Extension Worksheet – Topic 4, Worksheet 4

1 A source of sound of frequency 6700 Hz is placed at the open end of a horizontal tube that contains some powder. The other end of the tube is closed. It is observed that powder in the tube collects in piles that are separated by a distance of 2.4 cm.

a Explain why the powder collects in piles. [3]

b Calculate the speed of sound in the tube. [2]

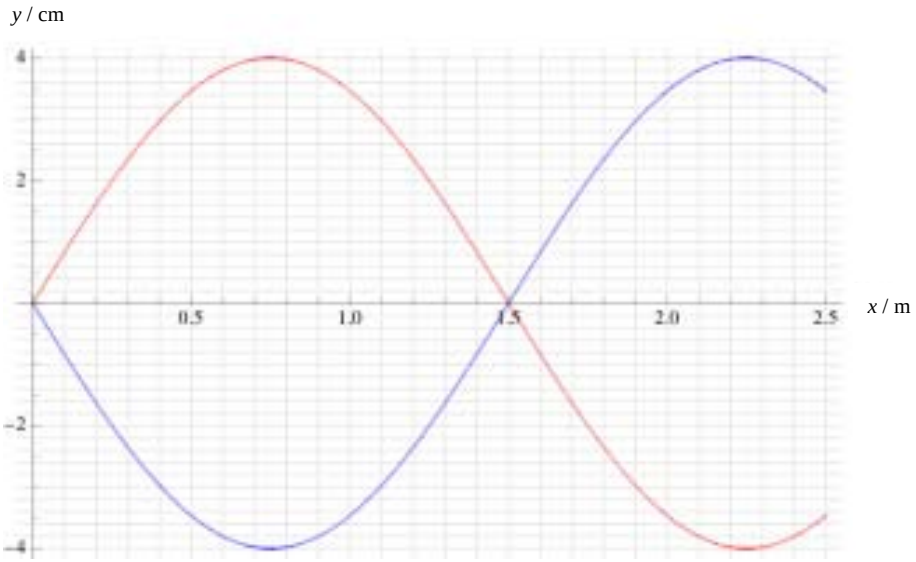
2 A tuning fork of frequency 720 Hz is placed over a cylinder containing some water. A strong sound is heard from the tube. Water is slowly removed from the cylinder while the tuning fork is sounded. The intensity of the sound first decreases but, at a particular water level, the intensity increases to a maximum again. The difference in the water level between the two positions of maximum sound intensity is 22 cm.

a Explain why the intensity of sound first decreases. [2]

b Estimate the speed of sound in the cylinder. [2]

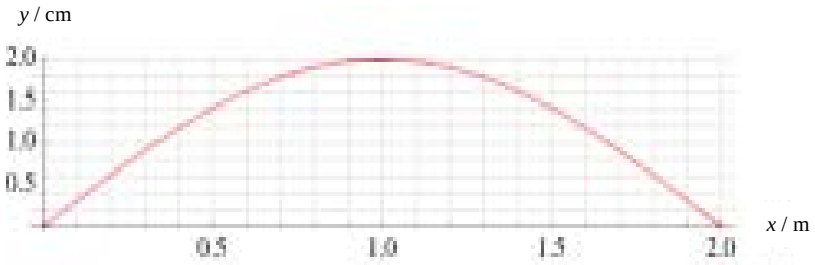
3 A string with both ends fixed oscillates in its fundamental harmonic mode. The frequency of the wave is 45 Hz and the speed is 180 m s^{-1}. Calculate the length of the string. [2]

4 The diagram shows the variation with distance (in m) of the displacement (in cm) of particles in a medium in which a longitudinal standing wave has been established. Positive displacements indicate displacements to the right.



A student states that the particle at x = 1.5 m is always at the centre of a compression. Comment on this statement. [3]

5 A string with both ends fixed oscillates in its fundamental harmonic mode. The diagram shows the string at a particular time when the displacement of the point at x = 1.0 m is 2.0 cm. The amplitude of oscillation of this point is 4.0 cm.



At this instant the point at x = 1.0 m is moving upwards. The frequency of the wave is 36 Hz. At this instant:

a Draw an arrow on the diagram to show the direction of the acceleration of the particle. [1]

b Calculate the speed of the particle. [3]

c Calculate the speed of the wave. [2]

d In the context of a standing wave, explain what is meant by the term **speed of the wave**. [2]

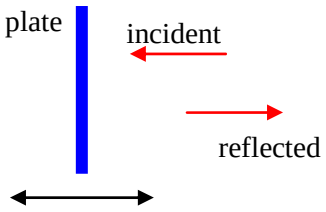
6 A stationary source of sound emits sound of frequency f and wavelength λ. An observer moves towards the source with constant velocity v. The speed of sound in still air is c. According to the moving observer:

a State an expression for the speed of sound, in terms of c and v. [2]

b Derive an expression for the wavelength of the sound measured by the observer in terms of λ. [2]

c Explain your answer to **b** using wavefront diagrams. [2]

7 A vertical metal plate is executing simple harmonic oscillations with amplitude 5.00 cm and frequency 25.0 Hz.



Sound waves of frequency 1200 Hz are emitted from a source and are incident on the plate. The reflected waves are received back at the source.

a Calculate the maximum speed of the plate. [2]

b Determine the range of frequencies of the reflected waves measured at the source. Take the speed of sound to be 340 m s^{-1}. [6]