = 0 s and 1 s. Figure 11-1(b) shows the displacement versus time at at x = 2 cm.

(i) Referring to Fig. 1(b), at 2 cm, what are the displacements y at t = 0 s and 1 s.

(ii) How long would the peak at x = 1 cm take to travel 1 wavelength?

(iii) For this this time, describe how the displacement y at x = 1 cm changes. Hence, state the significance of the time, T.

(iv) State the meaning of frequency, f. Find its value using the time, T.

(v) Given that 1 cycle of an oscillation is related to 2π radians, find the phase difference between the two waves in Fig. 1(a).

(b) deduce, from the definitions of speed, frequency and wavelength, the equation v = fλ

2.

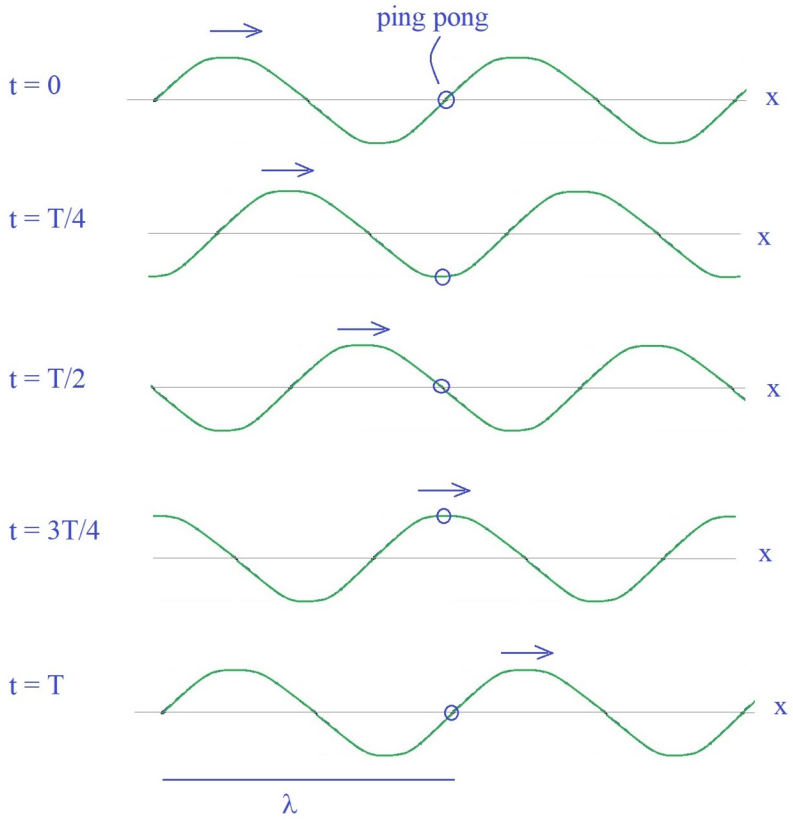

Figure 11-2

(a) A ping pong ball bobs up and down the surface of a river as a wave passes under it. The ping pong moves up and down once every T = 2 s. Find the frequency, f.

(b) The wavelength λ is 1 m. The ball bobs up and down once when 1 wavelength passes under it. Find the velocity v of the wave.

(c) Since 1 λ passes under the ball in 1 period T of the oscillation, write down an expression for the velocity v of the wave in terms of λ and T. Hence show that $v = f\lambda$.

(c) recall and use the equation $v = f\lambda$

(d) show an understanding that energy is transferred due to a progressive wave

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3. Give an example for each of the following waves which shows that it can transfer energy.

(a) sound
(b) light
(c) microwave
(d) water wave
(e) seismic wave

(e) recall and use the relationship, intensity $\propto$ (amplitude)^2

(f) show an understanding of and apply the concept that a wave from a point source and travelling without loss of energy obeys an inverse square law to solve problems

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4. The electromagnetic power radiated by the Sun is about 4×10^{26} W. Distance of Earth from Sun is 1.48×10^{11} km. Radius of Earth is 6378 km.

(i) Find the intensity of the radiation from Sun when it reaches Earth. (Ignore Earth's atmosphere for now.)

(ii) Find the power that Earth receives from Sun.

(g) analyse and interpret graphical representations of transverse and longitudinal waves

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5. (a) Sketch a graph to show 2 wavelengths of a transverse wave.

(b) Sketch a "picture graph" to show 2 wavelengths of a longitudinal wave. Using about 8 small circles to represent 1 wavelength..

In each case, label a distance to show a wavelength.

(h) show an understanding that polarisation is a phenomenon associated with transverse waves

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6. (i) Explain what is polarisation of a wave.

(ii) Why is it associated with transverse waves, but not longitudinal wave.

(i) recall and use Malus' law (intensity $\propto \cos^2\theta$) to calculate the amplitude and intensity of a plane polarised electromagnetic wave after transmission through a polarising filter

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7. Light is a transverse electromagnetic (EM) wave. It consists of electric field (E) and magnetic field (B), both perpendicular to the direction of travel.

A red light is passed through a polarising filter. Only E field component is a particular direction can pass.

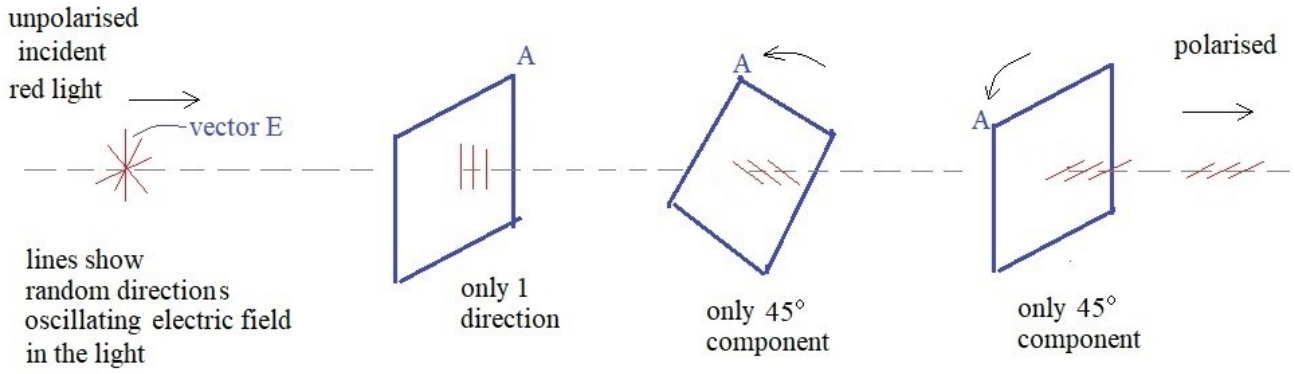

Figure 11-3

Write down in terms of the incident electric field amplitude E_0 the magnitudes of the electric field after it passes through

(i) filter A,
(ii) filter B, and
(iii) filter C.

In each case, write down also the intensity in terms of the initial intensity I_0.

(j) determine the frequency of sound using a calibrated oscilloscope

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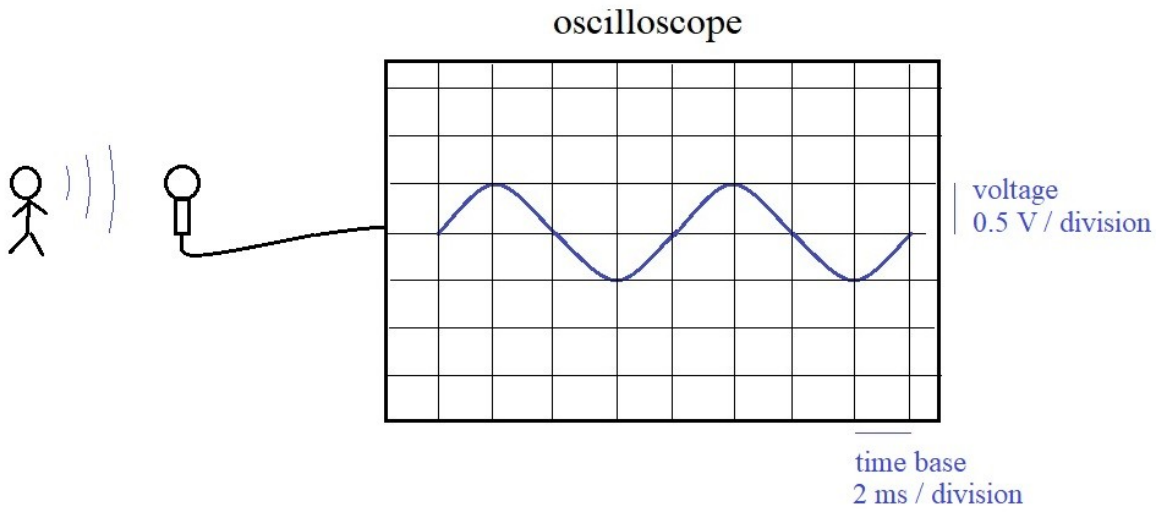

Figure 11-4

An oscilloscope is a device that can take a voltage input and plot a graph against time. The above sketch shows a simple setup.

(i) What is the period of the sound wave?

(ii) Find its frequency.

(k) determine the wavelength of sound using stationary waves.

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9. A loudspeaker in front of a wall emits a sound at a fixed frequency. A sound meter measures the intensity at various distances between speaker and wall.

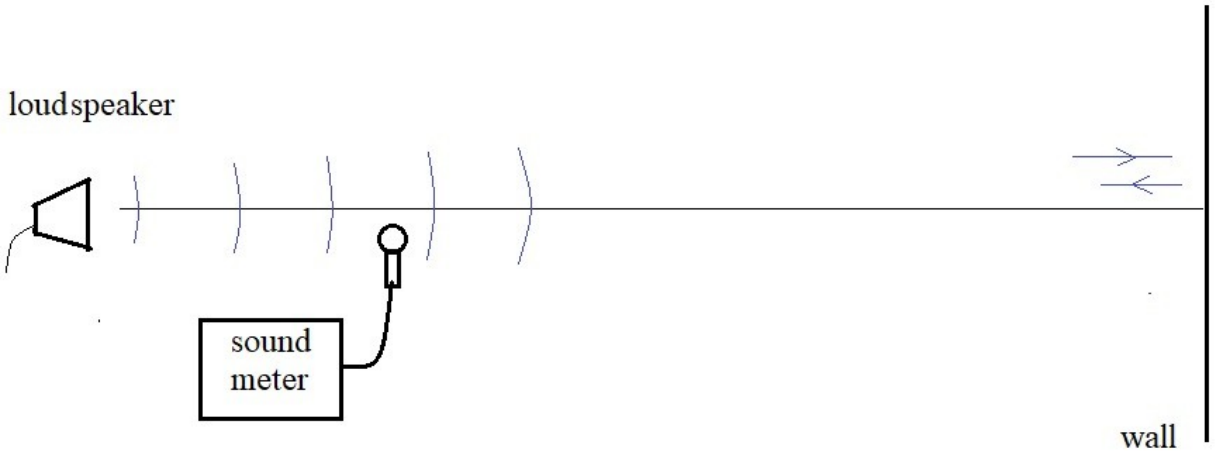

Figure 11-5

(a) Explain why the loudness increases and decreases at regular intervals as the microphone is moved towards the wall.

(b) The distance between to two neighbouring positions of minimum loudness is 40 cm. Find the wavelength of the sound.

(c) Given that the sound frequency is 440 Hz, find the speed of the sound.

Updated 26 Feb 2025