

Chapter 7: Simple Harmonic Motion, Forced Vibrations and Origin of Refractive Index**PROBLEMS**

7.1 The displacement in a string is given by the following equation:

$$y(x, t) = a \cos\left(\frac{2\pi}{\lambda} x - 2\pi \nu t\right)$$

where a , λ and ν represent the amplitude, wavelength and the frequency of the wave. Assume $a = 0.1$ cm, $\lambda = 4$ cm, $\nu = 1$ sec⁻¹. Plot the time dependence of the displacement at $x = 0, 0.5$ cm, 1.0 cm, 1.5 cm, 2 cm, 3 cm and 4 cm. Interpret the plots physically.

7.2 The displacement associated with a standing wave on a sonometer is given by the following equation:

$$y(x, t) = 2a \sin\left(\frac{2\pi}{\lambda} x\right) \cos 2\pi \nu t$$

If the length of the string is L then the allowed values of λ are $2L$, $2L/2$, $2L/3$, ... (see Sec. 13.2). Consider the case when $\lambda = 2L/5$; study the time variation of displacement in each loop and show that alternate loops vibrate in phase (with different points in a loop having different amplitudes) and adjacent loops vibrate out of phase.

7.3 A tunnel is dug through the earth as shown in Fig. 7.15. A mass is dropped at the point A along the tunnel. Show that it will execute simple harmonic motion. What will the time period be?

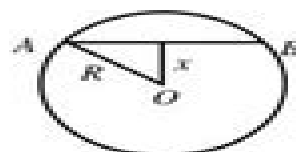


Fig. 7.15 For Problem 7.3

7.4 A 1 g mass is suspended from a vertical spring. It executes simple harmonic motion with period 0.1 sec. By how much distance had the spring stretched when the mass was attached?

7.5 A stretched string is given simultaneous displacement in the x - and y - directions such that

$$x(z, t) = a \cos\left(\frac{2\pi}{\lambda} z - 2\pi \nu t\right) \quad \text{and} \quad y(z, t) = a \cos\left(\frac{2\pi}{\lambda} z - 2\pi \nu t\right)$$

Study the resultant displacement (at a particular value of z) as a function of time.

7.6 In the above problem, if

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