14

WAVES

MCQs with One Correct Answer

1. A wave travelling along the x-axis is described by the equation $y(x, t) = 0.005 \cos(\alpha x - \beta t)$. If the wavelength and the time period of the wave are 0.08 m and 2.0s, respectively, then α and β in appropriate units are

(a) $\alpha = 25.00\pi, \beta = \pi$

(b) $\alpha = \frac{0.08}{\pi}, \beta = \frac{2.0}{\pi}$

(c) $\alpha = \frac{0.04}{\pi}, \beta = \frac{1.0}{\pi}$

(d) $\alpha = 12.50\pi, \beta = \frac{\pi}{2.0}$

2. A tuning fork of unknown frequency makes 3 beats/sec with a standard fork of frequency 384 Hz. The beat frequency decreases when a small piece of wax is put on the prong of the first. The frequency of the fork is:

(a) 387 Hz (b) 381 Hz

(c) 384 Hz (d) 390 Hz

3. A car emitting sound of frequency 500 Hz speeds towards a fixed wall at 4 m/s. An observer in the car hears both the source frequency as well as the frequency of sound reflected from the wall. If he hears 10 beats per second between the two sounds, the velocity of sound in air will be

(a) 330 m/s (b) 387 m/s

(c) 404 m/s (d) 340 m/s

4. 26 tuning forks are placed in a series such that each tuning fork produces 4 beats with its previous tuning fork. If the frequency of last tuning fork be three times the frequency of first tuning fork then the frequency of first tuning fork will be

(a) 76 Hz (b) 75 Hz

(c) 50 Hz (d) 25 Hz

5. Two trains are moving towards each other with speeds of 20m/s and 15 m/s relative to the ground. The first train sounds a whistle of frequency 600 Hz. The frequency of the whistle heard by a passenger in the second train before the train meets, is (the speed of sound in air is 340 m/s)

(a) 600 Hz (b) 585 Hz

(c) 645 Hz (d) 666 Hz

6. A progressive sound wave of frequency 500 Hz is travelling through air with a speed of 350 ms^{-1}. A compression maximum appears at a place at a given instant. The minimum time interval after which the rarefraction maximum occurs at the same point, is

(a) 200 s (b) $\frac{1}{250}$ s

(c) $\frac{1}{500}$ s (d) $\frac{1}{1000}$ s

7. When a wave travel in a medium, the particle displacement is given by the equation $y = a \sin 2\pi(bt - cx)$ where a, b and c are constants. The maximum particle velocity will be twice the wave velocity if

(a) $c = \frac{1}{\pi a}$ (b) $c = \pi a$

(c) $b = ac$ (d) $b = \frac{1}{ac}$

8. The number of possible natural oscillation of air column in a pipe closed at one end of length 85 cm whose frequencies lie below 1250 Hz are : (velocity of sound = 340 ms^{-1})

(a) 4 (b) 5

(c) 7 (d) 6

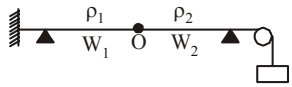
9. A hollow pipe of length 0.8 m is closed at one end. At its open end a 0.5 m long uniform string is vibrating in its second harmonic and it resonates with the fundamental frequency of the pipe. If the tension in the wire is 50 N and the speed of sound is 320 ms^{-1}, the mass of the string is

(a) 5 grams (b) 10 grams
(c) 20 grams (d) 40 grams

10. A uniform tube of length 60.5 cm is held vertically with its lower end dipped in water. A sound source of frequency 500 Hz sends sound waves into the tube. When the length of tube above water is 16 cm and again when it is 50 cm, the tube resonates with the source of sound. Two lowest frequencies (in Hz), to which tube will resonate when it is taken out of water, are (approximately).

(a) 281, 562 (b) 281, 843
(c) 276, 552 (d) 272, 544

11. Two wires W_1 and W_2 have the same radius r and respective densities ρ_1 and ρ_2 such that $\rho_2 = 4\rho_1$. They are joined together at the point O, as shown in the figure. The combination is used as a sonometer wire and kept under tension T. The point O is midway between the two bridges. When a stationary waves is set up in the composite wire, the joint is found to be a node. The ratio of the number of antinodes formed in W_1 and W_2 is :



(a) 1 : 1 (b) 1 : 2
(c) 1 : 3 (d) 4 : 1

12. Two engines pass each other moving in opposite directions with uniform speed of 30 m/s. One of them is blowing a whistle of frequency 540 Hz. Calculate the frequency heard by driver of second engine before they pass each other. Speed of sound is 330 m/sec:

(a) 450 Hz (b) 540 Hz
(c) 270 Hz (d) 648 Hz

13. A motor cycle starts from rest and accelerates along a straight path at $2m/s^2$. At the starting point of the motor cycle there is a stationary electric siren. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycle was at rest? (Speed of sound = 330 ms^{-1})

(a) 98 m (b) 147 m
(c) 196 m (d) 49 m

14. A small speaker delivers 2 W of audio output. At what distance from the speaker will one detect 120 dB intensity sound ? [Given reference intensity of sound as $10^{-12} W/m^2$]

(a) 40 cm (b) 20 cm
(c) 10 cm (d) 30 cm

15. A travelling wave represented by $y = A \sin(\omega t - kx)$ is superimposed on another wave represented by $y = A \sin(\omega t + kx)$. The resultant is

(a) A wave travelling along + x direction
(b) A wave travelling along – x direction
(c) A standing wave having nodes at

$$x = \frac{n\lambda}{2}, n = 0,1,2....$$

(d) A standing wave having nodes at

$$x = \left(n + \frac{1}{2}\right)\frac{\lambda}{2};\ n = 0,1,2....$$

16. A wire of length L and mass per unit length 6.0×10^{-3} kgm^{-1} is put under tension of 540 N. Two consecutive frequencies that it resonates at are: 420 Hz and 490 Hz. Then L in meters is:

(a) 2.1 m (b) 1.1 m
(c) 8.1 m (d) 5.1 m

17. An air column in a pipe, which is closed at one end, will be in resonance wtih a vibrating tuning fork of frequency 264 Hz if the length of the column in cm is (velocity of sound = 330 m/s)

(a) 125.00 (b) 93.75
(c) 62.50 (d) 187.50

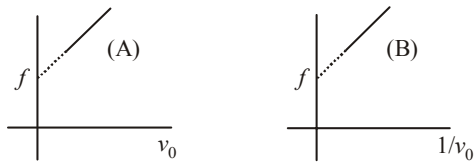
18. When two sound waves travel in the same direction in a medium, the displacements of a particle located at 'x' at time 't' is given by :

$y_1 = 0.05 \cos(0.50\pi x - 100\pi t)$
$y_2 = 0.05 \cos(0.46\pi x - 92\pi t)$

where y_1, y_2 and x are in meters and t in seconds. The speed of sound in the medium is :

(a) 92 m/s (b) 200 m/s
(c) 100 m/s (d) 332 m/s

19. A source of sound emits sound waves at frequency f_0. It is moving towards an observer with fixed speed v_s (v_s < v, where v is the speed of sound in air). If the observer were to move towards the source with speed v_0, one of the following two graphs (A and B) will given the correct variation of the frequency f heard by the observer as v_0 is changed.



The variation of f with v_0 is given correctly by:

(a) graph A with slope = $\frac{f_0}{(v+v_s)}$

(b) graph B with slope = $\frac{f_0}{(v-v_s)}$

(c) graph A with slope = $\frac{f_0}{(v-v_s)}$

(d) graph B with slope = $\frac{f_0}{(v+v_s)}$

20. A string is stretched between fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. Then, the lowest resonant frequency for this string is

(a) 105 Hz (b) 1.05 Hz

(c) 1050 Hz (d) 10.5 Hz

Numeric Value Answer

21. Equation of a stationary and a travelling waves are as follows $y_1 = a \sin kx \cos \omega t$ and $y_2 = a \sin(\omega t - kx)$. The phase difference between two points $x_1 = \frac{\pi}{3k}$ and $x_2 = \frac{3\pi}{2k}$ is ϕ_1 in the standing wave (y_1) and is ϕ_2 in travelling wave (y_2) then ratio $\frac{\phi_1}{\phi_2}$ is

22. The amplitude of a wave disturbance propagating in the positive y-direction is given by $y = \frac{1}{1+x^2}$ at time $t = 0$ and $y = \frac{1}{\left[1+(x-1)^2\right]}$ at $t = 2$ s, where x and y are in meters. The shape of the wave disturbance does not change during the propagation. The velocity of wave in m/s is

23. An organ pipe P_1 closed at one end vibrating in its first overtone and another pipe P_2 open at both ends vibrating in third overtone are in resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is

24. A string of length 0.4 m and mass 10^{-2} kg is clamped at its ends. The tension in the string is1.6 N. Identical wave pulses are generated at one end at regular intervals of time, Δt. The minimum value of Δt, so that a constructive interference takes place between successive pulses is

25. A source of sound of frequency 256Hz is moving rapidly towards a wall with a velocity of 5m/s. The speed of sound is 330 m/s. If the observer is between the wall and the source, then beats per second heard will be

26. A bat moving at 10 ms^{-1} towards a wall sends a sound signal of 8000 Hz towards it. On reflection it hears a sound of frequency f. The value of f in Hz is close to (speed of sound = 320 ms^{-1})

27. Two whistles A and B produce tones of frequencies 660 Hz and 596 Hz respectively. There is a listener at the mid-point of the line joining them. Now the whistle B and the listener both start moving with speed 30 m/s away from the whistle A. If the speed of sound be 330 m/s, how many beats will be heard by the listener?

28. A wire of density 9×10^{-3} kg cm^{-3} is stretched between two clamps 1 m apart. The resulting strain in the wire is 4.9×10^{-4}. The lowest frequency (in Hz) of the transverse vibrations in the wire is
(Young's modulus of wire $Y = 9 \times 10^{10}$ Nm^{-2}), (to the nearest integer), _____.

29. A one metre long (both ends open) organ pipe is kept in a gas that has double the density of air at STP. Assuming the speed of sound in air at STP is 300 m/s, the frequency difference between the fundamental and second harmonic of this pipe is _____ Hz.

30. Two identical strings X and Z made of same material have tension T_X and T_Z in them. If their fundamental frequencies are 450 Hz and 300 Hz, respectively, then the ratio T_X/T_Z is:

ANSWER KEY																			
1	(a)	**4**	(c)	**7**	(a)	**10**	(d)	**13**	(a)	**16**	(a)	**19**	(c)	**22**	(0.5)	**25**	(7.7)	**28**	(35.00)
2	(a)	**5**	(d)	**8**	(d)	**11**	(b)	**14**	(a)	**17**	(b)	**20**	(a)	**23**	(0.375)	**26**	(8516)	**29**	(106)
3	(c)	**6**	(d)	**9**	(b)	**12**	(d)	**15**	(d)	**18**	(b)	**21**	(0.85)	**24**	(0.1)	**27**	(4)	**30**	(2.25)