Exercise - V JEE-Problems

1. A metallic rod of length 1m is rigidly clamped at its mid-point. Longitudinal stationary waves are set up in the rod in such a way that there are two nodes on either side of the mid-point. The amplitude of an antinode is 2×10^{-6}m. Write the equation of motion at a point 2 cm from the mid-point and those of the constituent waves in the rod [Young's modulus = 2×10^{11} Nm^{-2}, density = 8000 Kg m^{-3}]. **[JEE-94, 6]**

2. Select the correct alternative : **[JEE-96, 2×2 = 4]**

(i) The extension in a string, obeying Hooke's law is x. The speed of wave in the stretched string is v. If the extension in the string is increased to 1.5 x, the speed of wave will be
(A) 1.22 v (B) 0.61 v (C) 1.50 v (D) 0.75 v

(ii) An open pipe is suddenly closed at one end with the result that the frequency of third harmonic of the closed pipe is found to be higher by 100 Hz than the fundamental frequency of the open pipe. The fundamental frequency of the open pipe is
(A) 200 Hz (B) 300 Hz (C) 240 Hz (D) 480 Hz

3. A place progressive wave of frequency 25 Hz, amplitude 2.5×10^{-5} m & initial phase zero propagates along the (–ve) x-direction with a velocity of 300 m/s. At any instant, the phase difference between the oscillations at two points 6m apart along the line of propagation is ______ & the corresponding amplitude difference is ______ m. **[JEE-97, 2]**

4. A wave travelling in a stretched string is described by the equation y = A sin (kx – ωt). The maximum particle velocity is
(A) Aω (B) ω/k (C) dω/dk (D) x/t **[JEE-97, 1]**

5. Select the correct alternative (s). **[JEE-98, 2 + 2 + 2]**

(i) The (x, y) co-ordinates of the corners of a square plate are (0, 0) (L, 0) (L, L) & (0, L). The edges of the plate are clamped & transverse standing waves are set up in it. If u(x, y) denotes the displacement of the plate at the point (x, y) at some instant of time, the possible expression(s) for u is/are : (a = positive constant)

(A) $a\cos\left(\frac{\pi x}{2L}\right)\cos\left(\frac{\pi y}{2L}\right)$ (B) $a\sin\left(\frac{\pi x}{L}\right)\sin\left(\frac{\pi y}{L}\right)$

(C) $a\sin\left(\frac{\pi x}{L}\right)\sin\left(\frac{2\pi y}{L}\right)$ (D) $a\cos\left(\frac{2\pi x}{L}\right)\sin\left(\frac{\pi y}{L}\right)$

(ii) A string of length 0.4 m & mass 10^{-2} kg is tightly clamped at its ends. The tension in the string is 1.6 N. Identical wave pulses are produced at one end at equal intervals of time, Δt. The minimum value of Δt which allows constructive interference between successive pulses is
(A) 0.05 s (B) 0.10 s (C) 0.20 s (D) 0.40 s

(iii) A transverse sinusoidal wave of amplitude a, wavelength λ & frequency f is travelling on a stretched string. The maximum speed of any point on the string is $\frac{v}{10}$, where v is speed of propagation of the wave. If a = 10^{-3}m and v = 10 ms^{-1}, then λ & f are given by
(A) $\lambda = 2\pi \times 10^{-2}$ m (B) $\lambda = 10^{-2}$ m
(C) $f = \frac{10^3}{2\pi}$Hz (D) f = 10^4 Hz

6. A long wire PQR is made by joining two wires PQ and QR of equal radii. PQ has length 4.8 m and mass 0.06 kg. QR has length 2.56 m and mass 0.2 kg. The wire PQR is under a tension of 80N. A sinusoidal wave-pulse of amplitude 3.5 cm is sent along the wire PQ from the end P. No power is dissipated during the propagation of wave-pulse. Calculate **[JEE-99, 4+6]**
(a) the time taken by the wave-pulse to reach the other end R of the wire, and
(b) the amplitude of the reflected and transmitted wave-pulses after the incident wave-pulse crosses the joint Q.

7. As a wave progagates : **[JEE-99, 3]**
(A) the wave intensity remains constant for a plane wave
(B) the wave intensity decreases as the inverse of the distance from the source for a spherical wave
(C) the wave intensity decreases as the inverse square of the distance from the source for a spherical wave
(D) total power of the sherical wave over the spherical surface centered at the source remains constant at all times.

8. y(x, t) = 0.8/ [$(4x + 5t)^2$ + 5] represents a moving pulse, where x & y are in meter and t in second. Then :
(A) pulse is moving in +x direction
(B) in 2s it will travel a distance of 2.5 m
(C) its maximum displacement is 0.16 m
(D) it is a symmetric pulse **[JEE-99, 3]**

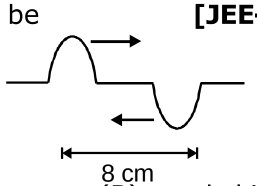
9. In a wave motion y = a sin (kx – ωt), y can represent :
(A) electric field (B) magnetic field
(C) displacement (D) pressure **[JEE-99, 3]**

10. Standing waves can be produced **[JEE-99, 3]**
(A) on a string clamped at both the ends
(B) on a string clamped at one end and free at the other
(C) when incident wave gets reflected from a wall
(D) when two identical waves with a phase difference of π are moving is same direction

11. Two vibrating strings of the same material but lengths L and 2L have radii 2r and r respectively. They are stretched under the same tension. Both the strings vibrate in their fundamental modes, the one of length L with frequency f_1 and the other with frequency f_2. The ratio f_1/f_2 is given by **[JEE-2000(Scr), 1]**
(A) 2 (B) 4 (C) 8 (D) 1

12. The ends of a stretched wire of length L are fixed at x = 0 and x = L. In one experiment, the displacement of the wire is $y_1 = A \sin(\pi x/L) \sin \omega t$ and energy is E_1 and in another experiment its displacement is $y_2 = A \sin(2\pi x/L) \sin 2\omega t$ and energy is E_2. Then **[JEE-2001(Scr)]**
(A) $E_2 = E_1$ (B) $E_2 = 2E_1$
(C) $E_2 = 4E_1$ (D) $E_2 = 16E_1$

13. Two pulses in a stretched string whose centres are initially 8cm apart are moving towards each other as shown in figure. The speed of each pulse is 2 cm/s. After 2 seconds, the total energy of the pulses will be **[JEE-2001(Scr)]**



(A) zero (B) purely kinetic
(C) purely potential
(D) partly kinetic and partly potential

14. A sonometer wire 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 mass M, the wire resonates with the same tuning fork forming three antinodes for the same positions of the bridges. The value of M is **[JEE-2002(Scr), 3]**
(A) 25 kg (B) 5 kg
(C) 12.5 kg (D) 1/25 kg

15. A stringe between x = 0 and x = l vibrates in fundamental mode. The amplitude A, tension T and mass per unit length μ is given. Find the total energy of the string. **[JEE-2003]**

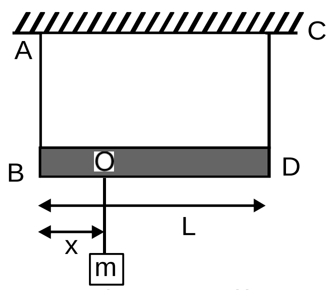
16. A string fixed at both ends is in resonance in its 2nd harmonic with a tuning fork of frequency f_1. Now its one end becomes free. If the frequency of the tuning fork is increased slowly from f_1 then again a resonance is obtained when the frequency is f_2. If in this case the string vibrates in nth harmonic then **[JEE-2005(Scr)]**

(A) $n = 3,\ f_2 = \frac{3}{4}f_1$ (B) $n = 3,\ f_2 = \frac{5}{4}f_1$

(C) $n = 5,\ f_2 = \frac{5}{4}f_1$ (D) $n = 5,\ f_2 = \frac{3}{4}f_1$

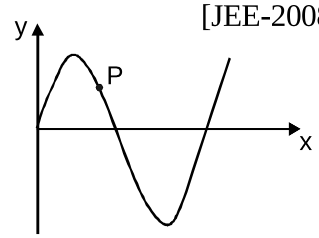
17. A transverse harmonic disturbance is produced in a string. The maximum transverse velocity is 3 m/s and maximum transverse acceleration is 90 m/s^2. If the wave velocity is 20 m/s then find the waveform. **[JEE-2005]**

18. A massless rod is suspended by two identical strings AB and CD of equal length. A block of mass m is suspended from point O such that BO is equal to 'x'. Further, it is observed that the frequency of 1st harmonic (fundamental frequency) in AB is equal to 2nd harmonic frequency in CD. Then, length of BO is **[JEE-2006]**



(A) $\frac{L}{5}$ (B) $\frac{L}{4}$ (C) $\frac{4L}{5}$ (D) $\frac{3L}{4}$

19. A transverse sinusoidal wave moves along a string in the positive x-direction at a speed of 10 cm/s. The wavelength of the wave is 0.5 m and its amplitude is 10 cm. At a particular time t, the snap-shot of the wave is shown in figure. The velocity of point P when its displacement is 5 cm is Figure : [JEE-2008]



(A) $\frac{\sqrt{3}\pi}{50}\hat{j}$ m/s (B) $-\frac{\sqrt{3}\pi}{50}\hat{j}$ m/s

(C) $\frac{\sqrt{3}\pi}{50}\hat{i}$ m/s (D) $-\frac{\sqrt{3}\pi}{50}\hat{i}$ m/s

20. A 20 cm long string, having a mass of 1.0 g, is fixed at both the ends. The tension in the string is 0.5 N. The string is set into vibrations using an external vibrator of frequency 100 Hz. Find the separation (in cm) between the successive nodes on the string. **[JEE 2009]**