JEE Main Level Practice Test-8

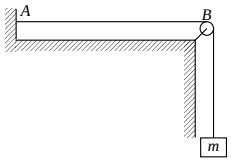
Topic : WAVES & DOPPLER'S EFFECT **Time: 75Min Marking +4 –1**

Section - A : MCQs with Single Option Correct

1. Equation of a plane progressive wave is given by $y = 0.6 \sin 2\pi\left(t - \frac{x}{2}\right)$. On reflection from a denser medium its amplitude becomes 2/3 of the amplitude of the incident wave. The equation of the reflected wave is :

(A) $y = 0.6 \sin 2\pi\left(t + \frac{x}{2}\right)$ (B) $y = -0.4 \sin 2\pi\left(t + \frac{x}{2}\right)$ (C) $y = 0.4 \sin 2\pi\left(t + \frac{x}{2}\right)$ (D) $y = -0.4 \sin 2\pi\left(t - \frac{x}{2}\right)$

2. A transverse wave is passing through a light string *AB* as shown in the figure. The equation of wave is $y = A \sin(\omega t - kx)$. The area of cross-section of string is *A* and density is ρ. The hanging mass is :



(A) Aω (B) $\frac{\omega}{kg}$

(C) $\frac{\rho A\omega^2}{k^2 g}$ (D) None

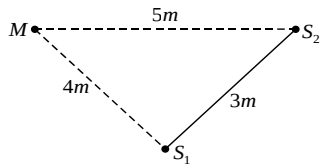
3. A source of frequency *f* emits waves of wavelength λ with speed *v* in some medium. If the frequency is changed from *f* to 2*f*, then the new wavelength & the wave speed are respectively :

(A) λ & *v* (B) $\frac{\lambda}{2}$ & 2*v* (C) $\frac{\lambda}{2}$ & *v* (D) $\frac{\lambda}{4}$ & $\frac{v}{2}$

4. Standing waves are produced by the superposition of two waves
$y_1 = 0.05 \sin(3\pi t - 2x)$
$y_2 = 0.05 \sin(3\pi t + 2x)$
where, *x* and *y* are in metres and *t* is in second. What is the amplitude of the particle at *x* = 0.5 m? Given, cos 57.3° = 0.54 :
(A) 2.7 cm (B) 5.4 cm (C) 8.1 cm (D) 10.8 cm

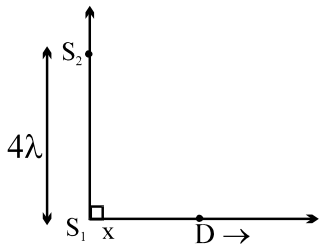
5. Two interfering waves of the same frequency have amplitudes in the ratio 1 : 3. If the intensity of the first wave is *I*, the intensity at the maxima of interference is :
(A) 16*I* (B) 8*I* (C) 4*I* (D) 64*I*

6. If the intensity of waves arriving at *M* from each of two coherent sources S_1 and S_2 is I as shown in figure.



The resultant intensity at *M*, if the wavelength of wave is 4 m, will be :
(A) Zero (B) 2*I* (C) 4*I* (D) 6*I*

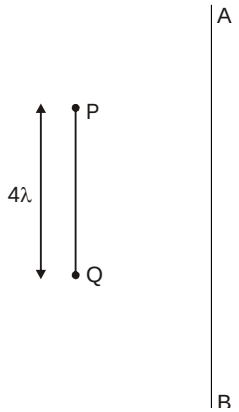
7. Two microwave sources S_1 and S_2 are located at a distance of 4λ from each other along *Y*-axis, with S_1 at the origin as shown in the figure. A microwave detector *D* moves along the *X*-axis away from S_1. The first maximum is obtained for x (> 0) equal to : (wavelength of the microwave is λ)



(A) λ (B) $1\frac{1}{6}\lambda$

(C) 3λ (D) $7\frac{1}{2}\lambda$

8. Two coherent sources of light *P* and *Q* each of the wavelength 'λ' are separated by a distance 4λ as shown. The maximum number of minima formed on line *AB* parallel to which runs from $-\infty$ to ∞ is :



(A) 6 (B) 8

(C) 3 (D) 4

9. Two coherent sources produce waves of different intensities which interface. After interference, the ratio of the maximum intensity to the minimum intensity is 4. The amplitude of waves are in ratio ?

(A) 16 : 9 (B) 5 : 3 (C) 3 : 1 (D) 25 : 9

10. 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 standing wave having nodes at $x = \left(n + \frac{1}{2}\right)\frac{\lambda}{2}$, $n = 0, 1, 2$

(B) A wave travelling along + x direction

(C) A wave travelling along – x direction

(D) A standing wave having nodes at $x = \frac{n\lambda}{2}$; $n = 0, 1, 2$

11. 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) $2f$ (B) f (C) $f/2$ (D) $3f/4$

12. Following are expressions for four plane simple harmonic waves :

(i) $y_1 = A\cos 2\pi\left(n_1 t + \frac{x}{\lambda_1}\right)$ (ii) $y_2 = A\cos 2\pi\left(n_1 t + \frac{x}{\lambda_1} + \pi\right)$

(iii) $y_3 = A\cos 2\pi\left(n_2 t + \frac{x}{\lambda_2}\right)$ (iv) $y_4 = A\cos 2\pi\left(n_2 t - \frac{x}{\lambda_2}\right)$

The pair of waves which will produce destructive interference and stationary wave respectively in a medium, are :

(A) (iii, iv), (i, ii) (B) (i, iii), (ii, iv) (C) (i, iv), (ii, iii) (D) (i, ii), (iii, iv)

13. A wave represented by the equation $y_1 = a\cos(kx - \omega t)$ is superimposed 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) $a\cos(kx - \omega t - \pi)$ (B) $a\cos(kx + \omega t + \pi)$ (C) $a\cos\left(kx + \omega t + \frac{\pi}{2}\right)$ (D) $a\cos\left(kx - \omega t + \frac{\pi}{2}\right)$

14. 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

15. 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 (velocity of sound = 330 m/s):

(A) 125.00 (B) 93.75 (C) 62.50 (D) 187.50

16. A sonometer wire of length 1.5 m is made of steel. The tension in it produces an elastic strain of 1%. What is the fundamental frequency of steel if density and elasticity of steel are 7.7×10^3 kg/m^3 and 2.2×10^{11} N/m^2 respectively?

(A) 188.5 Hz (B) 178.2 Hz (C) 200.5 Hz (D) 770 Hz

17. A sonometer wire of length 114 cm is fixed at both the ends. Where should the two bridges be placed so as to divide the wire into three segments whose fundamental frequencies are in the ratio 1 : 3 : 4 ?

(A) At 36 cm and 84 cm from one end (B) At 24 cm and 72 cm from one end
(C) At 48 cm and 96 cm from one end (D) At 72 cm and 96 cm from one end

18. Two friends are located at the same point on the circumference of a circular track of radius R. One friend starts cycling around the track with angular speed ω and simultaneously blowing a whistle of frequency f_0. Assuming v_s to be the speed of sound in air, the minimum frequency heard by the stationary friend is :

(A) $\frac{f_0}{1 + \frac{\omega R}{v_s}}$ (B) $f_0\left(1 - \frac{\omega R}{V_s}\right)$ (C) f_0 (D) Infinite

19. A predatory insect attempts to catch a prey. The predator moves with 17 m/s towards the prey, but the prey is moving twice faster at 34 m/s. During the chase, the predator unavoidably emits sound waves of natural frequency 380 Hz for a duration of 54 s. Then which of the folloing is correct : (Take speed of sound = 340 m/s)

(A) Prey hears sound at 360 Hz for 57s (B) Prey hears sound at 360 Hz for 54s

(C) Prey hears sound at 360 Hz for $\frac{972}{19}$ s (D) Prey hears sound at $\frac{3610}{9}$ Hz for $\frac{972}{19}$ s

20. A car moving toward a wall with a speed $\frac{v}{10}$ and wind is blowing in the direction from wall towards the car with same speed $\frac{v}{10}$, where v is the speed of sound with respect to air. The driver of the car sounds a whistle with a frequency f. The frequency of the echo as heard by the driver of the car is equal to :

(A) $\frac{9f}{8}$ (B) $\frac{27f}{22}$ (C) $\frac{12f}{11}$ (D) $\frac{32f}{33}$

Section- B: INTEGER Answer Type Questions

21. Two cars A and B are moving away from each other in opposite directions. Both the cars are moving with a speed of 20 ms^{-1} with respect to the ground. If an observer in car A detects a frequency 2000 Hz of the sound coming from car B, what is the natural frequency (in Hz) of the sound source in car B ? (speed of sound in air = 340 ms^{-1}) :

22. A stationary source emits sound waves of frequency 500 Hz. An observers moving along a line passing through the source detects sound to be of frequency 480 Hz. Calculate his speed in m/s. (Take speed of sound = 300 m/s)

23. A source of sound *S* is moving with a velocity of 50 m/s towards a stationary observer. The observer measures the frequency of the source as 1000 Hz. What will be the apparent frequency (in Hz) of the source when it is moving away from the observer after crossing him ? (Take velocity of sound in air is 350 m/s)

24. The displacement *y* of a wave traveling in the *x*-direction is given by $y = 10^{-4} \sin\left(600t - 2x + \frac{\pi}{3}m\right)$. Where *x* is expressed in metres and *t* in second. Calculate the speed of the wave in m/s.

25. The average power transmitted across a cross-section by two sound waves moving in the same direction are equal. The wave lengths of two sound waves are in the ratio of 1 : 2, then find the ratio of their pressure amplitudes.

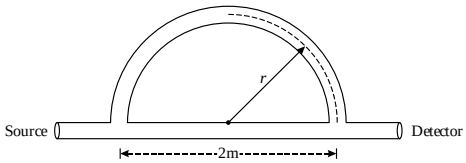
26. According to a factory administration regulation the sound intensity level in the workplace is 90 dB. Within the premises 32 identical machines produce a sound intensity level of 92.0 dB, how many machines can be operated simultaneously to bring the workplace into compliance with regulation ? (Take $10^{0.2}$=1.6)

27. 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 this return journey in a different train *B* he records a frequency of 6.0 kHz while approaching the same siren. What is the ratio of the velocity of train *B* to that of train *A* ?

28. Two sound sourced are moving away from a stationary observer in opposite directions with velocities v_1 and $v_2 (v_1 > v_2)$. The frequency of both the sources is 900 Hz. v_1 and v_2 are both much less than speed of sound, v = 300 m/s. Find the value of $(v_1 - v_2)$ (in m/s) so that beat frequency observed by observer is 9 Hz.

29. Three waves having amplitudes 10 μm, 12 μm & 5 μm arrive at a point having phase difference of π/2 in succession with each other. The amplitude of resulting wave is (in μm).

30. A tuning fork of frequency 250 Hz is vibrating at one end of a tube as shown in figure given below



If maximum sound is heard at the other end, then calculate the minimum possible wave velocity (in m/s) of wave.

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Answer Key

Topic : WAVES & DOPPLER'S EFFECT — ANSWER KEY

Section - A : MCQs with Single Option Correct

1. (B)	**2.** (C)	**3.** (C)	**4.** (B)
5. (A)	**6.** (B)	**7.** (B)	**8.** (B)
9. (C)	**10.** (A)	**11.** (B)	**12.** (D)
13. (B)	**14.** (D)	**15.** (B)	**16.** (B)
17. (D)	**18.** (A)	**19.** (A)	**20.** (B)

Section- B: INTEGER Answer Type Questions

21. [2250]	**22.** [12]	**23.** [750]	**24.** [300]
25. [1]	**26.** [20]	**27.** [2]	**28.** [3]
29. [13]	**30.** [285]		