Waves

Very Short Answer Type Questions

1. A sonometer wire is vibrating in resonance with a tuning fork. Keeping the tension applied same, the length of the wire is doubled. Under what conditions would the tuning fork still be is resonance with the wire?
2. An organ pipe of length L open at both ends is found to vibrate in its first harmonic when sounded with a tuning fork of 480 Hz. What should be the length of a pipe closed at one end, so that it also vibrates in its first harmonic with the same tuning fork?
3. A tuning fork A, marked 512 Hz, produces 5 beats per second, where sounded with another unmarked tuning fork B. If B is loaded with wax the number of beats is again 5 per second. What is the frequency of the tuning fork B when not loaded?
4. The displacement of an elastic wave is given by the function
   $y = 3 \sin \omega t + 4 \cos \omega t$.
   where y is in cm and t is in second. Calculate the resultant amplitude.
5. A sitar wire is replaced by another wire of same length and material but of three times the earlier radius. If the tension in the wire remains the same, by what factor will the frequency change?
6. At what temperatures (in °C) will the speed of sound in air be 3 times its value at O°C?
7. When two waves of almost equal frequencies n_1 and n_2 reach at a point simultaneously, what is the time interval between successive maxima?

Short Answer Type Questions

1. A steel wire has a length of 12 m and a mass of 2.10 kg. What will be the speed of a transverse wave on this wire when a tension of $2.06 * 10^4$N is applied?
2. A pipe 20 cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by a source of 1237.5 Hz ?(sound velocity in air = 330 m s^{-1})
3. A train standing at the outer signal of a railway station blows a whistle of frequency 400 Hz still air. The train begins to move with a speed of 10 m s^{-1} towards the platform. What is the frequency of the sound for an observer standing on the platform? (sound velocity in

air = 330 m s^{-1})

4. The wave pattern on a stretched string is shown in Fig. 15.2. Interpret what kind of wave this is and find its wavelength.

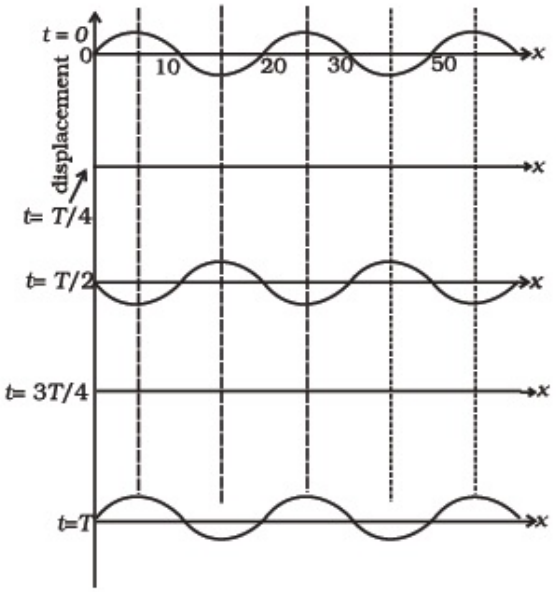

Fig. 15.2

5. The pattern of standing waves formed on a stretched string at two instants of time are shown in Fig. 15.3. The velocity of two waves superimposing to form stationary waves is 360 ms^{-1} and their frequencies are 256 Hz.

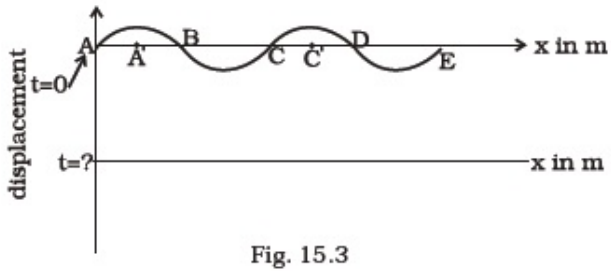

Fig. 15.3

- (a) Calculate the time at which the second curve is plotted.
- (b) Mark nodes and antinodes on the curve.
- (c) Calculate the distance between A′ and C ′ .

6. A tuning fork vibrating with a frequency of 512Hz is kept close to the open end of a tube filled with water (Fig. 15.4). The water level in the tube is gradually lowered. When the water level is 17cm below the open end, maximum intensity of sound is heard. If the room temperature is 20°C, calculate

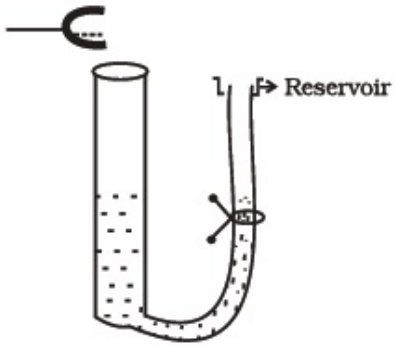

Fig. 15.4

   - (a) speed of sound in air at room temperature
   - (b) speed of sound in air at 0°C
   - (c) if the water in the tube is replaced with mercury, will there be any difference in your observations?

7. Show that when a string fixed at its two ends vibrates in 1 loop, 2 loops, 3 loops and 4 loops, the frequencies are in the ratio 1:2:3:4.

Long Answer Type Questions

1. The earth has a radius of 6400 km. The inner core of 1000 km radius is solid. Outside it, there is a region from 1000 km to a radius of 3500 km which is in molten state. Then again from 3500 km to 6400 km the earth is solid. Only longitudinal (P) waves can travel inside a liquid. Assume that the P wave has a speed of 8 km s^{-1} in solid parts and of 5 km s^{-1} in liquid parts of the earth. An earthquake occurs at some place close to the surface of the earth. Calculate the time after which it will be recorded in a seismometer at a

diametrically opposite point on the earth if wave travels along diameter?

2. If c is r.m.s. speed of molecules in a gas and v is the speed of sound waves in the gas, show that c/v is constant and independent of temperature for all diatomic gases.
3. Given below are some functions of x and t to represent the displacement of an elastic wave.
   - (a) $y = 5 \cos (4x) \sin (20t)$
   - (b) $y = 4 \sin (5x - t/2) + 3 \cos (5x - t/2)$
   - (c) $y = 10 \cos [(252 - 250) \pi t] \cos [(252+250)\pi t]$
   - (d) $y = 100 \cos (100\pi t + 0.5x)$

   State which of these represent
   - (a) a travelling wave along –x direction
   - (b) a stationary wave
   - (c) beats
   - (d) a travelling wave along +x direction.

   Given reasons for your answers

4. In the given progressive wave
   $y = 5 \sin (100\pi t - 0.4\pi x)$
   where y and x are in m, t is in s. What is the
   - (a) amplitude
   - (b) wave length
   - (c) frequency
   - (d) wave velocity
   - (e) particle velocity amplitude.

5. For the harmonic travelling wave $y = 2 \cos 2\pi (10 t - 0.0080 x + 3.5)$ where x and y are in cm and t is second. What is the phase difference between the oscillatory motion at two points separated by a distance of
   - (a) 4 m
   - (b) 0.5 m
   - (c) $\lambda / 2$
   - (d) $3 \lambda / 4$ (at a given instant of time)
   - (e) What is the phase difference between the oscillation of a particle located at x = 100 cm, at t = T s and t = 5 s?