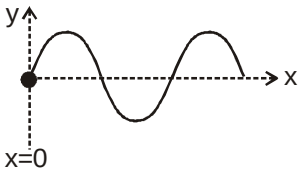
Exercise - III (Subjective Problems)

1. Consider the wave y = (5 mm) sin (1 cm^{-1}) x – (60 s^{-1})t] Find (a) the amplitude (b) the wave number, (c) the wavelength, (d) the frequency, (e) the time period and (f) the wave velocity.

2. The wave function for a traveling wave on a taut string is (in SI unit)
$y(x, t) = (0.350 \text{ m}) \sin (10 \pi t - 3\pi x + \pi/4)$
(a) What are the speed and direction of travel of the wave ?
(b) What is the vertical displacement of the string at t = 0, x = 0.100 m ?
(c) What are wavelength and frequency of the wave ?
(d) What is the maximum magnitude of the transverse speed of a particle of the string ?

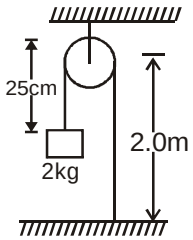
3. The string shown in figure is driven at a frequecy of 5.00 Hz. The amplitude of the motion is 12.0 cm, and the wave speed is 20.0 m/s. Furthermore, the wave is such that y = 0 at x = 0 and t = 0. Determine (a) the angular frequency and (b) wave number for this wave. (c) Write an expression for the wave function. Calculate (d) the maximum transverse speed and (e) the maximum transverse acceleration of a point on the string.



4. Two strings A and B with μ = 2 kg/m and μ = 8 kg/m respectively are joined in series and kept on a horizontal table with both the ends fixed. The tension in the string is 200 N. If a pulse of amplitude 1 cm travels in A towards the junction, then find the amplitude of reflected and transmitted pulse.

5. A parabolic pulse given by equation y (in cm) = 0.3 – 0.1 $(x - 5t)^2$ ($y \geq 0$) x in meter and t in second travelling in a uniform string. The pulse passes through a boundary beyond which its velocity becomes 2.5 m/s. What will be the amplitude of pulse in this medium after transmission ?

6. In the arrangement shown in figure, the string has mass of 4.5 g. How much time will it take for a transverse disturbance produced at the floor to reach the pulley ? Take g = 10 m/s^2



7. A uniform rope of length 12 m and mass 6 kg hange vertically from a rigid support. A block of mass 2 kg is attached to the free end of the rope. A transverse pulse of wavelength 0.06 m is produced at the lower end of the rope. What is the wavelength of the pulse when it reaches the top of the rope ?

8. A particle on stretched string supporting a travelling wave, takes 5.0 ms to move from its mean position to the extreme position. The distance between two consecutive particles, which are at their mean position, is 2.0 cm. Find the frequency, the wavelength and the wave speed.

9. A 6.00 m segment of a long string has a mass of 180 g. A high-speed photograph shows the at segment contains four complete cycles of wave. The string is vibrating sinusoidally with a frequency of 50.0 Hz and a peak=to-valley displacement of 15.0 cm. (The "peak-to-valley" displacement is the vertical distance from the farthest positive displacement to the farthest negative displacement. (a) Write the function that describes this wave traveling in the positive x direction. (b) Determine the power being supplied to the string.

10. A 200 Hz wave with amplitude 1 mm travels on a long string of linear mass density 6 g/m kept under a tension of 60 N. (a) Find the average power transmitted across a given point on the string. (b) Find the total energy associated with the wave in a 2.0m long portion of the string.

11. The equation of a plane wave travelling along positive direction of x-axis is $y = a \sin \frac{2\pi}{\lambda}(vt - x)$
When this wave is reflected at a rigid surface and its amplitude becomes 80%, then find the equation of the reflected wave

12. A travelling wave of amplitude 5 A is partially reflected from a boundary with the amplitude 3 A. Due to superposition of two waves with different amplitudes in opposite directions a standing wave

pattern is formed. Determine the amplitude at node and antinodes.

13. Two waves are described by

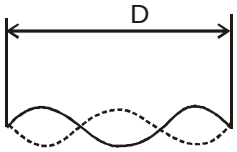
$y_1 = 0.30 \sin [\pi(5x - 200)t]$

and $y_2 = 0.30 \sin [\pi(5x - 200t) + \pi/3]$

where y_1, y_2 and x are in meters and t is in seconds. When these two waves are combined, a traveling wave is produced. What are the (a) amplitude, (b) wave speed, and (c) wave length of that traveling wave ?

14. What are (a) the lowest frequency, (b) the second lowest frequency, and (c) the third lowest frequency for standing waves on a wire that is 10.0 m long has a mass of 100 g. and is stretched under a tension of 250 N which is fixed at both ends ?

15. A nylon guitar string has a linear density of 7.20 g/m and is under a tension of 150 N. The fixed supports are distance D = 90.0 cm apart. The string is oscillating in the standing wave pattern shown in figure. Calculate the (a) speed wavelength, and (c) frequency of the traveling waves whose superposition gives this standing wave.



16.A string that is stretched between fixed supports separated by 75.0 cm has resonant frequencies of 420 and 315 Hz with no intermediate resonant frquencies. What are
(a) the lowest resonant frequencies and (b) the wave speed ?

17. A string oscillates according to the equation

$$y' = (0.50 \text{ cm}) \sin \left[\left(\frac{\pi}{3}\text{cm}^{-1}\right)x\right] \cos [(40\ \pi\ \text{s}^{-1})t]$$

What are the (a) amplitude and (b) speed of the two waves (identical except for direction of travel) whose superposition gives this oscillation ? (c) What is the distance between nodes ? (d) What is the transverse speed of a particle of the string at the position x = 1.5 cm when t = 9/8 s ?

18. In an experiment of standing waves, a string 90 cm long is attached to the prong of an electrically driven tuning fork that oscillates perpendicular to the length of the string at a frequency of 60 Hz. The mass of the string is 0.044 kg. What tension must the string be under (weights are attached to the other end) if it is to oscillate in four loops ?

19. A string vibrates in 4 loops with a frequency of 400 Hz.
(a) What is its fundamental frequency ?
(b) What is frequency will cause it to vibrate into 7 loops.

20.A string fixed at both ends is vibrating in the lowest mode of vibration for which a point at quarter of its lengths from one end is a point of maximum displacement. The frequency of vibration in this mode is 100 Hz. What will be the frequency emitted when it vibrates in the next mode such that this point is again a point of maximum displacement.

21. A guitar string is 90 cm long and has a fundamental frequency of 124 Hz. Where should it be pressed to produced a fundamental frequency of 186 Hz ?

22. A 2.00 m long rope, having a mass of 80 g, is fixed at one end and is tied to a light string at the other end. The tension in the string is 256 N. (a) Find the frequencies of the fundamental and the first two overtones. (b) Find the wavelength in the fundamental and the first two overtones.

23. A stretched uniform wire of a sonometer between two fixed knife edges, when vibrates in its second harmonic gives 1 beat per second with a vibrating tuning fork of frequency 200 Hz. Find the percentage change in the tension of the wire to be in unison with the tuning fork.

24. A sonometer wires resonates with a given tuning fork forming standing waves with five antinodes between the two bridges when a mass of 9 kg is suspended from the wire. When this mass is replaced by M, the wire resonates with the same tuning fork forming three antinodes for the same position of bridges. Find the value of M.

25. A 40 cm long wire having a mass 3.2 gm and area of c.s. 1 mm^2 is stretched between the support 40.05 cm apart. In its fundamental mode. It vibrate with a frequency 1000/64 Hz. Find the young's modulus of the wire.

26. A steel rod having a length of 1m is fastened at its middle. Assuming young's modulus to be 2×10^{11} Pa, and density to be 8 gm/cm^3 find the fundamental frequency of the longitudinal vibration and frequency of first overtone.