10 - WAVES

(Answers at the end of all questions)

1) When two tuning forks (fork 1 and fork 2) are sounded simultaneously, 4 beats per second are heard. Now, some tape is attached on the prong of fork 2. When the tuning forks are sounded again, 6 beats per second are heard. If the frequency of fork 1 is 200 Hz, then what was the original frequency of fork 2 ?
(a) 202 Hz (b) 200 Hz (c) 204 Hz (d) 196 Hz [AIEEE 2005]

2) An observer moves towards a stationary source of sound with a velocity one-fifth of the velocity of sound. What is the percentage increase in the apparent frequency ?
(a) 0.5 % (b) zero (c) 20 % (d) 5 % [AIEEE 2005]

3) The displacement y of a particle in a medium can be expressed as
$y = 10^{-6} \sin (100t + 20x + \pi / 4)$ m, where t is in second and x in metre. The speed of the wave is
(a) 2000 m/s (b) 5 m/s (c) 20 m/s (d) 5π m/s [AIEEE 2004]

4) The displacement y of a wave travelling in the x – direction is given by
$y = 10^{-4} \sin (600t - 20x + \pi / 3)$ metres, where x is expressed in metres and t in seconds. The speed of the wave motion is
(a) 200 m/s (b) 300 m/s (c) 600 m/s (d) 1200 m/s [AIEEE 2003]

5) A tuning fork of frequency 256 Hz makes 5 beats per second with the vibrating string of a piano. The beat frequency decreases to 2 beats per second, when the tension in the piano string is slightly increased. The frequency of the piano string before increasing the tension was
(a) (256 + 2) Hz (b) (256 + 5) Hz (c) (256 - 2) Hz (d) (256 - 5) Hz [AIEEE 2003]

6) The displacement of a wave is given by the equation $y = 2 \sin (\pi / 1.6) (64t - x)$. The frequency of the wave is
(a) 30 Hz (b) 25 Hz (c) 20 Hz (d) 15 Hz [AIEEE 2002]

7) Transverse are generated in two uniform wires A and B by attaching their free ends to a vibrating source of frequency 600 Hz. The diameter of wire A is one-third that of wire B and tension in the wire A is double that in wire B. What is the ratio of velocities of waves of waves in wire A and B ?
(a) $\sqrt{3} : 2$ (b) $2 : \sqrt{3}$ (c) $3 : \sqrt{2}$ (d) $\sqrt{2} : 3$ [AIEEE 2002]

8) If the phase difference between two points is 60 ° on a wave velocity of 360 m /s and frequency 500 Hz, then path difference between the two points is
(a) 1 cm (b) 6 cm (c) 12 cm (d) 24 cm [AIEEE 2002]

9) A resonance air column of length 40 cm resonates with a tuning fork of frequency 450 Hz. Ignoring end correction, the velocity of sound in air will be
(a) 720 m /s (b) 820 m /s (c) 920 m /s (d) 1020 m /s [AIEEE 2002]

10) An observer is moving towards a stationary source of frequency 250 Hz with a velocity of 40 m /s. If the velocity of sound is 330 m /s, the apparent frequency heard by the observer will be
(a) 320 Hz (b) 300 Hz (c) 280 Hz (d) 260 Hz [AIEEE 2002]

(Answers at the end of all questions)

11) An open pipe is in resonance in second harmonic with frequency f_1. Now one end of the tube is closed and frequency is increased to f_2 such that the resonance again occurs in nth harmonic. Choose the correct option.

(a) $n = 3$, $f_2 = (3/4) f_1$ (b) $n = 3$, $f_2 = (5/4) f_1$
(c) $n = 5$, $f_2 = (5/4) f_1$ (d) $n = 5$, $f_2 = (3/4) f_1$ [IIT 2005]

12) A tuning fork of 512 Hz is used to produce resonance in a resonance tube experiment. The level of water at first resonance is 30.7 cm and at second resonance is 63.2 cm. The maximum possible error in calculating velocity of sound in cm / s is

(a) 204.8 (b) 102.4 (c) 51.2 (d) 153.60 [IIT 2005]

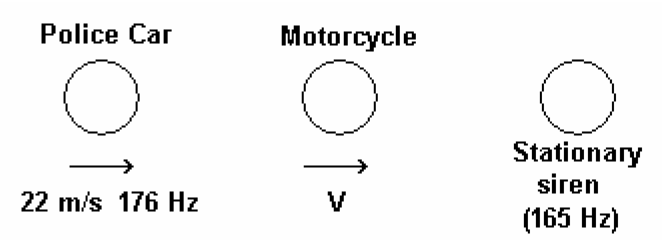
13) A closed organ pipe of length L and an open organ pipe contain gases of densities ρ_1 and ρ_2 respectively. The compressibility of gases are equal in both the pipes. Both the pipes are vibrating in their first overtone with the same frequency. The length of the organ pipe is

(a) $\frac{L}{3}$ (b) $\frac{4L}{3}$ (c) $\frac{4L}{3}\sqrt{\frac{\rho_1}{\rho_2}}$ (d) $\frac{4L}{3}\sqrt{\frac{\rho_2}{\rho_1}}$ [IIT 2004]

14) A source of sound of frequency 600 Hz is placed inside water. The speed of sound in water is 1500 m/s and in air it is 300 m/s . The frequency of sound recorded by an observer who is standing in air is

(a) 200 Hz (b) 3000 Hz (c) 120 Hz (d) 600 Hz [IIT 2004]

15) A police car moving at 22 m / s, chases a motorcyclist. The police man sounds his horn at 176 Hz, while both of them move towards a stationary siren of frequency 165 Hz. Calculate the speed of the motorcycle, if it is given that he does not observe any beats.



(a) 33 m / s (b) 22 m / s (c) zero (d) 11 m / s [IIT 2003]

16) In the experiment for the determination of the speed of sound in air using the resonance column method, the length of the air column that resonates in the fundamental mode, with a tuning fork is 0.1 m. When this length is changed to 0.35 m, the same tuning fork resonates with the first overtone. Calculate the end correction.

(a) 0.012 m (b) 0.025 m (c) 0.05 m (d) 0.024 m [IIT 2003]

17) A siren placed at a railway platform is emitting sound of frequency 5 kHz. A passenger sitting in a moving train A records a frequency of 5.5 kHz while the train approaches the siren. During his return journey in a different train B he records a frequency of 6.0 kHz while approaching the same siren. The ratio of velocity of train B to that of train A is

(a) 242 / 252 (b) 2 (c) 5 / 6 (d) 11 / 6 [IIT 2002]

18) 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

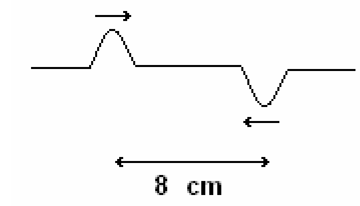
(a) 25 kg (b) 5 kg (c) 12.5 kg (d) 1 / 25 kg [IIT 2002]

19) 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 $y_1 = A \sin\left(\frac{\pi x}{L}\right) \sin \omega t$ and energy is E_1 and in another experiment, its displacement is $y_2 = A \sin\left(\frac{2\pi x}{L}\right) \sin 2\omega t$ and energy is E_2. Then

(a) $E_2 = E_1$ (b) $E_2 = 2E_1$ (c) $E_2 = 4E_1$ (d) $E_2 = 16E_1$ [IIT 2001]

20) Two pulses in a stretched string, whose centres are initially 8 cm apart, are moving towards each other as shown in the figure. The speed of each pulse is 2 cm/s. After 2 seconds, the total energy of the pulses will be

(a) zero (b) purely kinetic (c) purely potential
(d) partly kinetic and partly potential



[IIT 2001]

21) A train moves towards a stationary observer with speed 34 m / s. The train sounds a whistle and its frequency registered by the observer is f_1. If the speed of the train is reduced to 17 m / s, the frequency registered is f_2. If the speed of sound is 340 m / s, then the ratio f_1 / f_2 is

(a) 18 / 19 (b) 1 / 2 (c) 2 (d) 19 / 18 [IIT 2000]

22) 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 ν_1 and the other with frequency ν_2. The ratio ν_1 / ν_2 is given by

(a) 2 (b) 4 (c) 8 (d) 1 [IIT 2000]

23) Two monoatomic ideal gases 1 and 2 of molecular masses m_1 and m_2 respectively are enclosed in separate containers kept at the same temperature. Te ratio of the speed of sound in gas 1 to that in gas 2 is given by

(a) $\sqrt{\frac{m_1}{m_2}}$ (b) $\sqrt{\frac{m_2}{m_1}}$ (c) $\frac{m_1}{m_2}$ (d) $\frac{m_2}{m_1}$ [IIT 2000]

24) The ratio of the speed of sound in nitrogen gas to that in helium gas at 300 K is

(a) $\sqrt{\frac{2}{7}}$ (b) $\sqrt{\frac{1}{7}}$ (c) $\frac{\sqrt{3}}{5}$ (d) $\frac{\sqrt{6}}{5}$ [IIT 1999]

25) As a wave propagates

(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 of the square of the distance from the source for a spherical wave.
(d) total intensity of the spherical wave over the spherical surface centered at the source remains constant at all times. [IIT 1999]

26) $Y(x, t) = \dfrac{0.8}{[(4x + 5t)^2 + 5]}$ represents a moving pulse where x and y are n metres and t in second. Then
(a) pulse is moving positive X-direction
(b) in 2 s it will travel a distance of 2.5 m
(c) its maximum displacement is 0.16 m
(d) it is a symmetric pulse [IIT 1999]

27) In a wave motion $y = A \sin(kx - \omega t)$, y can represent
(a) electric field (b) magnetic field
(c) displacement (d) pressure [IIT 1999]

28) Standing waves can be produced
(a) on a string clamped at both 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 in the same direction [IIT 1999]

29) In hydrogen spectrum, the wavelength of H_α line is 656 nm, whereas in the spectrum of a distant galaxy, H_α line wavelength is 706 nm. Estimated speed of galaxy with respect to earth is
(a) 2x10^8 m / s (b) 2x10^7 m / s (c) 2x10^6 m / s (d) 2x10^5 m / s [IIT 1999]

30) A string of length 0.4 m and mass 0.01 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, which allows constructive interference between successive pulses is
(a) 0.05 s (b) 0.10 s (c) 0.20 s (d) 0.40 s [IIT 1998]

31) The (x, y) coordinates of the corners of a square plate are (0, 0), (L, 0), (L, L) and (0, L). The edges of the plate are clamped and 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) $a \cos\left(\dfrac{\pi x}{2L}\right) \cos\left(\dfrac{\pi y}{2L}\right)$ (b) $a \sin\left(\dfrac{\pi x}{L}\right) \sin\left(\dfrac{\pi y}{L}\right)$
(c) $a \sin\left(\dfrac{\pi x}{L}\right) \sin\left(\dfrac{2\pi y}{L}\right)$ (d) $a \cos\left(\dfrac{2\pi x}{L}\right) \sin\left(\dfrac{\pi y}{L}\right)$ [IIT 1998]

32) A transverse sinusoidal wave of amplitude a, wavelength λ and frequency f is travelling on a stretched string. The maximum speed of any point on the string is v / 10, where v is the speed of propagation of the wave. If a = 0.001 m and v = 10 m / s, then λ and f are given by
(a) $\lambda = 2\pi \times 10^{-2}$ m (b) $\lambda = 10^{-3}$ m
(c) $f = \dfrac{10^3}{2\pi}$ Hz (d) $f = 10^4$ Hz [IIT 1998]

33) A traveling wave in a stretched string is described by the equation $y = A \sin(kx - \omega t)$. The maximum particle velocity is
(a) $A\omega$ (b) ω / k (c) $d\omega / dk$ (d) x / ω [IIT 1997]

34) A whistle giving out 450 Hz approaches a stationary observer at a speed of 33 m / s. The frequency heard by the observer in Hz is
(a) 409 (b) 429 (c) 517 (d) 500 [IIT 1997]

35) The extension in a string, obeying Hooke's law is X. The speed of sound in the stretched string is V. If the extension in the string is increased to 1.5 X, the speed of sound will be
(a) 1.22 V (b) 0.61 V (c) 1.50 V (d) 0.75 V [IIT 1996]

36) 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 [IIT 1996]

37) The displacement y of a particle executing periodic motion is given by

$y = 4 \cos^2\left(\frac{1}{2}t\right)\sin(1000t)$.

The expression may be considered to be a result of the superposition of _______ independent harmonic motions.
(a) two (b) three (c) four (d) five [IIT 1992]

38) Two identical straight wires are stretched so as to produce 6 beats per second when vibrating simultaneously. On changing the tension slightly in one of them, the beat frequency remains unchanged. Denoting by T_1, T_2, the higher and the lower initial tensions in the strings, it could be said that while making the above changes in tension
(a) T_2 was decreased (b) T_1 was increased
(c) T_2 was increased (d) T_1 was decreased [IIT 1991]

39) A wave is represented by the equation $y = A \sin(10\pi x + 15\pi t + \pi/3)$, where x is in metres and t is in seconds. The expression represents
(a) a wave traveling in the positive x-direction with a velocity 1.5 m / s
(b) a wave traveling in the negative x-direction with a velocity 1.5 m / s
(c) a wave traveling in the negative x-direction having a wavelength 0.2 m
(d) a wave traveling in the positive x-direction having a wavelength 0.2 m [IIT 1990]

40) Velocity of sound in air 320 m / s. A pipe closed at one end has a length of 1 m. Neglecting end corrections, the air column in the pipe can resonate for sound of frequency
(a) 80 Hz (b) 240 Hz (c) 320 Hz (d) 400 Hz [IIT 1989]

41) A wave represented by the equation $y = a\cos(kx - \omega t)$ is superposed with another wave to form a stationary wave such that the point x = 0 is a node. The equation for the other wave is
(a) $a\sin(kx + \omega t)$ (b) $-a\cos(kx - \omega t)$
(c) $-a\cos(kx + \omega t)$ (d) $-a\sin(kx - \omega t)$ [IIT 1988]

42) An organ pipe P_1, closed at one end and vibrating in its first harmonic, and another pipe P_2, open at both ends and vibrating in its third harmonic, are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is
(a) $\frac{8}{3}$ (b) $\frac{3}{8}$ (c) $\frac{1}{2}$ (d) $\frac{1}{3}$ [IIT 1988]

10 - WAVES

(Answers at the end of all questions)

43) The displacement of particles in a string stretched in the x-direction is represented by y. Among the following expressions for y, those describing wave motion are

(a) $\cos kx \sin \omega t$ (b) $k^2x^2 - \omega^2t^2$

(c) $\cos^2 (kx + \omega t)$ (d) $\cos (k^2x^2 - \omega^2t^2)$ [IIT 1987]

44) A tube closed at one end and containing air produces, when excited, the fundamental note of frequency 512 Hz. If the tube is open at both ends the fundamental frequency that can be excited is (in Hz)

(a) 1024 (b) 512 (c) 256 (d) 128 [IIT 1986]

45) An air column in a pipe which is closed at one end, will be in resonance with a vibrating tuning fork of frequency 264 Hz if the length of the column in cm is

(a) 31.25 (b) 62.50 (c) 93.75 (d) 125 [IIT 1985]

46) A transverse wave is described by the equation $Y = Y_0 \sin 2\pi (ft - x / \lambda)$. The maximum particle velocity is equal to four times the wave velocity if

(a) $\lambda = \frac{\pi Y_0}{4}$ (b) $\lambda = \frac{\pi Y_0}{2}$ (c) πY_0 (d) $2 \pi Y_0$ [IIT 1984]

47) A wave equation which gives the displacement along the y-direction is given by $y = 10^{-4} \sin (60t + 2x)$ where x and y are in metres and t is time in seconds. This represents a wave

(a) traveling with a velocity of 30 m / s in the negative x-direction

(b) of wavelength π m

(c) of frequency $30 / \pi$ Hz

(d) of amplitude 10^{-4} m traveling along the negative x-direction [IIT 1982]

48) A cylindrical tube, open at both ends, has a fundamental frequency f in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air-column is now

(a) $\frac{f}{2}$ (b) $\frac{3f}{2}$ (c) f (d) 2f [IIT 1981]

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
d	c	b	b	b	c	d	c	a	c	c	a	c	d	b	b	b	a	c	b	d

22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
d	b	c	a,c,d	b,c,d	all	a,b,c	b	b	b,c	a,c	a	d	a	a	b	c,d	b,c	a,b,d

41	42	43	44	45	46	47	48
c	b	a	a	a,c	b	a,b,c,d	c