EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

Equation of Travelling Wave

1. A wave is represented by the equation -

$$y = (0.002\ mm)\sin[(50s^{-1})t + (2m^{-1}x)]$$

(A) Wave velocity = 100 m/s (B) Wavelength = 2m

(C) Frequency = $\frac{25}{\pi} Hz$ (D) Amplitude = .001mm

PWV081

2. A plane progressive wave is represented by the equation $y = 0.25 \cos(2\pi t - 2\pi x)$. The equation of a wave is with double the amplitude and half frequency but travelling in the opposite direction will be

(A) $y = 0.5 \cos(\pi t - \pi x)$ (B) $y = 0.5 \cos(2\pi t + 2\pi x)$

(C) $y = 0.25 \cos(\pi t + 2\pi x)$ (D) $y = 0.5 \cos(\pi t + \pi x)$

PWV083

3. The equation of a wave is given (all quantity expressed in SI units) $Y = 0.05 \sin 10\pi(t - 0.01x)$ along the x-axis. The magnitude of phase difference between the points separated by a distance of 10 m along x-axis is :-

(A) $\pi/2$ (B) π (C) 2π (D) $\pi/4$

PWV085

4. A travelling pulse is given by $f(x, t) = A \exp\left(\frac{2abxt - a^2x^2 - b^2t^2}{c^2}\right)$, where A, a, b, and c are positive constants of appropriate dimensions. The speed of the pulse is :

(A) $\frac{b}{a}$ (B) $\frac{2b}{a}$ (C) $\frac{cb}{a}$ (D) $\frac{b}{2a}$

PWV086

5. The equation of a simple harmonic wave is given by:

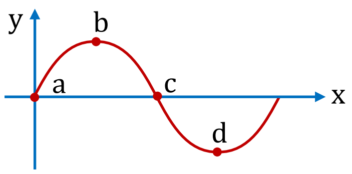
$$y = 3 \sin\frac{\pi}{2}(50\,t - x)$$

where x and y are in meters and t is in seconds. The ratio of maximum particle velocity to the wave velocity is:

(A) 3π (B) π (C) 2π (D) $\frac{3}{2}\pi$

PWV090

6. The figure shows a simple harmonic progressive transverse wave, progressing towards the right. The particle having the maximum acceleration directed downwards is represented by



(A) a (B) b (C) c (D) d

PWV092

7. A transverse sinusoidal wave moves along a string in the positive x direction. In figure (I) displacement of particle at P as a function of time is given and in figure (II) at a particular time t-the snap shot of wave is shown. The wave velocity (cm/s) and velocity of particle at P (cm/s) will be

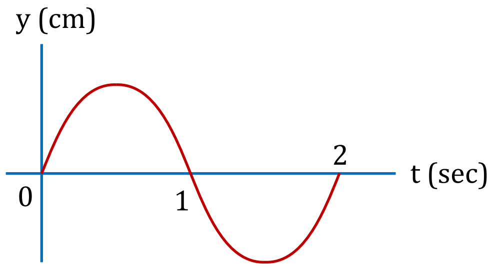


Figure-I

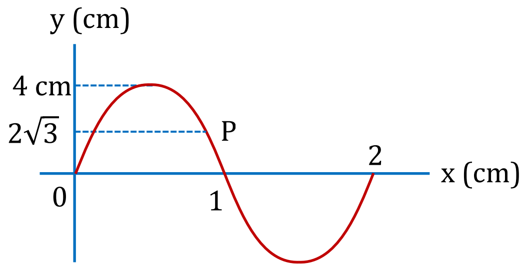
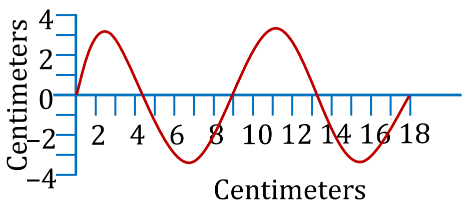


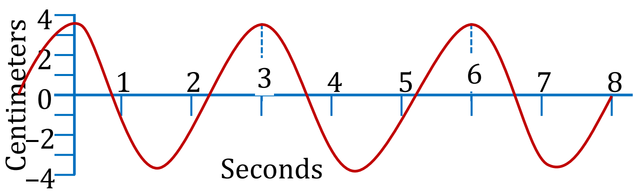
Figure-II

(A) $1\,\hat{i}, -3\pi\,\hat{j}$ (B) $1\,\hat{i}, 3\pi\,\hat{j}$ (C) $1\,\hat{i}, 2\pi\,\hat{j}$ (D) $-1\,\hat{i}, -2\pi\,\hat{j}$

PWV093

8. A transverse wave is travelling along a horizontal string. The first picture shows the shape of the string at an instant of time. This picture is superimposed on a coordinate system to help you make any necessary measurements. The second picture is a graph of the vertical displacement of one point along the string as a function of time. How far does this wave travel along the string in one second?

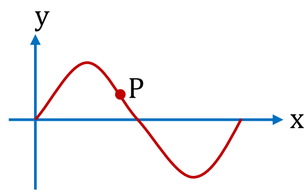




(A) 0.3 cm (B) 3.0 cm (C) 9.0 cm (D) 27 cm

PWV094

9. 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 P when its displacement is 5 cm is :



(A) $\frac{\sqrt{3}\pi}{100}\hat{j}\,m/s$ (B) $-\frac{\sqrt{3}\pi}{50}\hat{j}m/s$ (C) $\frac{\sqrt{3}\pi}{50}\hat{j}m/s$ (D) $-\frac{\sqrt{3}\pi}{50}\hat{i}m/s$

PWV095

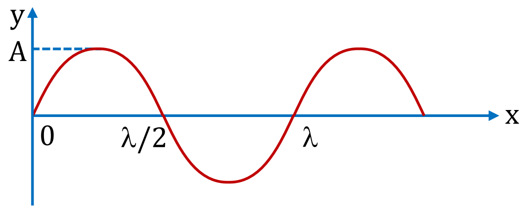
10. A wave propagates in a string in the positive x-direction with velocity v. The shape of the string at $t = t_0$ is given by $f(x, t_0) = A \sin\left(\frac{x^2}{a^2}\right)$: then, the wave equation at any instant t is given by

(A) $g(x, t) = A \sin\frac{[x - v(t - t_0)]^2}{a^2}$ (B) $g(x,t) = A\sin\frac{[x + v(t - t_0)]^2}{a^2}$

(C) $g(x,t) = A\sin\frac{[x - v(t + t_0)]^2}{a^2}$ (D) $g(x,t) = A\sin\frac{[x + v(t + t_0)]^2}{a^2}$

PWV096

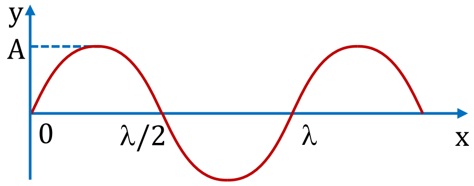
11. Here given snap shot of a progressive wave at $t = 0$ with time period $= T$. Then the equation of the wave if wave is going in $+ve$ x-direction and if wave is going in $-ve$ x-direction will be respectively. $\left(\text{Here, } T = \frac{2\pi}{\omega}\right)$

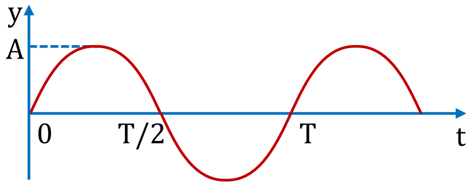


(A) $y = A \sin(kx + \omega t), y = A \sin(kx - \omega t)$
(B) $y = A \cos(kx + \omega t), y = A \cos(kx - \omega t)$
(C) $y = A \sin(\omega t - kx), y = A \sin(\omega t + kx)$
(D) $y = A \sin(kx - \omega t), y = A \sin(kx + \omega t)$

PWV097

12. Here given figure (i) shows snapshot at $t = T/4$ and figure (ii) shows motion of particle at $x = \lambda/4$. Then the possible equations of the wave will be $\left(\text{Here } T = \frac{2\pi}{\omega}\right)$:-

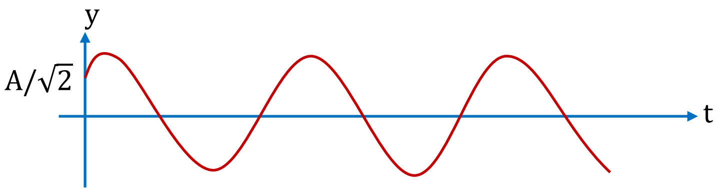
(i) 

(ii) 

(A) $y = A \sin\left(\omega t + kx - \frac{\pi}{2}\right)$
(B) $y = A \sin\left(\omega t - kx + \frac{\pi}{2}\right)$
(C) Both $y = A \cos\left(\omega t + kx - \frac{\pi}{2}\right)$ and $y = A \cos\left(\omega t - kx + \frac{\pi}{2}\right)$
(D) Both $y = A \sin\left(\omega t + kx - \frac{\pi}{2}\right)$ and $y = A \sin\left(\omega t - kx + \frac{\pi}{2}\right)$

PWV098

13. This is the graph of particle present at $x = \lambda/2$. Find the equation of wave travelling along $-x$ axis ?



(A) $A \sin\left[\omega t - kx - \frac{3\pi}{4}\right]$
(B) $A \sin\left[\omega t + kx - \frac{3\pi}{4}\right]$
(C) $\frac{A}{\sqrt{2}} \sin\left[\omega t + kx - \frac{3\pi}{4}\right]$
(D) $\frac{A}{\sqrt{2}} \sin\left[\omega t - kx - \frac{3\pi}{4}\right]$

PWV100

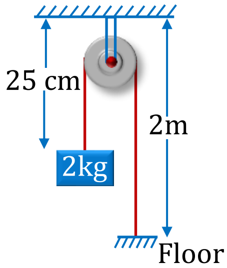
14. At $x = 0$ particle oscillates by law $y = \frac{3}{2t^2+1}$. If wave is propagating along $-ve$ x axis with velocity $2m/s$. Find equation of wave.

(A) $y = \frac{3}{2\left(t-\frac{x}{2}\right)^2+1}$
(B) $y = \frac{3}{2\left(t+\frac{x}{2}\right)^2+1}$
(C) $y = \frac{3}{2\left(t-\frac{z}{2}\right)^2+1}$
(D) $y = \frac{3}{2\left(t+\frac{z}{2}\right)^2+1}$

PWV102

Speed of Travelling Wave

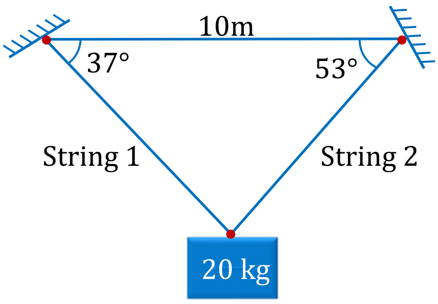
15. In the given figure the string has mass 4.5 g. Find the time taken by a transverse pulse produced at the floor to reach the pulley. (g = 10 ms^{-2}).



(A) 0.015 sec (B) 0.02 sec (C) 0.035 sec (D) 0.045 sec

PWV107

16. A mass of 20 kg is hanging with support of two strings of same linear mass density. Now pulses are generated in both strings at same time near the joint at mass. Ratio of time, taken by a pulse travel through string 1 to that taken by pulse on string 2 is



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

PWV108

17. A rope AB of length L placed on a smooth horizontal surface and pulled by a horizontal force F at end B. The mass of rope is m. If a transverse wave travels from A to B in time T, the value of $\frac{9T^2F}{mL}$ is

(A) 24 (B) 36 (C) 48 (D) 65

PWV109

Energy and Power in Travelling Wave

18. A wave moving with constant speed on a uniform string passes the point x = 0 with amplitude A_0, angular frequency ω_0 and average rate of energy transfer P_0. As the wave travels down the string it gradually loses energy and at the point x = λ, the average rate of energy transfer becomes $\frac{P_0}{2}$.

At the point x = λ, angular frequency and amplitude are respectively:

(A) ω_0 and $\frac{A_0}{\sqrt{2}}$ (B) $\frac{\omega_0}{\sqrt{2}}$ and A_0

(C) less than ω_0 and A_0 (D) $\omega_0/\sqrt{2}$ and $A_0/\sqrt{2}$

PWV145

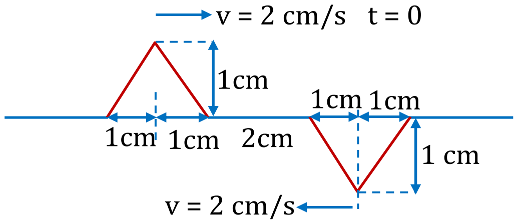
19. A transverse wave is passing through a stretched string with a speed of 20 m/s. The tension in the string is 20 N. At a certain point P on the string, it is observed that energy is being transferred at a rate of 40mW at a given instant. Find the speed of point P.

(A) 40 cm/s (B) 20 cm/s (C) 2 mm/s (D) 20 mm/s

PWV148

Superposition of Waves, Reflection and Transmission of Waves

20. Two triangular wave pulses are traveling towards each other on a stretched string as shown in figure.

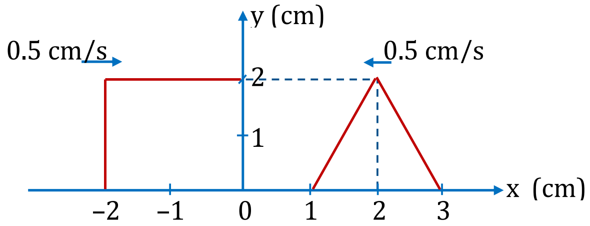


Speed of each pulse is 2 cm/s. Find maximum displacement of particle of string at $t = 1s$. The leading edges of the pulses are 2.00 cm apart at $t = 0$.

(A) +1cm (B) –1 cm (C) +2 cm (D) zero

PWV112

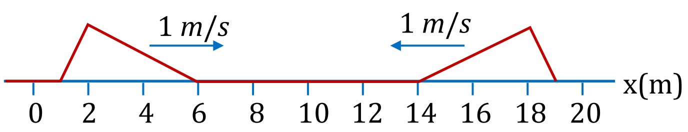
21. Figure shows a rectangular pulse and a triangular pulse approaching each other along x-axis. The pulse speed is 0.5 cm/s. What is the resultant displacement of medium particles due to superposition of waves at $x = 0.25$ cm and $t = 1$ sec.?

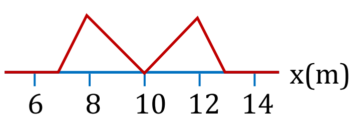


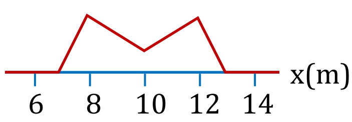
(A) 1 cm (B) 2 cm (C) 2.5 cm (D) 3 cm

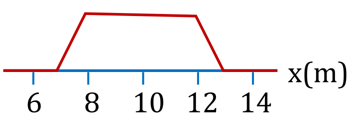
PWV113

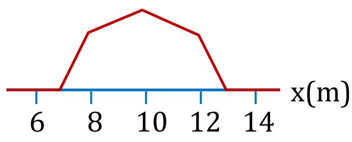
22. Two pulses on a string approach each other at speeds of 1 m/s. What is the shape of the string at $t = 6s$?



(A) 

(B) 

(C) 

(D) 

PWV114

23. Two waves having equations

$x_1 = a \sin(\omega t + \phi_1)$, $\quad x_2 = a \sin(\omega t + \phi_2)$

If in the resultant wave the frequency and amplitude remain equal to those of superimposing waves. Then phase difference between them is

(A) $\frac{\pi}{6}$ (B) $\frac{2\pi}{3}$ (C) $\frac{\pi}{4}$ (D) $\frac{\pi}{3}$

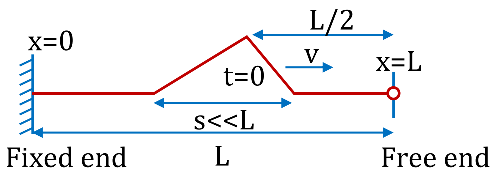
PWV116

24. The two interfering waves have intensities in the ratio 16 : 9. The ratio of intensities of maxima and minima in the interference pattern will be

(A) 1 : 121 (B) 49 : 1 (C) 9 : 4 (D) 4 : 9

PWV117

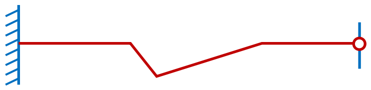
25. A small pulse travelling with speed v in a string is shown at $t = 0$, moving towards free end. Which of these is not **CORRECTLY** matched.



(i) $t = \frac{L}{v}$ (P)

(ii) $t = \frac{2L}{v}$ (Q)

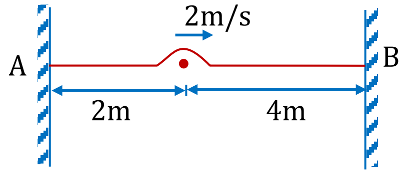
(iii) $t = \frac{3L}{v}$ (R)



(A) (i) (B) (ii) (C) (iii) (D) None of these

PWV120

26. A string is tied at two rigid supports. A pulse is generated on the string as shown in figure. Minimum time after which string will regain its shape: (Neglect the time during reflection)



(A) 2 sec (B) 4 sec (C) 6 sec (D) None of these

PWV121

27. A wave is represented by the equation $y = 10 \sin 2\pi(100t - 0.02x) + 10 \sin 2\pi(100t + 0.02x)$. The maximum amplitude and loop length are respectively:

(A) 20 units and 30 units (B) 20 units and 25 units

(C) 30 units and 20 units (D) 25 units and 20 units

PWV122

28. A wave represented by the equation $y = A \cos(kx - \omega t)$ is superimposed with another wave to form a stationary wave such that the point $x = 0$ is a node. The equation of the other wave is:

(A) $-A \sin(kx + \omega t)$ (B) $-A \cos(kx + \omega t)$ (C) $A \sin(kx + \omega t)$ (D) $A \cos(kx + \omega t)$

PWV123

29. Five waveforms moving with equal speeds on the x-axis

$y_1 = 8 \sin(\omega t + kx)$; $y_2 = 6 \sin(\omega t + \frac{\pi}{2} + kx)$; $y_3 = 4 \sin(\omega t + \pi + kx)$; $y_4 = 2 \sin(\omega t + \frac{3\pi}{2} + kx)$;

$y_5 = 4\sqrt{2} \sin(\omega t - kx + \frac{\pi}{4})$ are superimposed on each other. The resulting wave is :

(A) $8\sqrt{2} \cos kx \sin(\omega t + \frac{\pi}{4})$ (B) $8\sqrt{2} \sin(\omega t - kx + \frac{\pi}{4})$

(C) $8\sqrt{2} \sin kx \cos(\omega t + \frac{\pi}{4})$ (D) $8 \sin(\omega t + kx)$

PWV124

30. A composite string is made up by joining two strings of different masses per unit length μ and 4μ respectively. The composite string is under the same tension. A transverse wave pulse $Y = (6\ mm) \sin(5t + 40x)$, where t is in seconds and x in metres, is sent along the lighter string towards the joint. The joint is at $x = 0$. The equation of the wave pulse reflected from the joint is

(A) $(2\ mm) \sin(5t - 40x)$ (B) $(4\ mm) \sin(40x - 5t)$

(C) $-(2\ mm) \sin(5t - 40x)$ (D) $(2\ mm) \sin(5t - 10x)$

PWV125

31. A wave of amplitude $10cm$ travelling on a string is reflected from denser string. Energy of transmitted wave is 64% of the incident wave. Amplitude of reflected wave is

(A) 6 cm (B) 6.4 cm (C) 8 cm (D) None of these

PWV126

Standing Waves

32. Which two of the given transverse waves will give stationary waves when get superimposed

$z_1 = a\cos(kx - \omega t)$ ...(A)

$z_2 = a\cos(kx + \omega t)$ ...(B)

$z_3 = a\cos(ky - \omega t)$ ...(C)

(A) A and B (B) A and C (C) B and C (D) Any two

PWV127

33. A standing wave having 3 nodes and 2 antinodes is formed between two atoms having a distance 1.21 $\mathring{A}$ between them. The wavelength of the standing wave is

(A) 1.21 $\mathring{A}$ (B) 2.42 $\mathring{A}$ (C) 6.05 $\mathring{A}$ (D) 3.63 $\mathring{A}$

PWV132

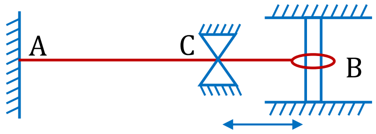
34. A standing wave is represented by $Y = A\sin(100t)\cos(0.01x)$ where Y and A are in *millimeter*, t is in seconds and x is in *meter*. The velocity of wave is

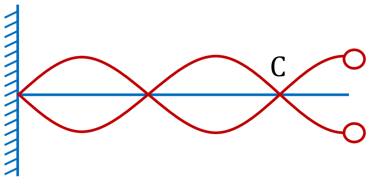
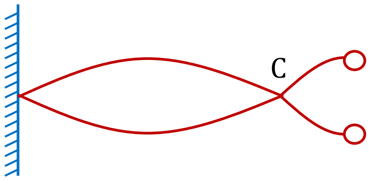
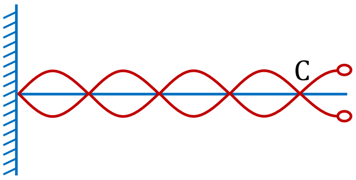
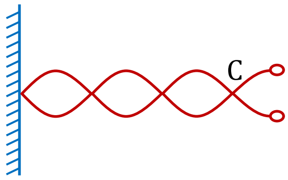
(A) $10^4\ m/s$ (B) $1\ m/s$

(C) $10^{-4}\ m/s$ (D) Not derivable from above data

PWV135

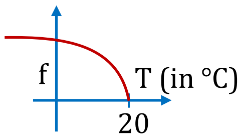
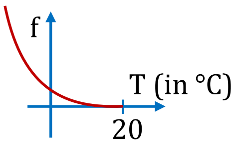
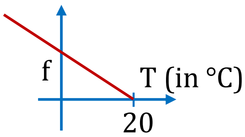
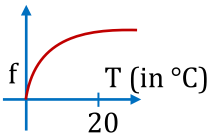
35. A 1m long wire having tension T is fixed at A and free at B. The point C, 20 cm from B is constrained to be stationary. What is shape of string for fundamental mode?



(A) 
(B) 
(C) 
(D) 

PWV140

36. A metal wire is clamped between two vertical walls. At 20 °C the unstrained length of the wire is exactly equal to the separation between walls. If the temperature of the wire is decreased the graph between fundamental frequency (f) and temperature (T) of the wire is

(A) 
(B) 
(C) 
(D) 

PWV141

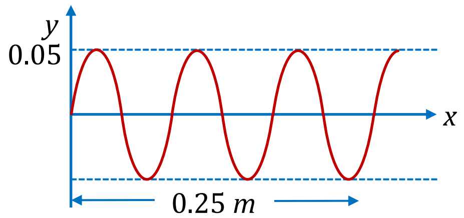
37. The ends of a stretched wire of length L are fixed at $x = 0$ and $x = L$. In one experiment, the displacement of the wire is $y_1 = A \sin(\pi x/L) \sin \omega t$ and energy is E_1 and in another experiment its displacement is $y_2 = A \sin(2\pi x/L) \sin 2\omega t$ and energy is E_2. Then

(A) $E_2 = E_1$ (B) $E_2 = 2E_1$ (C) $E_2 = 4E_1$ (D) $E_2 = 16E_1$

PWV152

Displacement and Pressure Wave Equation

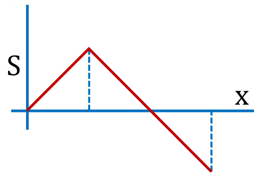
38. If the speed of the wave shown in the figure is 330m/s in the given medium, then the equation of the wave propagating in the positive x-direction will be (all quantities are in M.K.S. units)



(A) $y = 0.05 \sin 2\pi\,(4000t - 12.5x)$
(B) $y = 0.05 \sin 2\pi\,(4000t - 122.5x)$
(C) $y = 0.05 \sin 2\pi\,(3300t - 10x)$
(D) $y = 0.05 \sin 2\pi(3300x - 10t)$

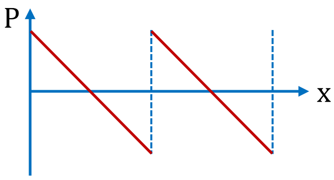
PWV154

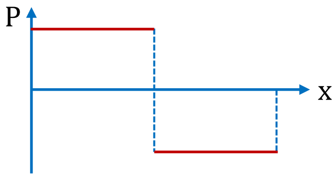
39. A sound wave is propagating through a medium such that displacement v/s x graph is

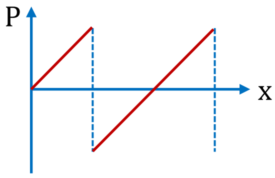


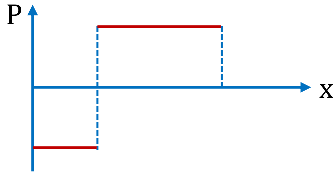
$\Delta p = -\beta\left(\frac{\delta s}{\delta x}\right) = \beta s_0 k \sin(kx - \omega t)$

Corresponding excess pressure v/s x graph will be

(A) 

(B) 

(C) 

(D) 

PWV155

40. A plane transverse wave is propagating in a direction making an angle of 30° with positive x-axis in the x-y plane. Find phase difference between points (0, 0, 0) and (1, 1, 1). Wavelength of the wave is $1m$:-

(A) $2\pi\ rad$ (B) $\left(\sqrt{3}+1\right)\pi\ rad$ (C) $\left(\sqrt{2}+1\right)\pi\ rad$ (D) None

PWV168

Properties of Sound

41. Mark the **INCORRECT** statement about longitudinal pressure wave.

(A) The density variation and the longitudinal velocity of the particles have their maxima and minima at the position of equilibrium of the particles.

(B) At the position of maximum displacement, the density is at the ambient (environment) value.

(C) Greatest compression occurs at the same time and place where the velocity of the particles is maximum and in direction of wave propagation.

(D) Greatest rarefaction occurs at the same time and place where the velocity of the particles is maximum and in direction of wave propagation.

PWV156

42. If the velocity of sound in hydrogen at 27°C is 1200 ms^{-1}, velocity of sound in oxygen at the same temperature will be

(A) 3740 ms^{-1} (B) 300 ms^{-1} (C) 1000 ms^{-1} (D) 2000 ms^{-1}

PWV157

43. It is found that an increase in pressure of 100 kPa causes a certain volume of water to decrease by 5×10^{-3} percent of its original volume. Then the speed of sound in the water is about (density of water $10^3\ kg/m^3$)

(A) 330 m/s (B) 1414 m/s (C) 1732 m/s (D) 2500 m/s

PWV158

44. A point source of sound is located somewhere along the x-axis. Experiments show that the same wave front simultaneously reaches listeners at $x = -8\ m$ and $x = +2.0\ m$.

A third listener is positioned along the positive y-axis. What is her y-coordinate (in m) if the same wave front reaches her at the same instant as it does the first two listeners?

(A) 4 (B) 3 (C) 2 (D) 5

PWV159

45. The S-waves (transverse) and P-waves (longitudinal) produced by earthquakes travel at different speeds through the earth. If the S-waves travel about 4000 m/s while the P-waves travel at nearly 7000 m/s, how far away must an earthquake be for the P-waves to arrive 2 minutes before the S-waves?

(A) 360 km (B) 480 km (C) 840 km (D) 1120 km

PWV161

46. At what temperature velocity of sound is double than that of at 0°C

(A) 819 K (B) 819°C (C) 600°C (D) 600 K

PWV162

47. If the density of oxygen is 16 times that of hydrogen, what will be the ratio of their corresponding velocities of sound waves?

(A) 1 : 4 (B) 4 : 1 (C) 16 : 1 (D) 1 : 16

PWV163

48. The speed of longitudinal wave is 100 times the speed of transverse wave in a taut brass wire. If the Young's modulus of brass is $1.0 \times 10^{11}\ N/m^2$, the stress in wire is

(A) $1.0 \times 10^7\ N/m^2$ (B) $1.0 \times 10^6\ N/m^2$ (C) $1.0 \times 10^5\ N/m^2$ (D) $1.0 \times 10^8\ N/m^2$

PWV164

49. A man is standing between two parallel cliffs and fires a gun. If he hears first echo at 1.5 second and second after 3.5s respectively, the distance between the cliffs is

(Velocity of sound in air = 340 ms^{-1})

(A) 500 m (B) 650 m (C) 850 m (D) 950 m

PWV165

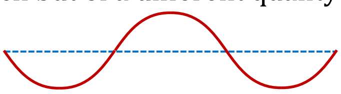
50. A is singing a note and at the same time B is also singing a note with $1/8^{th}$ the frequency of A. The energies of the two sounds are equal. The displacement amplitude of the note of B is:

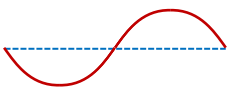
(A) same as that of A (B) twice that of A

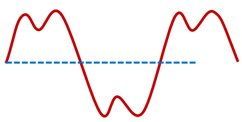
(C) four times that of A (D) eight times that of A

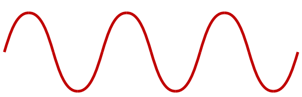
PWV166

51. A microphone is connected to an oscilloscope. The diagram shows the trace on the screen when the microphone receives a pure note. Which trace can be obtained when a musical instrument produces a note of the same pitch but of a different quality?



(A) 

(B) 

(C) 

(D) 

PWV167

52. A sound absorber attenuates the sound level by 20 dB. The intensity decreases by a factor of:-

(A) 1000 (B) 10000 (C) 10 (D) 100

PWV171

Interference of Waves

53. Which of the following is the equation of a spherical wave :-

(A) $S = S_0 \sin (Kx - \omega t)$ (B) $S = S_0 \cos (Kx - \omega t)$

(C) $S = (S_0/x) \sin (\omega t - Kx)$ (D) $S = (S_0/x^2) \sin(\omega t - Kx)$

PWV169

54. Three coherent waves of equal frequencies having amplitude 10 μm, 4μm and 7 μm respectively, arrive at a given point with successive phase difference of $\pi/2$. The amplitude of the resulting wave in μm is given by

(A) 5 (B) 6 (C) 3 (D) 4

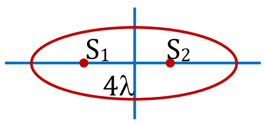
PWV175

55. The ratio of intensities between two coherent sound sources is 4 : 1. The difference of loudness in dB between maximum and minimum intensities when they interfere in space is:

(A) 10 log 2 (B) 20 log 3 (C) 10 log 3 (D) 20 log 2

PWV176

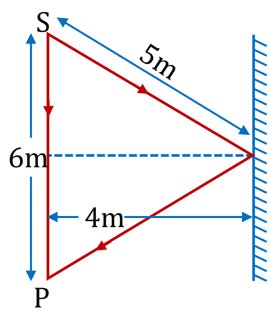
56. S_1, S_2 are two coherent sources of sound located along x-axis separated by 4λ where λ is wavelength of sound emitted by them. Number of maxima located on the elliptical boundary around it will be :



(A) 16 (B) 12 (C) 8 (D) 4

PWV177

57. A person standing at a distance of 6m from a source of sound receives sound wave in two ways, one directly from the source and other after reflection from a rigid boundary as shown in the figure. The maximum wavelength for which, the person will receive maximum sound intensity, is

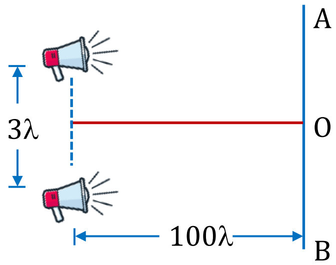


(A) 4 m (B) $\frac{16}{3}$ m (C) 2 m (D) $\frac{8}{3}$ m

PWV178

58. Two loudspeakers are emitting sound waves of wavelength λ with an initial phase difference of $\frac{\pi}{2}$.

At what minimum distance from O on the line AB will one hear a maxima?



(A) $25\,\lambda$ (B) $\frac{100\lambda}{\sqrt{15}}$ (C) $\frac{25\lambda}{3}$ (D) $50\,\lambda$

PWV179

Standing Waves and Beats

59. The fundamental frequency of a closed organ pipe is same as the first overtone frequency of an open organ pipe. If the length of open pipe is 50 *cm*, the length of closed pipe is:-

(A) 25 *cm* (B) 12.5 *cm* (C) 100 *cm* (D) 200 *cm*

PWV187

60. The second overtone of an open pipe A and a closed pipe B have the same frequencies. The ratio of fundamental frequency of A to the fundamental frequency of B is:

(A) 3 : 5 (B) 5 : 3 (C) 5 : 6 (D) 6 : 5

PWV188

61. Two organ pipes, each closed at one end, gives 5 beats per sec, when emitting their fundamental notes. If their lengths are in the ratio of 50 : 51, their fundamental frequencies (in *Hz*) are -

(A) 255, 250 (B) 255, 260 (C) 260, 265 (D) 265, 270

PWV189

62. An organ pipe open at both ends is resonating with a tuning fork of frequency 400 *Hz*. The pipe can not have length of (velocity of sound 350 m/s)

(A) $\frac{7}{16}\,m$ (B) $\frac{7}{8}\,m$ (C) $\frac{7}{4}\,m$ (D) $\frac{1}{4}\,m$

PWV191

63. A closed organ pipe is vibrating in its second overtone. The length of the pipe is 10 *cm* and maximum amplitude of vibration of particles of the air in the pipe is 2 *mm*. Then the amplitude of S.H.M. of the particles at 9 *cm* from the open end is:

(A) $\sqrt{3}\,mm$ (B) $\sqrt{2}\,mm$ (C) $\frac{\sqrt{3}}{2}\,mm$ (D) None of these

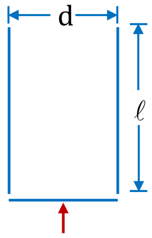
PWV199

64. A resonance tube is resonated with tuning fork of frequency 256 *Hz*. If the length of first and second resonating air columns are 32 *cm* and 100 *cm*, then end correction will be

(A) 1 *cm* (B) 2 *cm* (C) 4 *cm* (D) 6 *cm*

PWV200

65. A tube of diameter d and of length ℓ unit is open at both the ends. Its fundamental frequency of resonance is found to be f_1. The velocity of sound in air is 330 m/sec. One end of tube is now closed. The lowest frequency of resonance of tube is now f_2. Taking into consideration the end correction, $\frac{f_2}{f_1}$ is



(A) $\frac{(\ell+0.6\times d)}{(\ell+0.3\times d)}$ (B) $\frac{1}{2}\frac{(\ell+0.3\times d)}{(\ell+0.6\times d)}$ (C) $\frac{1}{2}\frac{(\ell+0.6\times d)}{(\ell+0.3\times d)}$ (D) $\frac{1}{2}\frac{(d+0.3\ell)}{(d+0.6\ell)}$

PWV201

66. In a resonance tube water is filled so that height of air column is 0.1 m when it resonates in its fundamental mode. Now water is removed so that the height of air column becomes 0.35 m and it resonates with next higher frequency. Then end correction is :-

(A) 0.012 m (B) 0.025 m (C) 0.05 m (D) 0.24 m

PWV202

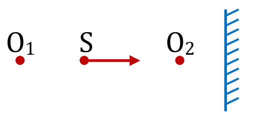
67. Two organ pipes, each closed at one end, give 6 beats per sec, when emitting their fundamental nodes. If their lengths are in the ratio of 6 : 5, their fundamental frequencies (in Hz) are f_1 and f_2 then find the value of $f_1 + f_2$:-

(A) 66 (B) 62 (C) 68 (D) 64

PWV206

Doppler Effect

68. A source of sound producing sound of frequency 100 Hz is moving towards a wall with velocity 20 m/s as shown. If O_1 and O_2 are two stationary observers and beat frequencies heard by them are f_1 and f_2 respectively between sound directly from source and sound reflected from wall. Then: (Assume velocity of sound to be 330 m/s)



Wall

(A) $f_1 = 0\ Hz$ (B) $f_1 = f_2$ (C) $f_1 > f_2$ (D) $f_1 < f_2$

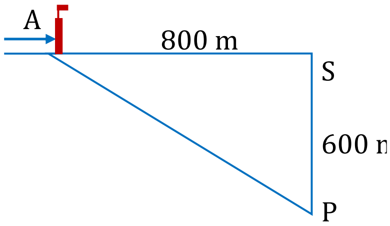
PWV212

69. A police van moving with velocity 22 m/s and emitting sound of frequency 176 Hz, follows a motor cycle in turn is moving towards a stationary car and away from the police van. The stationary car is emitting frequency 165 Hz. If motorcyclist does not hear any beats then his velocity is (v_s = 330 m/s)

(A) 22 m/s (B) 24 m/s (C) 20 m/s (D) 18 m/s

PWV213

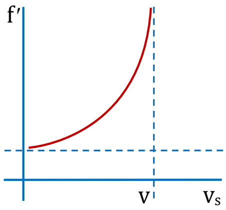
70. A person P is 600 m away from the station when train is approaching station with 72 km/h, it blows a whistle of frequency 800 Hz when 800 m away from the station. Find the frequency heard by the person. Speed of sound = 340 ms^{-1}.

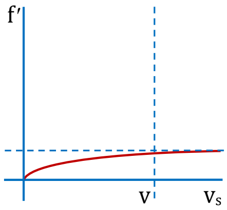


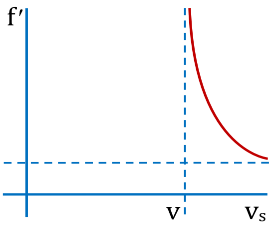
(A) 800 Hz (B) 839.5 Hz (C) 829.5 Hz (D) 843.5 Hz

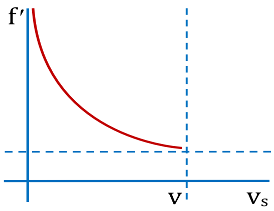
PWV214

71. Which of the following graphs represents a plot of the frequency f' of a sound wave perceived by a stationary observer versus the speed v_s of the source approaching towards him?

(A)


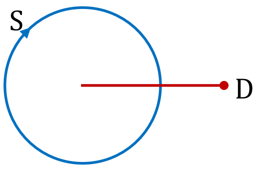
(B)


(C)


(D)


PWV216

72. A source of sound moves along a circle of radius 2 m with constant angular velocity 40 radian/s. Frequency of the source is 300 Hz. A detector is kept of some distance from the circle in the same plane of the circle (as shown in figure). Which of the following is not the possible value of frequency registered by the detector ? (Speed of sound = 320 m/s)



(A) 250 Hz (B) 360 Hz (C) 396 Hz (D) 220 Hz

PWV221

73. A source of frequency n and an observer are moving on a straight line with velocities a and b respectively. If the source is ahead of the observer and if the medium is also moving in the direction of their motion with velocity c (the velocity of sound being v) then the apparent frequency of sound heard by the observer would be :

(A) $\left(\frac{v+c+b}{v+c+a}\right)n$ (B) $\left(\frac{v-c+b}{v-c+a}\right)n$ (C) $\left(\frac{v-c-b}{v-c-a}\right)n$ (D) $\left(\frac{v+c-b}{v+c-a}\right)n$

PWV222

74. A source of sound S is having frequency f. Wind is blowing from source to observer O with velocity u. If speed of sound with respect to air is C, the wavelength of sound detected by O is:

(A) $\frac{C+u}{f}$ (B) $\frac{C-u}{f}$ (C) $\frac{C(C+u)}{(C-u)f}$ (D) $\frac{C}{f}$

PWV227

75. A sound wave of wavelength λ travels towards the right horizontally with a velocity v. It strikes and reflects from a vertical plane surface, travelling at acceleration a starting from rest. The number of positive crests striking in a time interval of 5 sec on the wall is

(A) $5\frac{\left(v+\frac{5a}{2}\right)}{\lambda}$ (B) $5\frac{\left(v-\frac{5a}{2}\right)}{\lambda}$ (C) $5\,v/\lambda$ (D) $(v-5a)/5\lambda$

PWV228

76. The observed wavelength of light coming from a distant galaxy is found to be increased by 0.5% as compared with that coming from a terrestrial source. The galaxy is

(A) Stationary with respect to the earth

(B) Approaching the earth with velocity of light

(C) Receding from the earth with the velocity of light

(D) Receding from the earth with a velocity equal to $1.5 \times 10^6 m/s$

PWV231

77. A star producing light of wavelength 6000 Å moves away from the earth with a speed of 5 km/sec. Due to Doppler effect the shift in wavelength will be $(c = 3 \times 10^8 m/\sec)$

(A) 0.1 Å (B) 0.05 Å (C) 0.2 Å (D) 1 Å

PWV232

78. If the shift of wavelength of light emitted by a star is towards violet, then this shows that star is

(A) Stationary (B) Moving towards earth

(C) Moving away from earth (D) Information is incomplete

PWV233

79. Assuming that universe is expanding, if the spectrum of light coming from a star which is going away from earth is tested, then in the wavelength of light

(A) There will be no change

(B) The spectrum will move to infrared region

(C) The spectrum will seems to shift to ultraviolet side

(D) None of the above

PWV234

80. A light source approaches the observer with velocity 0.8 c. The doppler shift for the light of wavelength 5500 $\AA$ is

(A) 4400 $\AA$ (B) 1833 $\AA$ (C) 3167 $\AA$ (D) 7333 $\AA$

PWV236

MULTIPLE CORRECT TYPE QUESTIONS

Equation of Travelling Wave

81. 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 meters and t is time in seconds. This represents a wave

(A) travelling with a velocity of 30 ms^{-1} in the negative x direction.

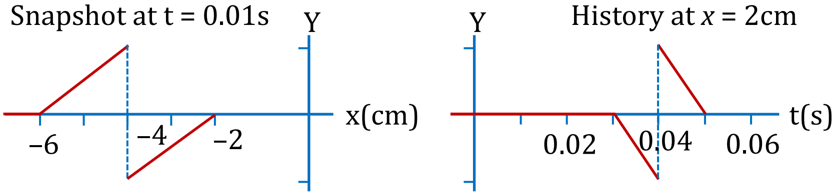
(B) of wavelength π m

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

(D) of amplitude 10^{-4} m

PWV087

82. Figure shows a snapshot graph and a history graph for a wave pulse on a stretched string. They describe the same wave from two perspectives.



(A) the wave is travelling in positive x-direction

(B) the wave is travelling in negative x-direction

(C) the speed of the wave is 2 m/s

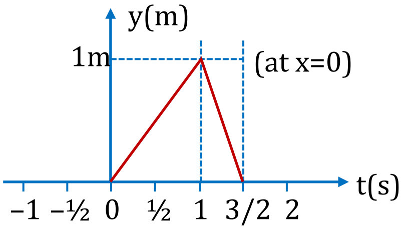
(D) the peak is located at $x = -6$ cm at $t = 0$

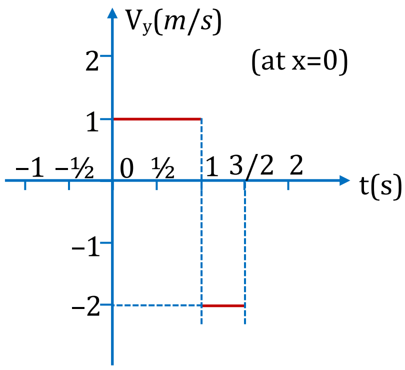
PWV058

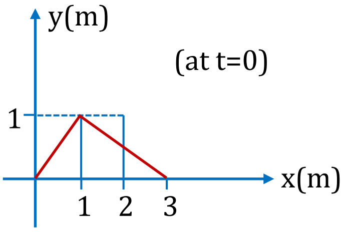
83. Consider a hypothetical wave pulse (at time $t = 0$) given by the following (y, x in meter)

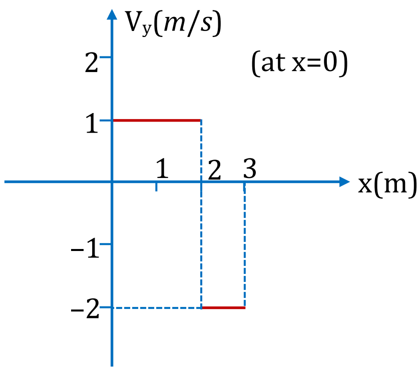
$$y = 0, x < 0 \;;\; y = x/2, 2 > x \geq 0 \;;\; y = 3 - x, 3 \geq x \geq 2 \;;\; y = 0, x > 3$$

The pulse travels leftwards (negative x direction) at speed $v = 2$ m/s. Which of the following plots are correct? [V_y is the velocity of particle]

(A) 

(B) 

(C) 

(D) 

PWV056

Energy and Power in Travelling Wave

84. Two mechanical waves, $y_1 = 2 \sin 2\pi (50t - 2x)$ and $y_2 = 4 \sin 2\pi (ax + 100t)$ propagate in a medium with same speed.

(A) The ratio of their intensities is 1 : 16
(B) The ratio of their intensities is 1 : 4
(C) The value of 'a' is 4 units
(D) The value of 'a' is 2 units

PWV146

Standing Waves

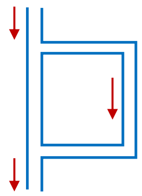
85. An string has resonant frequencies given by 1001 Hz and 2639 Hz.

(A) If the string is fixed at one end only, 910 Hz can be a resonance frequency.
(B) If the string is fixed at one end only, 1911 Hz can be a resonance frequency.
(C) If the string is fixed at both the ends, 364 Hz can be one of the resonant frequency.
(D) 1001 Hz is definitely not the fundamental frequency of the string.

PWV134

Interference of Waves

86. A sound consists of four frequencies $\rightarrow$ 300 Hz, 900 Hz, 2400 Hz and 4500 Hz. A sound 'filter' is made by passing this sound through a bifurcated pipe as shown. The sound waves have to travel a distance of 50 cm more in the right branch-pipe than in the straight pipe. The speed of sound in air is 300 m/s. Then, which of the following frequencies will be almost completely muffled or "silenced" at the outlet?



(A) 300 Hz
(B) 900 Hz
(C) 2400 Hz
(D) 4500 Hz

PWV055

Standing Waves and Beats

87. Two tuning forks of frequency 250 Hz and 256 Hz produce beats. If a maximum of intensity is observed just now, after how much time the minimum is observed at the same place ?

(A) $\frac{1}{18}$ sec.
(B) $\frac{1}{4}$ sec.
(C) $\frac{1}{3}$ sec.
(D) $\frac{1}{12}$ sec.

PWV053

Doppler Effect

88. A car moves towards a hill with speed v_c. It blows a horn of frequency f which is heard by an observer following the car with speed v_0. The speed of sound in air is v.

(A) the wavelength of sound reaching the hill is $\frac{v}{f}$

(B) the wavelength of sound reaching the hill is $\frac{v - v_c}{f}$

(C) the beat frequency observed by the observer is $\left(\frac{v + v_o}{v - v_c}\right) f$

(D) the beat frequency observed by the observer is $\frac{2v_c(v + v_o)f}{v^2 - v_c^2}$

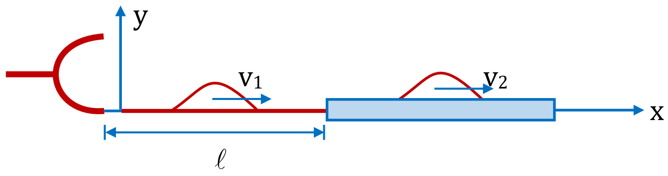
PWV054

COMPREHENSION TYPE QUESTIONS

Superposition of Waves, Reflection and Transmission of Waves

PARAGRAPH FOR QUESTION NOS. 89 TO 91

A harmonic oscillator at $x = 0$, oscillates with a frequency $\frac{\omega}{2\pi}$ and amplitude a. It is generating waves at end of a thin string in which velocity of wave is v_1 and which is connected to another heavier string in which velocity of wave is v_2 as shown, length of first string is ℓ.



89. If harmonic oscillator oscillates by an equation $y = a \sin \omega t$. The equation of incident wave in first string is

(A) $y = a \sin \omega \left(t - \frac{x}{v_1}\right)$ (B) $y = a \sin \omega \left(t + \frac{x}{v_1}\right)$

(C) $y = a \sin \left[\omega \left(t - \frac{x}{v_1}\right) + \pi\right]$ (D) $y = a \sin \left[\omega \left(t + \frac{x}{v_1}\right) + \pi\right]$

PWV128

90. Equation of transmitted wave in second string if its amplitude is a_t is

(A) $y = a_t \sin \omega \left(t - \frac{x}{v_2}\right)$ (B) $y = a_t \sin \omega \left(t - \frac{\ell}{v_1}\right)$

(C) $y = a_t \sin \omega \left(t - \frac{\ell}{v_1} - \frac{x-\ell}{v_2}\right)$ (D) $y = a_t \sin \omega \left(t - \frac{x}{v_2}\right)$

PWV129

91. Equation of reflected wave, if it is reflecting at the joint and amplitude of reflected wave is a_R

(A) $y = a_R \sin \omega \left(t - \frac{x}{v_2}\right)$ (B) $y = a_R \sin \left[\omega \left(t - \frac{\ell}{v_1} - \frac{\ell-x}{v_1}\right) + \pi\right]$

(C) $y = a_R \sin \left[\omega \left(t + \frac{x}{v_1}\right) + \pi\right]$ (D) $y = a_R \sin \left[\omega \left(t + \frac{2\ell+x}{v_1}\right) + \pi\right]$

PWV130

Standing Waves and Beats

PARAGRAPH FOR QUESTION NO. 92 TO 94

A metallic rod of length $1m$ has one end free and other end rigidly clamped. Longitudinal stationary waves are set up in the rod in such a way that there are total six antinodes present along the rod. The amplitude of an antinode is 4×10^{-6} m. Young's modulus and density of the rod are 6.4×10^{10} N/m^2 and 4×10^3 Kg/m^3 respectively. Consider the free end to be at origin and at $t = 0$ particles at free end are at positive extreme.

92. The equation describing displacements of particles about their mean positions is

(A) $s = 4\times10^{-6} \cos\left(\frac{11\pi}{2}x\right)\cos(22\pi\times10^3 t)$ (B) $s = 4\times10^{-6} \cos\left(\frac{11\pi}{2}x\right)\sin(22\pi\times10^3 t)$

(C) $s = 4\times10^{-6} \cos(5\pi x)\cos(20\pi\times10^3 t)$ (D) $s = 4\times10^{-6} \cos(5\pi x)\sin(20\pi\times10^3 t)$

PWV194

93. The equation describing stress developed in the rod is

(A) $140.8\pi\times10^{4}\cos\left(\frac{11}{2}\pi x+\pi\right)\cos\left(22\pi\times10^{3}t\right)$

(B) $140.8\pi\times10^{4}\sin\left(\frac{11}{2}\pi x+\pi\right)\cos\left(22\pi\times10^{3}t\right)$

(C) $128\pi\times10^{4}\cos(5\pi x+\pi)\cos(20\pi\times10^{3}t)$

(D) $128\pi\times10^{4}\sin(5\pi x+\pi)\cos(20\pi\times10^{3}t)$

PWV195

94. The magnitude of strain at midpoint of the rod at t = 1 sec is

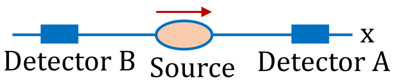
(A) $11\sqrt{3}\pi\times10^{-6}$ (B) $11\sqrt{2}\pi\times10^{-6}$ (C) $10\sqrt{3}\pi\times10^{-6}$ (D) $10\sqrt{2}\pi\times10^{-6}$

PWV196

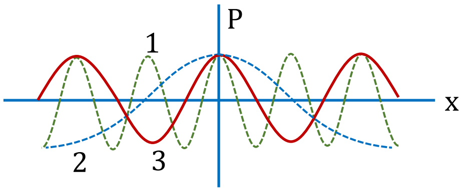
Doppler Effect

PARAGRAPH FOR QUESTION NO. 95 TO 98

A source emitting a sound wave at a certain frequency moves with constant speed along an x-axis figure (a). The source moves directly towards a stationary detector A and directly away from another stationary detector B. The superimposed three plots of figure (b) indicate the pressure function $P(x)$ of the sound wave as measured by detector A, by detector B, and by someone (c) in the rest frame of the source.



(a)



(b)

95. Which of the following plot corresponds to the measurement done by detector A?

(A) 1 (B) 2

(C) 3 (D) These plots are not possible

PWV217

96. The plot corresponding to the measurement done by detector B is

(A) 1 (B) 2

(C) 3 (D) These plots are not possible

PWV218

97. The plot corresponding to the measurement done by the detector C is

(A) 1 (B) 2

(C) 3 (D) These plots are not possible

PWV219

98. Now the source stops and begins to move along y-axis with same speed, the plot which corresponds to the measurement of B now is

(A) 1 (B) 2

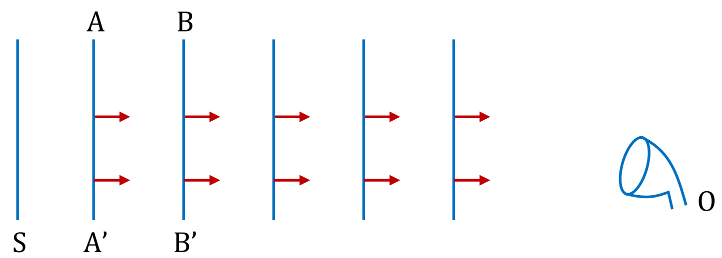
(C) 3 (D) None of these

PWV220

MATRIX MATCH TYPE QUESTION

Doppler Effect

99. Consider a large plane diaphragm 'S' emitting sound and a detector 'O'. The diagram shows plane wavefronts for the sound wave travelling in air towards right when source, observer and medium are at rest. AA' and BB' are fixed imaginary planes. Column-I describes about the motion of source, observer or medium and column-II describes various effects. Match them correctly.

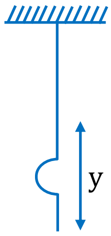


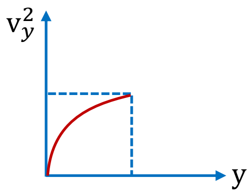
	Column-I		Column-II
(A)	Source starts moving towards right	(P)	Distance between any two wavefronts will increase.
(B)	Air starts moving towards right	(Q)	Distance between any two wavefronts will decrease.
(C)	Observer and source both move towards left with same speed.	(R)	The time needed by sound to move from plane AA' to BB' will increase.
(D)	Source and medium (air) both move towards right with same speed.	(S)	The time needed by sound to move from plane AA' to BB' will decrease.
		(T)	Frequency received by observer increases.

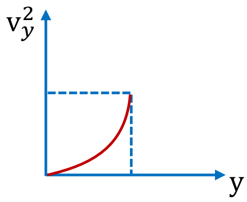
PWV225

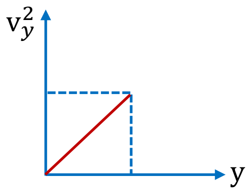
MISCELLANEOUS QUESTION

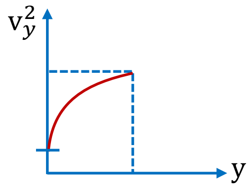
100. A nonuniform rope of length ℓ hangs from a ceiling. Mass per unit length of rope (μ) changes as $\mu = \mu_0 e^y$, where y is the distance along the string from its lowest point. Then graph between square of velocity of wave and y will be best represented as :



(A) 

(B) 

(C) 

(D) 

PWV238

PARAGRAPH FOR QUESTION 101 AND 102

A thin string is held at one end and oscillated vertically, so that

$$y(x = 0, t) = 8 \sin 4t \ [cm]$$

Neglect the gravitational force. The string's density is $0.2\left[\frac{kg}{m}\right]$ and its tension is $20N$. The string passes through a bath filled with 1 kg water. Due to friction, heat is transferred to the bath. The heat transfer efficiency is 50%.

101. The power transfer to the bath is :-

(A) 0.0512 watt (B) 0.0124 watt (C) 0.1024 watt (D) 0.0345 watt

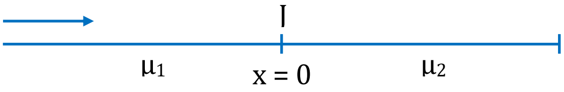
PWV239

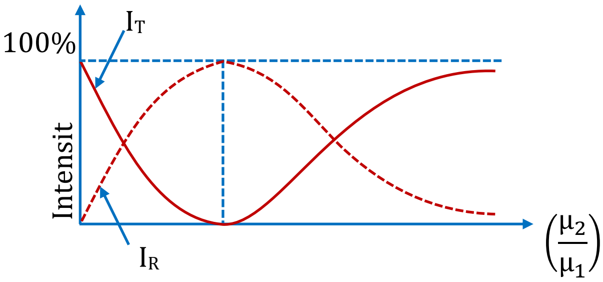
102. The time passes before the temperature of the bath rises one degree kelvin is nearly :-

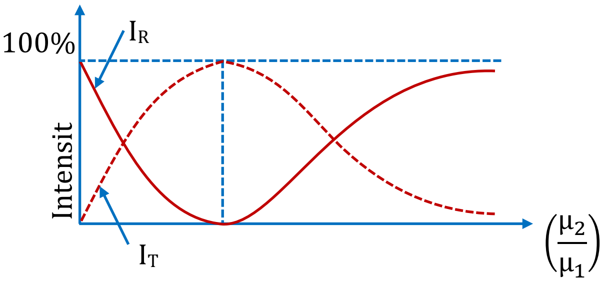
(A) 11.4 $hr.$ (B) 22.8 $hr.$ (C) 5.6 $hr.$ (D) 8 $hr.$

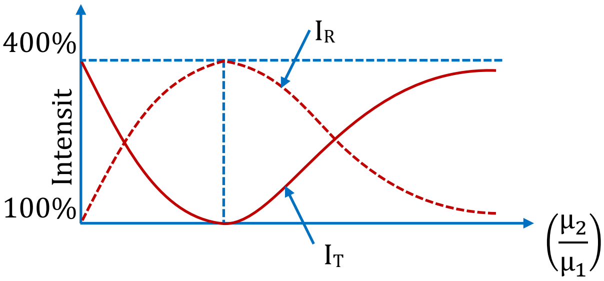
PWV240

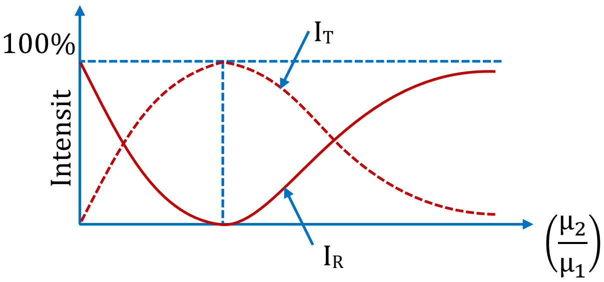
103. A transverse wave travelling in a string of linear mass density μ_1 is incident on junction point *J*. The intensities of reflected and transmitted wave both as a function of $\left(\frac{\mu_1}{\mu_2}\right)$ are plotted. The correct sketch is :



(A)


(B)


(C)


(D)


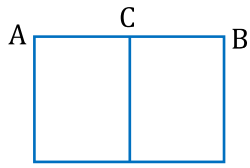
PWV241

104. Three sound waves of equal amplitudes have frequencies $(\nu - 1)$, ν, $(\nu + 1)$. They superpose to give beats. The number of beats produced per second will be :-

(A) 2 (B) 1 (C) 4 (D) 3

PWV242

105. AB is a cylinder of length 1.0 m filled with a thin flexible adibatic membrane C (see figure) at the middle and two other thin flexible adiabatic membranes A and B at the ends. The portions AC and BC contain hydrogen and oxygen gasses respectively at same pressure. Standing waves are setup in two columns such that membrane A acts as antinode and B as node (speed of sound in oxygen is 330 m/s) The frequency of these vibrations for which the membrane C is a node is :



(A) 330 Hz (B) 550 Hz (C) 1485 Hz (D) 660 Hz

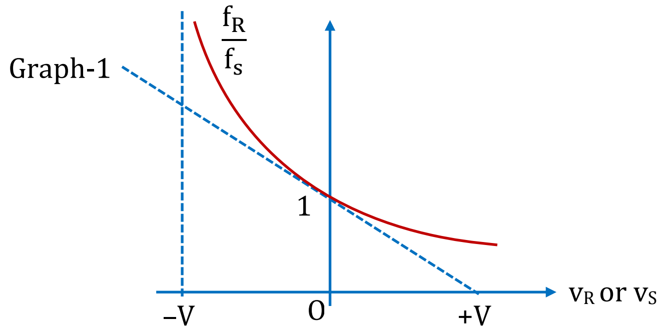
PWV243

106. Consider :

Case-1 : A moving source moving with velocity v_s and a stationary receiver.

Case-2 : A moving receiver moving with velocity v_R and a stationary source.

In either case f_R represents frequency heard by receiver and f_S represents frequency emitted by source. Figure shows graph of $\frac{f_R}{f_S}$ on y axis and v_s or v_R on x axis. Mark the **CORRECT** option(s)



(A) Graph-1 corresponds to moving receiver and Graph-2 corresponds to moving source.

(B) Graph-2 corresponds to moving receiver and Graph-1 corresponds to moving source.

(C) Graphs to left of origin represents approaching listener and to right represents receding listener.

(D) Graphs to right of origin represents approaching source and to left represent receding source.

PWV244

EXERCISE - S

Equation of Travelling Wave

1. A plane progressive wave of frequency 25 Hz, amplitude 2.5×10^{-5} m and initial phase zero propagates along the negative 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 ...., and the corresponding amplitude difference is ...... m.

PWV091

2. A sinusoidal wave is moving along the positive x-direction as shown in figure (i) and (ii).

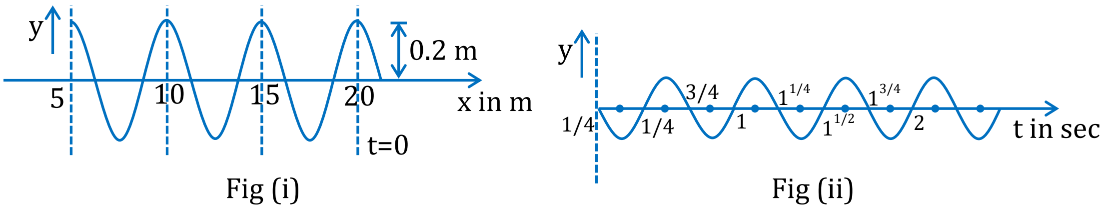


Fig (i) Fig (ii)

(i) Write the complete expression for the wave y (x, t).

(ii) Find the possible values of x_0 for which figure (ii) refers.

PWV261

Speed of Travelling Wave

3. A long uniform string of mass density 0.1 kg/m is stretched with a force of 40 N. One end of the string (x = 0) is oscillating transversely (sinusoidally) with an amplitude of 0.02 m and a period of 0.1 sec, so that travelling waves in the +x direction are set up.

(a) What is the velocity of the waves?

(b) What is their wavelength?

(c) If at the driving end (x = 0) the displacement (y) at t = 0 is 0.01 m with dy/dt negative, what is the equation of the travelling waves?

PWV104

4. A uniform rope of length L and mass m is held at one end and whirled in a horizontal circle with angular velocity ω. Ignore gravity. Find the time required for a transverse wave to travel from one end of the rope to the other.

PWV110

5. A non-uniform rope of mass M and length L has a variable linear mass density given by $\mu = kx$ where x is the distance from one end of the wire and k is a constant.

(a) Show that $M = kL^2/2$

(b) Show that the time required for a pulse generated at one end of the wire to travel to the other end is given by $t = \sqrt{\dfrac{8ML}{9F}}$ where F (constant)is the tension in the wire.

PWV111

6. A uniform string of length L and total mass M is suspended vertically and a transverse pulse is given at the top end of it. At the same moment a body is released from rest and falls freely from the top of the string. How far from the bottom does the body pass the pulse?

PWV262

Energy and Power in Travelling Wave

7. A long string under tension of 100 N has one end at x = 0. A sinusoidal wave is generated at x = 0 whose equation is given by $y = (0.01\ cm)\sin\left[\left(\frac{\pi x}{10}m\right) - 50\pi t(\text{sec})\right]$

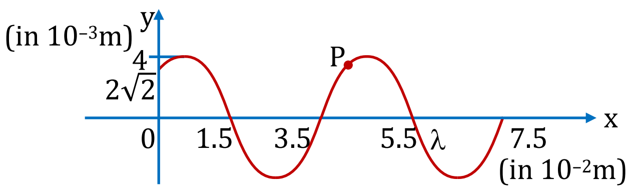
(i) Sketch the shape of the string at $t = \frac{1}{50}$ sec.

(ii) Find the average power transmitted by the wave.

(iii) Draw velocity time graph of particle at x = 5 m.

PWV143

8. The figure shows a snap photograph of a vibrating string at t = 0. The particle P is observed moving up with velocity $20\pi\ cm/s$. The angle made by string with x-axis at P is 6°.



(a) Find the direction in which the wave is moving.

(b) The equation of the wave.

(c) The total energy carried by the wave per cycle of the string, assuming that μ, the mass per unit length of the string = 50 gm/m.

PWV144

9. Sinusoidal waves 5 mm in amplitude are to be transmitted along a string having a linear mass density equal to $4 \times 10^{-2}\ kg/m$. If the source can deliver an average power of 90 W and the string is under a tension of 100 N, then find the frequency (in Hz) at which the source can operate.

(Take $\pi^2 = 10$)

PWV147

10. A progressive wave on a string having linear mass density ρ is represented by $y = A\sin\left(\frac{2\pi}{\lambda}x - \omega t\right)$ where y is in mm. Find the total energy (in μJ) passing through origin from $t = 0$ to $t = \frac{\pi}{2\omega}$.

[Take : $\rho = 3 \times 10^{-2}\ kg/m$; $A = 1mm$; $\omega = 100\ rad/sec$; $\lambda = 16\ cm$]

PWV149

Standing Waves

11. A 40 *cm* long wire having a mass 3.2 *gm* and area of cross-section 1 mm^2 is stretched between the supports 40.05 *cm* apart. In its fundamental mode it vibrates with a frequency of 1000/64 *Hz*. Find the young's modulus of the wire.

PWV131

12. A string, fixed at both ends, vibrates in a resonant mode with a separation of 2.0 *cm* between the consecutive nodes. For the next higher resonant frequency, this separation is reduced to 1.6 *cm*. Find the length of the string.

PWV136

13. Three resonant frequencies of a string are 90, 150 and 210 *Hz*.

(a) Find the highest possible fundamental frequency of vibration of this string.

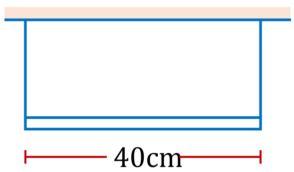
(b) Which harmonics of the fundamental are the given frequencies ?

(c) Which overtones are these frequencies ?

(d) If the length of the string is 80 *cm*, what would be the speed of a transverse wave on this string?

PWV137

14. A uniform horizontal rod of length 40 *cm* and mass 1.2 *kg* is supported by two identical wires as shown in figure. Where should a mass of 4.8 *kg* be placed on the rod so that the same tuning fork may excite the wire on left into its fundamental vibrations and that on right into its first overtone? Take $g = 10\ ms^{-2}$.



PWV138

15. Figure shows an aluminium wire of length 60 *cm* joined to a steel wire of length 80 *cm* and stretched between two fixed supports. The tension produced is 40 *N*. The cross-sectional area of the steel wire is 1.0 mm^2 and that of the aluminium wire is 3.0 mm^2. What could be the minimum frequency of a tuning fork which can produce standing waves in the system with the joint as a node? The density of aluminium is 2.6 $g\ cm^{-3}$ and that of steel is 7.8 $g\ cm^{-3}$.

PWV139

16. A wire, fixed at both ends is seen to vibrate at a resonant frequency of 240 *Hz* and also at 320 *Hz*.

(a) What could be the maximum value of the fundamental frequency?

(b) If transverse waves can travel on this string at a speed of 40 ms^{-1}, what is its length?

PWV142

17. A string 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.

PWV153

Properties of Sound

18. The sound level at a point 5.0 *m* away from a point source is 40*dB*. What will be the level at a point 50*m* away from the source?

PWV172

19. If the intensity of sound is doubled, by how many decibels does the sound level increase?

PWV173

20. Sound with intensity larger than 120*dB* appears painful to a person. A small speaker delivers 2.0 *W* of audio output. How close can the person get to the speaker without hurting his ears?

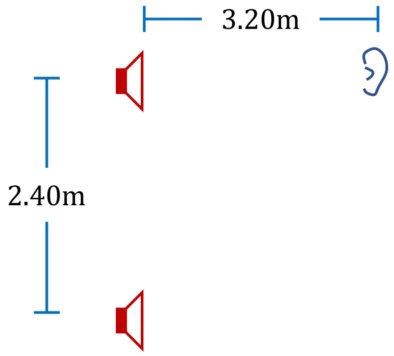
PWV174

Interference of Waves

21. In Quincke's experiment the sound detected is changed from a maximum to a minimum when the sliding tube is moved through a distance of 2.50 *cm*. Find the frequency of sound if the speed of sound in air is 340 ms^{-1}.

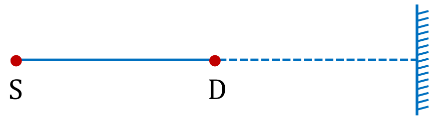
PWV180

22. Two stereo speakers are separated by a distance of 2.40*m*. A person stands at a distance of 3.20 *m* directly in front of one of the speakers as shown in figure. Find the frequencies in the audible range (20-2000 *Hz*) for which the listener will hear a minimum sound intensity. Speed of sound in air = 320 ms^{-1}.



PWV181

23. A source of sound *S* and a detector *D* are placed at some distance from one another. A big cardboard is placed near the detector and perpendicular to the line *SD* as shown in figure. It is gradually moved away and it is found that the intensity changes from a maximum to a minimum as the board is moved through a distance of 20 *cm*. Find the frequency of the sound emitted. Velocity of sound in air is 336 ms^{-1}.



PWV182

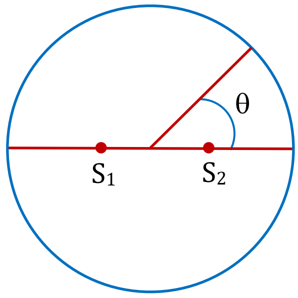
24. Two sources of sound S_1 and S_2, emitting waves of equal wavelength 20.0 *cm*, are placed with a separation of 20.0 *cm* between them. A detector can be moved on a line parallel to $S_1 S_2$ and at a distance of 20.0 *cm* from it. Initially, the detector is equidistant from the two sources. Assuming that the waves emitted by the sources are in phase, find the minimum distance through which the detector should be shifted to detect a minimum of sound.

PWV183

25. Three sources of sound S_1, S_2 and S_3 of equal intensity are placed in a straight line with $S_1S_2 = S_2S_3$. At a point P, far away from the sources, the wave coming from S_2 is 120° ahead in phase of that from S_1. Also, the wave coming from S_3 is 120° ahead of that from S_2. What would be the resultant intensity of sound at P?

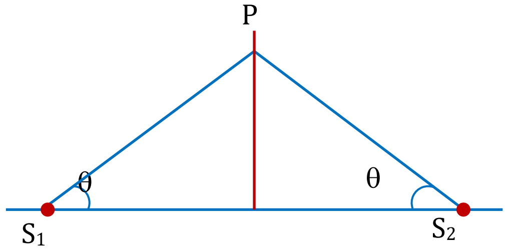
PWV184

26. Figure shows two coherent sources S_1 and S_2 which emit sound of wavelength λ in phase. The separation between the sources is 3λ. A circular wire of large radius is placed in such a way that S_1 and S_2 lies in its plane and the middle point of S_1, S_2 is at the centre of the wire. Find the value of cosθ for which constructive interference takes place.



PWV185

27. Two sources of sound S_1 and S_2 vibrate at same frequency and are in phase. The intensity of sound detected at a point P as shown in the figure is I_0.



(a) If θ equals 45°, what will be the intensity of sound detected at this point if one of the sources is switched off?

(b) What will be the answer of the previous part if θ = 60°?

PWV186

Standing Waves and Beats

28. A steel rod having a length of 1 m 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.

PWV192

29. Two narrow cylindrical pipes A and B have the same length. Pipe A is open at both ends and is filled with a monoatomic gas of molar mass M_A. Pipe B is open at one end and closed at the other end, and is filled with a diatomic gas of molar mass M_B. Both gases are at the same temperature.

(a) If the frequency of the second harmonic of the fundamental mode in pipe A is equal to the frequency of the third harmonic of the fundamental mode in pipe B, determine the value of M_A/M_B.

(b) Now the open end of pipe B is also closed (so that the pipe is closed at both ends). Find the ratio of the fundamental frequency in pipe A to that in pipe B.

PWV193

30. The displacement of the medium in a sound wave is given by the equation $y_1 = A\cos(ax + bt)$ where A, a and b are positive constants. The wave is reflected by an obstacle situated at $x = 0$. The intensity of the reflected wave is 0.64 times that of the incident wave.

(a) What are the wavelength and frequency of incident wave?

(b) Write the equation for the reflected wave.

(c) In the resultant wave formed after reflection, find the maximum and minimum values of the particle speeds in the medium.

(d) Express the resultant wave as a superpositions of standing wave and a travelling wave. What are the positions of the antinodes of the standing wave? What is the directions of propagation of travelling wave?

PWV197

31. An open organ pipe filled with air has a fundamental frequency $500Hz$. The first harmonic of another organ pipe closed at one end and filled with carbon dioxide has the same frequency as that of the first harmonic of the open organ pipe. Calculate the length of each pipe. Assume that the velocity of sound in air and in carbondioxide to be 330 and 264 m/s respectively.

PWV198

32. The air column in a pipe closed at one end is made to vibrate in its second overtone by a tuning fork of frequency 440 Hz. The speed of sound in air is 330 ms^{-1}. End corrections may be neglected. Let P_0 denote the mean pressure at any point in the pipe and ΔP_0 the maximum amplitude of pressure variation.

(a) Find the length L of the air column.

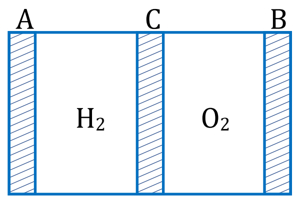
(b) What is the amplitude of pressure variation at the middle of the column?

(c) What are the maximum and minimum pressure at the open end of the pipe?

(d) What are the maximum and minimum pressure at the closed end of the pipe?

PWV204

33. AB is a cylinder of length $1m$ fitted a thin flexible diaphragm C at the middle and other thin flexible diaphragms A and B at the ends. The portions AC and BC contain hydrogen and oxygen gases respectively. The diaphragms A and B are set into vibrations of same frequency. What is the minimum frequency of these vibration for which diaphragm C is a node?



(Under the conditions of experiment, Velocity of sound in hydrogen $v_H = 1100\ m/s$, Velocity of sound in oxygen $v_0 = 300\ m/s$).

PWV205

34. A Kundt's tube apparatus has a copper rod of length 1.0 m clamped at 25 cm from one of the ends. The tube contains air in which the speed of sound is 340 m/s. the powder collects in heaps separated by a distance of 5.0 cm. Find the speed of sound waves in copper.

PWV207

35. A source of sound with adjustable frequency produces 2 beats per second with a tuning fork when its frequency is either 476 Hz or 480 Hz. What is the frequency of the tuning fork?

PWV208

36. A tuning fork produces 4 beats per second with another tuning fork of frequency 256 Hz. The first one is now loaded with a little wax and the beat frequency is found to increase to 6 per second. What was the original frequency of the tuning fork?

PWV209

37. A tuning fork of frequency 256 Hz produces 4 beats per second with a wire of length 25 cm vibrating in its fundamental mode. The beat frequency decreases when the length is slightly shortened. What could be the minimum length by which the wire be shortened so that it produces no beats with the tuning fork?

PWV210

38. A, B and C are three tuning forks. Frequency of A is 350 Hz. Beats produced by A and B are 5 per second and by B and C are 4 per second. When a wax is put on A beat frequency between A and B is 2Hz and between A and C is 6Hz. Then, find the frequency of B and C respectively.

PWV211

Doppler Effect

39. A car is moving towards a huge wall with a speed = $c/10$, where c = speed of sound in still air. A wind is also blowing parallel to the velocity of the car in the same direction and with the same speed. If the car sounds a horn of frequency f, then what is the frequency of the reflected sound of the horn heard by driver of the car?

PWV223

40. A boat is travelling in a river with a speed of 10 m/s along the stream flowing with a speed 2 m/s. From this boat, a sound transmitter is lowered into the river through a rigid support. The wavelength of the sound emitted from the transmitter inside the water is 14.45 mm. Assume that attenuation of sound in water and air is negligible:

(a) What will be the frequency detected by a receiver kept inside the river downstream ?

(b) The transmitter and the receiver are now pulled up into air. The air is blowing with a speed 5 m/sec in the direction opposite the river stream. Determine the frequency of the sound detected by the receiver.

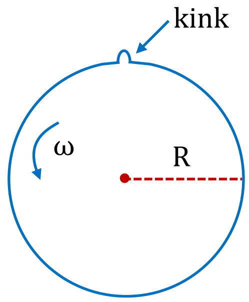
(Temperature of the air and water = 20°C ; Density of river water = 10^3 Kg/m^3; Bulk modulus of the water = 2.088×10^9 Pa; Gas constant R = 8.31 $J/mol\text{-}K$; Mean molecular mass of air = 28.8×10^{-3} kg/mol; C_P/C_V for air = 1.4)

Note: Boat velocity is with respect to ground and receiver is stationary w.r.t. ground

PWV230

MISCELLANEOUS QUESTION

41. A loop of rope is whirled at an angular velocity 100 rad/sec, so that it becomes a taut circle of radius 1m. A kink develops in the whirling rope as shown in figure. Linear mass density of the rope is 0.1 kg/m. The speed of kink relative to rope (in m/s) is V. The value of $V/20$ is :-



PWV245

42. A particular guitar wire is 30.0 cm long and vibrates at a frequency of 196 Hz in fundamental mode when no finger is placed on it. The next higher notes on the scale are 220 Hz, 247 Hz, 262 Hz and 294 Hz. How far from the end of the string must the finger be placed to play these notes ?

PWV246

43. A steel wire 8×10^{-4} m in diameter is fixed to a support at one end and is wrapped round a cylindrical tuning peg 5 mm in diameter at the other end. The length of the wire between the peg and the support is 0.06 m. The wire is initially kept taut but without any tension. What will be the fundamental frequency of vibration of the wire if it is tightened by giving the peg a quarter of a turn?

Density of steel = 7800 kg/m^3, Y of steel = 20×10^{10} N/m^2.

PWV247

44. A steel of wire of length 25 cm is fixed at its ends to rigid walls. Young's modulus of steel = 200 GPa, coefficient of linear thermal expansion = $10^{-5}/°C$. Initially, the wire is just taut at 20°C temperature. The density of steel = 8.0 g/cc. A tuning fork of frequency 200 Hz is touched to the wire, to execute oscillations. Simultaneously, the temperature is slowly lowered. At what temperature will resonance occur corresponding to the third overtone?

PWV248

45. A string 25 cm long and having a mass of 2.5 gm is under tension. A pipe closed at one end is 40 cm long. When the string is set vibrating in its first overtone and the air in the pipe in its fundamental frequency, 8 beats per second are heard. It is observed that decreasing the tension in the string decreases beat frequency. If the speed of sound in air is 320 m/s, find the tension in the string.

PWV249

46. A supersonic jet plane moves parallel to the ground at speed v = 0.75 mach (1 mach = speed of sound). The frequency of its engine sound is ν_0 = 2 kHz and the height of the jet plane is h = 1.5 km. At some instant an observer on the ground hears a sound of frequency $\nu = 2\nu_0$, Find the instant prior to the instant of hearing when the sound wave received by the observer was emitted by the jet plane. Velocity of sound wave in the condition of observer = 340 m/s.

PWV250

EXERCISE - JEE (Main) PYQ

1. A pipe of length 85 cm is closed from one end. Find the number of possible natural oscillations of air column in the pipe whose frequencies lie below 1250 Hz. The velocity of sound in air is 340 m/s. **[JEE (Main) 2014]**

(1) 12 (2) 8 (3) 6 (4) 4

PWV032

2. A train is moving on a straight track with speed 20 ms^{-1}. It is blowing its whistle at the frequency of 1000 Hz. The percentage change in the frequency heard by a person standing near the track as the train passes him is (speed of sound = 320 ms^{-1}) close to: **[JEE (Main) 2015]**

(1) 6% (2) 12% (3) 18% (4) 24%

PWV033

3. An observer is moving with half the speed of light towards stationary microwave source emitting waves at frequency 10GHz. What is the frequency of the microwave measured by the observer? (speed of light = 3×10^8 ms^{-1}) **[JEE (Main) 2017]**

(1) 15.3 GHz (2) 10.1 GHz (3) 12.1 GHz (4) 17.3 GHz

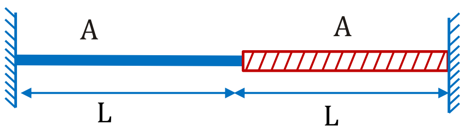
PWV034

4. A heavy ball of mass M is suspended from the ceiling of a car by a light string of mass m ($m << M$). When the car is at rest, the speed of transverse waves in the string is 60 ms^{-1}. When the car has acceleration a, the wave–speed increases to 60.5 ms^{-1}. The value of a, in terms of gravitational acceleration g, is closest to: **[JEE (Main) 2019]**

(1) $\frac{g}{5}$ (2) $\frac{g}{20}$ (3) $\frac{g}{10}$ (4) $\frac{g}{30}$

PWV035

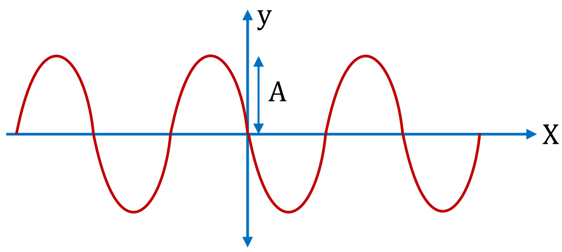
5. A wire of length 2L, is made by joining two wires A and B of same length but different radii r and 2r and made of the same material. It is vibrating at a frequency such that the joint of the two wires forms a node. If the number of antinodes in wire A is p and that in B is q then the ratio $p : q$ is : **[JEE (Main) 2019]**



(1) 4 : 9 (2) 3 : 5 (3) 1 : 4 (4) 1 : 2

PWV036

6. A progressive wave travelling along the positive x-direction is represented by $y(x,t) = A \sin(kx - \omega t + \phi)$. Its snapshot at $t = 0$ is given in the figure:

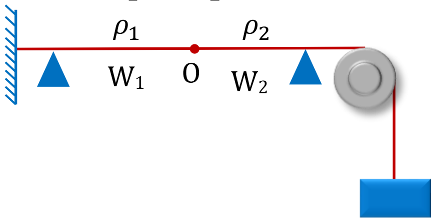


For this wave, the phase ϕ is : **[JEE (Main) 2019]**

(1) 0 (2) $-\frac{\pi}{2}$ (3) π (4) $\frac{\pi}{2}$

PWV037

7. 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 wave 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 to W_2 is : **[JEE (Main) 2019]**



(1) 1 : 3 (2) 1 : 1 (3) 4 : 1 (4) 1 : 2

PWV038

8. A closed organ pipe has a fundamental frequency of 1.5 kHz. The number of overtones that can be distinctly heard by a person with this organ pipe will be:
(Assume that the highest frequency a person can hear is 20,000 Hz) **[JEE (Main) 2019]**
(1) 7 (2) 5 (3) 6 (4) 4

PWV039

9. A person standing on an open ground hears the sound of a jet Aeroplane, coming from north at an angle 60° with ground level. But he finds the Aeroplane right vertically above his position. If υ is the speed of sound, speed of the plane is: **[JEE (Main) 2019]**

(1) $\frac{2\upsilon}{\sqrt{3}}$ (2) υ (3) $\frac{\upsilon}{2}$ (4) $\frac{\sqrt{3}}{2}\upsilon$

PWV040

10. In a resonance tube experiment when the tube is filled with water up to height of 17.0 cm from bottom, it resonates with a given tuning fork. When the water level is raised the next resonance with the same tuning fork occurs at a height of 24.5 cm. If the velocity of sound in air is 330 m/s, the tuning fork frequency is: **[JEE (Main) 2020]**
(1) 1100 Hz (2) 3300 Hz (3) 2200 Hz (4) 550 Hz

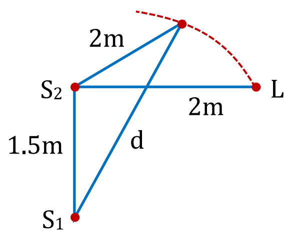
PWV041

11. Assume that the displacement(s) of air is proportional to the pressure difference (Δp) created by a sound wave. Displacement(s) further depends on the speed of sound (v), density of air (ρ) and the frequency (f). If $\Delta p \sim 10\ Pa$, $v \sim 300\ m/s$, $\rho \sim 1\ kg/m^3$ and $f \sim 1000\ Hz$, then s will be the order of (Take multiplicative constant to be 1) **[JEE (Main) 2020]**

(1) 10 mm (2) $\frac{3}{100}\ mm$ (3) 1 mm (4) $\frac{1}{10}\ mm$

PWV042

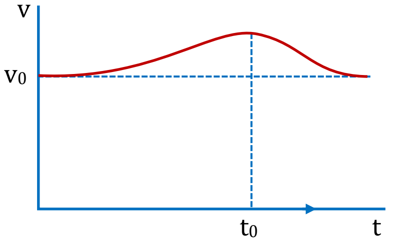
12. Two coherent sources of sound, S_1 and S_2, produce sound waves of the same wavelength, $\lambda = 1\ m$, in phase. S_1 and S_2 are placed 1.5 m apart (see fig.) A listener, located at L, directly in front of S_2 finds that the intensity is at a minimum when he is 2m away from S_2. The listener moves away from S_1, keeping his distance from S_2 fixed. The adjacent maximum of intensity is observed when the listener is at a distance d from S_1. Then, d is : **[JEE (Main) 2020]**

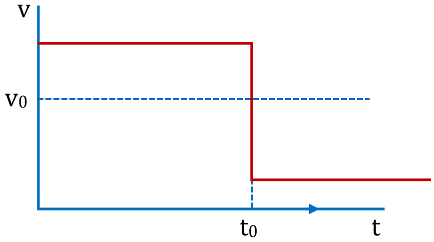


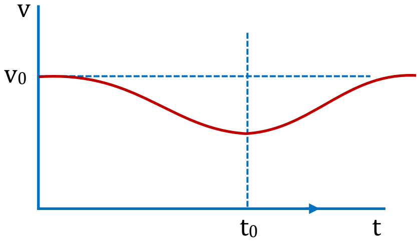
(1) 12m (2) 3m
(3) 5m (4) 2m

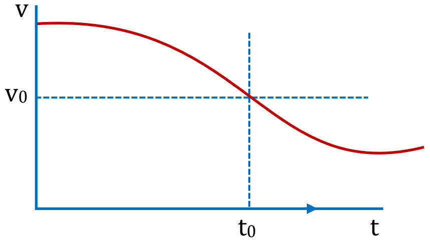
PWV043

13. A sound source S is moving along a straight track with speed v, and is emitting sound of frequency v_0. An observer is standing at a finite distance, at the point O, from the track. The time variation of frequency heard by the observer is best represented by :
(t_0 represents the instant when the distance between the source and observer is minimum)
[JEE (Main) 2020]

(1) 

(2) 

(3) 

(4) 

PWV044

14. Two waves are simultaneously passing through a string and their equations are :
$y_1 = A_1 \sin k(x - vt)$, $y_2 = A_2 \sin k(x - vt + x_0)$. Given amplitudes $A_1 = 12\ mm$ and $A_2 = 5\ mm$, $x_0 = 3.5\ cm$ and wave number $k = 6.28\ cm^{-1}$. The amplitude of resulting wave will be .... mm.
[JEE (Main) 2021]
PWV045

15. Two travelling waves produces a standing wave represented by equation,
$y = 1.0\ mm \cos(1.57 cm^{-1})\ x \sin(78.5\ s^{-1})t$. The node closest to the origin in the region $x > 0$ will be at x = ... cm.
[JEE (Main) 2021]
PWV046

16. Sound travels in a mixture of two moles of helium and n moles of hydrogen. If rms speed of gas molecules in the mixture is $\sqrt{2}$ times the speed of sound, then the value of n will be
[JEE (Main) 2022]
(1) 1 (2) 2 (3) 3 (4) 4
PWV047

17. A transverse wave is represented by $y = 2 \sin\left(\omega t - kx\right)$ cm. The value of wavelength (in cm) for which the wave velocity becomes equal to the maximum particle velocity, will be
[JEE (Main) 2022]
(1) 4π (2) 2π (3) π (4) 2
PWV048

18. A steel wire with mass per unit length $7.0 \times 10^{-3}\ kg\ m^{-1}$ is under tension of 70 N. The speed of transverse waves in the wire will be: **[JEE (Main) 2023]**
(1) $200\ \pi\ m/s$ (2) $100\ m/s$ (3) $10\ m/s$ (4) $50\ m/s$
PWV049

19. A person observes two moving trains, '*A*' reaching the station and '*B*' leaving the station with equal speed of 30 m/s. If both trains emit sounds with frequency 300 Hz, (Speed of sound : 330 m/s) approximate difference of frequencies heard by the person will be : **[JEE (Main) 2023]**
(1) 33 Hz (2) 55 Hz (3) 80 Hz (4) 10 Hz
PWV050

EXERCISE - JEE (Advanced) PYQ

1. One end of a taut string of length $3m$ along the x–axis is fixed at $x = 0$. The speed of the waves in the string is $100\ ms^{-1}$. The other end of the string is vibrating in the y direction so that stationary waves are set up in the string. The possible waveform(s) of these stationary waves is (are):

[JEE (Advanced) 2014]

(A) $y(t) = A \sin\frac{\pi x}{6}\cos\frac{50\pi t}{3}$

(B) $y(t) = A \sin\frac{\pi x}{3}\cos\frac{100\pi t}{3}$

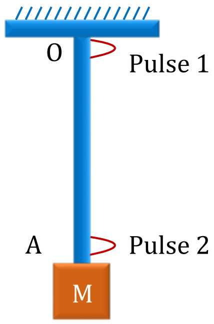
(C) $y(t) = A \sin\frac{5\pi x}{6}\cos\frac{250\pi t}{3}$

(D) $y(t) = A \sin\frac{5\pi x}{2}\cos 250\pi t$

PWV069

2. A block M hangs vertically at the bottom end of a uniform rope of constant mass per unit length. The top end of the rope is attached to a fixed rigid support at O. A transverse wave pulse (Pulse 1) of wavelength λ_0 is produced at point O on the rope. The pulse takes time T_{OA} to reach point A. If the wave pulse of wavelength λ_0 is produced at point A (Pulse 2) without disturbing the position of M it takes time T_{AO} to reach point O. Which of the following options is/are correct

[JEE (Advanced) 2017]



(A) The time $T_{AO} = T_{OA}$.

(B) The velocities of the two pulses (Pulse 1 and Pulse 2) are the same at the midpoint of rope.

(C) The wavelength of Pulse 1 becomes longer when it reaches point A.

(D) The velocity of any pulse along the rope is independent of its frequency and wavelength.

PWV070

3. Answer the following by appropriately matching the lists based on the information given in the paragraph. A musical instrument is made using four different metal strings, 1, 2, 3 and 4 with mass per unit length μ, 2μ, 3μ and 4μ respectively. The instrument is played by vibrating the strings by varying the free length in between the range L_0 and $2L_0$. It is found that in string-1 (μ) at free length L_0 and tension T_0 the fundamental mode frequency is f_0. **[JEE (Advanced) 2019]**

List-I gives the above four strings while list-II lists the magnitude of some quantity.

	List-I		**List-II**
(I)	String-1(μ)	(P)	1
(II)	String-2 (2μ)	(Q)	1/2
(III)	String-3 (3μ)	(R)	$1/\sqrt{2}$
(IV)	String-4 (4μ)	(S)	$1/\sqrt{3}$
		(T)	3/16
		(U)	1/16

The length of the string 1,2,3 and 4 are kept fixed at $L_0, \frac{3L_0}{2}, \frac{5L_0}{4}$ and $\frac{7L_0}{4}$, respectively. Strings 1, 2, 3 and 4 are vibrated at their 1^{st}, 3^{rd}, 5^{th} and 14^{th} harmonics, respectively such that all the strings have same frequency. The correct match for the tension in the four strings in the units of sT_0 will be

(A) I → P, II → Q, III → T, IV → U
(B) I → T, II → Q, III → R, IV → U
(C) I → P, II → Q, III → R, IV → T
(D) I → P, II → R, III → T, IV → U

PWV071

4. A student is performing an experiment using a resonance column and a tuning fork of frequency 244 s^{-1}. He is told that the air in the tube has been replaced by another gas (assume that the column remains filled with the gas). If the minimum height at which resonance occurs is (0.350 ± 0.005) m, the gas in the tube is

(**Useful information :** $\sqrt{167RT} = 640\ J^{1/2}$ mole$^{-1/2}$; $\sqrt{140RT} = 590\ J^{1/2}$ mole$^{-1/2}$. The molar masses M in grams are given in the options. Take the values of $\sqrt{\frac{10}{M}}$ for each gas as given there.)

[JEE (Advanced) 2014]

(A) Neon $\left(M = 20, \sqrt{\frac{10}{20}} = \frac{7}{10}\right)$
(B) Nitrogen $\left(M = 28, \sqrt{\frac{10}{28}} = \frac{3}{5}\right)$
(C) Oxygen $\left(M = 32, \sqrt{\frac{10}{32}} = \frac{9}{16}\right)$
(D) Argon $\left(M = 36, \sqrt{\frac{10}{36}} = \frac{17}{32}\right)$

PWV072

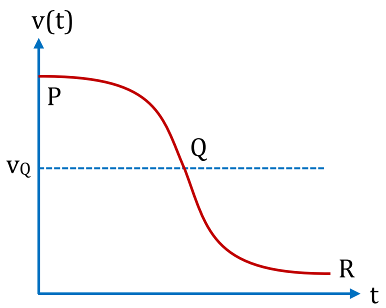
5. Four harmonic waves of equal frequencies and equal intensities I_0 have phase angles 0, $\pi/3$, $2\pi/3$ and π. When they are superposed, the intensity of the resulting wave is nI_0. The value of n is.

[JEE (Advanced) 2015]

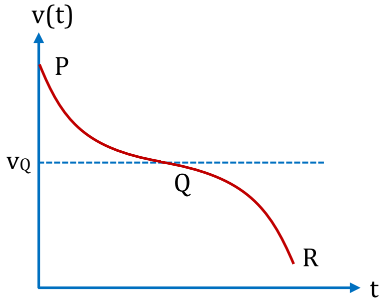
PWV073

6. Two loudspeakers M and N are located 20m apart and emit sound at frequencies 118 Hz and 121 Hz, respectively. A car is initially at a point P, 1800 m away from the midpoint Q of the line MN and moves towards Q constantly at 60 km/hr along the perpendicular bisector of MN. It crosses Q and eventually reaches a point R, 1800 m away from Q. Let $\nu(t)$ represent the beat frequency measured by a person sitting in the car at time t. Let ν_P, ν_Q and ν_R be the beat frequencies measured at locations P, Q and R, respectively. The speed of sound in air is 330 ms^{-1}. Which of the following statement(s) is(are) true regarding the sound heard by the person? **[JEE (Advanced) 2016]**

(A) The plot below represents schematically the variation of beat frequency with time



(B) The plot below represents schematically the variations of beat frequency with time



(C) The rate of change in beat frequency is maximum when the car passes through Q

(D) $v_P + v_R = 2v_Q$

PWV074

7. A stationary source emits sound of frequency $f_0 = 492\ Hz$. The sound is reflected by a large car approaching the source with a speed of $2\ ms^{-1}$. The reflected signal is received by the source and superposed with the original. What will be the beat frequency of the resulting signal in Hz ? (Given that the speed of sound in air is $330\ ms^{-1}$ and the car reflects the sound at the frequency it has received). **[JEE (Advanced) 2017]**

PWV075

8. Two men are walking along a horizontal straight line in the same direction. The man in front walks at a speed $1.0\ ms^{-1}$ and the man behind walks at a speed $2.0\ ms^{-1}$. A third man is standing at a height $12m$ above the same horizontal line such that all three men are in a vertical plane. The two walking men are blowing identical whistles which emit a sound of frequency $1430\ Hz$. The speed of sound in air is $330\ ms^{-1}$. At the instant, when the moving men are $10\ m$ apart, the stationary man is equidistant from them. The frequency of beats in Hz, heard by the stationary man at this instant, is ____________. **[JEE (Advanced) 2018]**

PWV076

9. In an experiment to measure the speed of sound by a resonating air column, a tuning fork of frequency $500\ Hz$ is used. The length of the air column is varied by changing the level of water in the resonance tube. Two successive resonances are heard at air columns of length $50.7\ cm$ and $83.9\ cm$. Which of the following statements is (are) true ? **[JEE (Advanced) 2018]**

(A) The speed of sound determined from this experiment is $332\ ms^{-1}$

(B) The end correction in this experiment is $0.9\ cm$

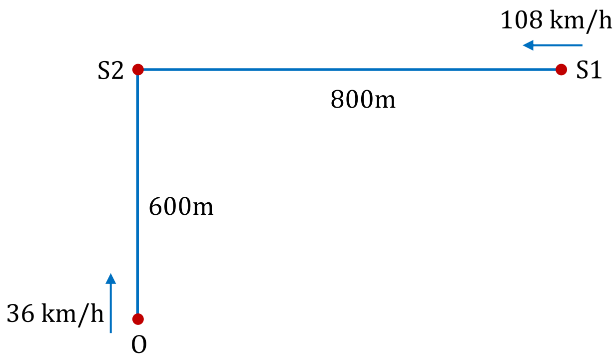
(C) The wavelength of the sound wave is $66.4\ cm$

(D) The resonance at $50.7\ cm$ corresponds to the fundamental harmonic

PWV077

10. A train S_1, moving with a uniform velocity of $108\ km/h$, approaches another train S_2 standing on a platform. An observer O moves with a uniform velocity of $36\ km/h$ towards S_2, as shown in figure. Both the trains are blowing whistles of same frequency $120\ Hz$. When O is $600\ m$ away from S_2 and distance between S_1 and S_2 is $800\ m$, the number of beats heard by O is ______.

[Speed of the sound = $330\ m/s$]



[JEE (Advanced) 2019]

PWV078

11. A stationary tuning fork is in resonance with an air column in a pipe. If the tuning fork is moved with a speed of 2 ms^{-1} in front of the open end of the pipe and parallel to it, the length of the pipe should be changed for the resonance to occur with the moving tuning fork. If the speed of sound in air is 320 ms^{-1}, the smallest value of the percentage change required in the length of the pipe is ________. **[JEE (Advanced) 2020]**

PWV079

12. A source, approaching with speed u towards the open end of a stationary pipe of length L, is emitting a sound of frequency f_s. The farther end of the pipe is closed. The speed of sound in air is v and f_0 is the fundamental frequency of the pipe. For which of the following combination(s) of u and f_s, will the sound reaching the pipe lead to a resonance ? **[JEE (Advanced) 2021]**

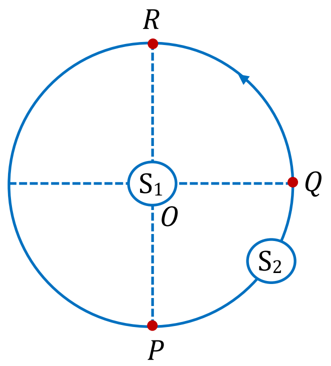
(A) $u = 0.8\ v$ and $f_s = f_0$
(B) $u = 0.8\ v$ and $f_s = 2f_0$
(C) $u = 0.8\ v$ and $f_s = 0.5\ f_0$
(D) $u = 0.5\ v$ and $f_s = 1.5\ f_0$

PWV080

PARAGRAPH FOR Q.NO. 13 AND 14

S_1 and S_2 are two identical sound sources of frequency 656 Hz. *The* source S_1 is located at O and S_2 moves anti-clockwise with a uniform speed $4\sqrt{2}\ ms^{-1}$ on a circular path around O, as shown in the figure. There are three points P, Q and R on this path such that P and R are diametrically opposite while Q is equidistant from them. A sound detector is placed at point P. The source S_1 can move along direction OP.

[Given: The speed of sound in air is 324 ms^{-1}] **[JEE (Advanced) 2023]**



13. When only S_2 is emitting sound and it is Q, the frequency of sound measured by the detector in Hz is _________.

PWV259

14. Consider both sources emitting sound. When S_2 is at R and S_1 approaches the detector with a speed 4 ms^{-1}, the beat frequency measured by the detector is ______Hz.

PWV260

JEE (Main) Practice Paper

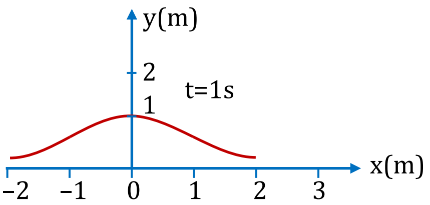
This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

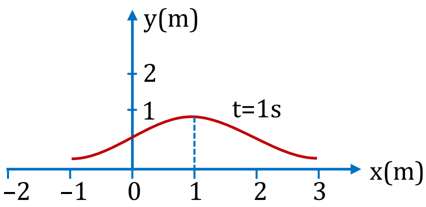
SECTION–A

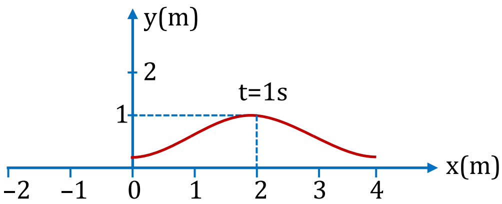
- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

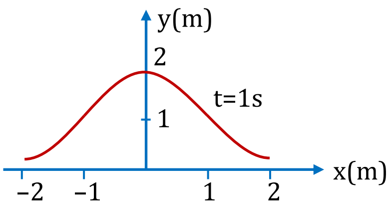
Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

1. A wave pulse is given by the equation $y = f(x, t) = A \exp(-B(x - vt)^2)$. Given $A = 1.0m$, $B = 1.0\ m^{-2}$ and $v = +2.0\ m/s$, which of the following graph shows the correct wave profile at the instant $t = 1\ s$?

(1) 

(2) 

(3) 

(4) 

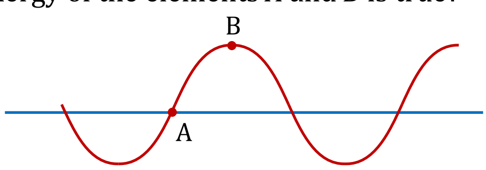
PWV001

2. A wave travels on a light string. The equation of the wave is $Y = A \sin(kx - \omega t + 30°)$. It is reflected from a heavy string tied to an end of the light string at $x = 0$. If 64% of the incident energy is reflected the equation of the reflected wave is

(1) $Y = 0.8\,A \sin(kx - \omega t + 30^0 + 180^0)$
(2) $Y = 0.8\,A \sin(kx + \omega t + 30^0 + 180^0)$
(3) $Y = 0.8\,A \sin(kx + \omega t - 30^0)$
(4) $Y = 0.8\,A \sin(kx + \omega t + 30^0)$

PWV002

3. A progressive wave is travelling in a string as shown. Then which of the following statement about *KE* and potential energy of the elements *A* and *B* is true?



(1) For point *A* : kinetic energy is maximum and potential energy is min.
(2) For point *B* : kinetic energy is minimum and potential energy is min.
(3) For point *A* : kinetic energy is minimum and potential energy is max.
(4) For point *B* : kinetic energy is minimum and potential energy is max.

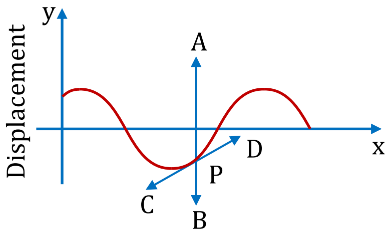
PWV003

4. The displacement from the position of equilibrium of a point 4 *cm* from a source of sinusoidal oscillations is half the amplitude at moment $t = T/6$ (T is the time period). Assume that the source was at mean position at $t = 0$. The wavelength of the running wave is

(1) 0.96 *m* (2) 0.48 *m* (3) 0.24 *m* (4) 0.12 *m*

PWV004

5. The figure below shows a snap photograph of a simple harmonic progressive wave, progressing in the negative X-axis, at a given instant. The direction of the velocity of the particle at the stage P on the figure is best represented by the arrow.



(1) $\overrightarrow{PA}$ (2) $\overrightarrow{PB}$

(3) $\overrightarrow{PC}$ (4) $\overrightarrow{PD}$

PWV005

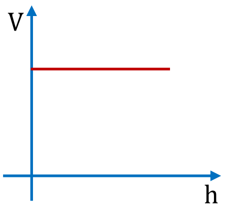
6. The function of x and t that does not represent a progressive wave is :-

(1) $y = 2 \sin (4t - 3x)$ (2) $y = e^{[4+(4t-3x)]}$ (3) $y = [4t - 3x]^{-1}$ (4) $y = [4t-3x]$

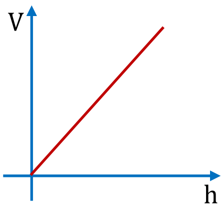
PWV006

7. A uniform rope having some mass hangs vertically from a rigid support. A transverse wave pulse is produced at the lower end. The speed (v) of the wave pulse varies with height (h) from the lower end as:

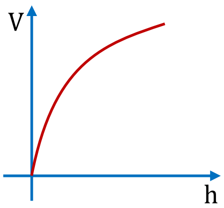
(1)



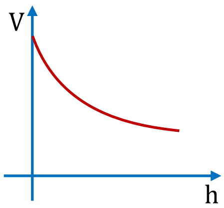
(2)



(3)



(4)



PWV007

8. For a travelling one dimensional mechanical sinusoidal, wave, which option is incorrect;

(1) potential energy and kinetic energy of an element become maximum simultaneously.

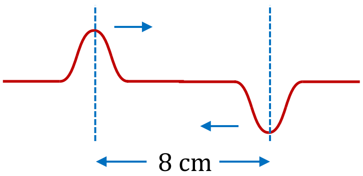
(2) all particles oscillate with the same frequency and the same amplitude

(3) all particles may come to rest simultaneously

(4) we can find two particles, in a length equal to half of a wavelength, which have the same non-zero acceleration simultaneously.

PWV008

9. Two pulses in a stretched string whose centers 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



(1) Zero

(2) Purely kinetic

(3) Purely potential

(4) Partly kinetic and partly potential

PWV009

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

PWV010

11. Two stretched wires *A* and *B* of the same lengths vibrate independently. If the radius, density and tension of wire *A* are respectively twice those of wire *B*, then the fundamental frequency of vibration of *A* relative to that of *B* is

(1) 1 : 1 (2) 1 : 2 (3) 1 : 4 (4) 1 : 8

PWV011

12. Beats are heard when the A strings of two violins are played. The beat frequency decreases as the tension in the A string of violin 1 is slowly increased. Which of the following statement is correct?

(1) the fundamental frequency of the A string in violin 1 is less than that for violin 2.

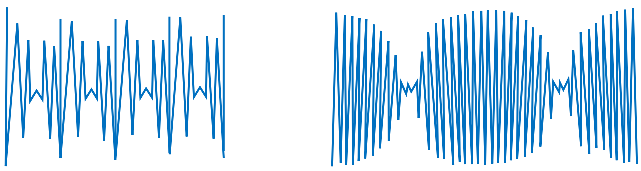
(2) the fundamental frequency of the A string in violin 1 is greater than that for violin 2.

(3) the fundamental frequency of the A string in violin 1 may be greater or less than that for violin 2 depending on the linear mass densities of the two strings.

(4) None of these

PWV012

13. Two waves with similar frequencies are added. The resulting waveform oscillates with the average frequency and with an oscillating amplitude that changes with a frequency equal to the difference between the original frequencies. These oscillations in the amplitude are known as beats. The traces show the resulting waveforms that occur when two different pairs of waves are added. Graph is for the same time interval in both cases, which of the following statements is TRUE?



(1) On average, the waves on the left had higher frequencies, but the difference between frequencies less.

(2) On average, the waves on the right had higher frequencies, but the difference between frequencies less.

(3) On average, the waves on the left had higher frequencies, but the difference between frequencies more.

(4) On average, the waves on the right had higher frequencies, but the difference between frequencies more.

PWV013

14. If l_1 and l_2 are the lengths of air column for the first and second resonance when a tuning fork of frequency *n* is sounded on a resonance tube, then the distance of the displacement antinode from the top end of the resonance tube is:

(1) $2(l_2 - l_1)$ (2) $\frac{1}{2}(2l_1 - l_2)$ (3) $\frac{l_2 - 3l_1}{2}$ (4) $\frac{l_2 - l_1}{2}$

PWV014

15. A sound wave has a wavelength of 3.0 *m*. The distance from a compression center to the adjacent rarefaction center is :-

(1) 0.75 *m* (2) 1.5 *m*

(3) 3.0 *m* (4) need to know wave speed

PWV015

16. The fig.(i) shows the graphical representation of the air molecules in a tube of air (length = *L*) at atmospheric pressure on the absolute pressure *P*(*x*) graph. Which one of the following pictures corresponds to the absolute pressure *P*(*x*) graph of fig. (ii).

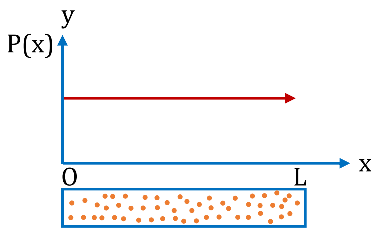


Figure (i)

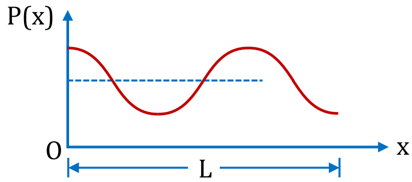
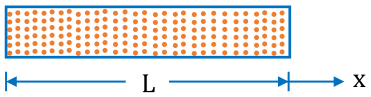
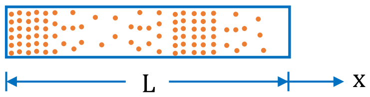
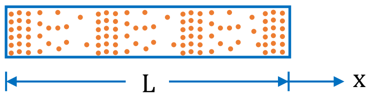
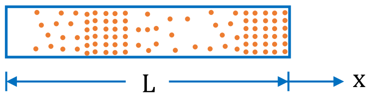


Figure (ii)

(1) 

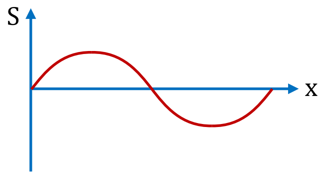
(2) 

(3) 

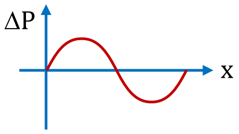
(4) 

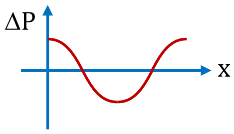
PWV016

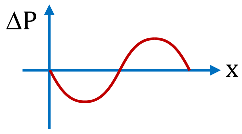
17. If a sound wave is travelling and snap shot at $t = 0$ is as shown in figure.

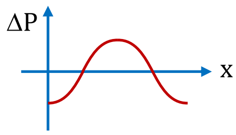


Choose snapshot of pressure variation.

(i) 

(ii) 

(iii) 

(iv) 

(1) For wave travelling towards right or left (i) is correct.

(2) For wave travelling towards right graph (iv) and for wave travelling towards left graph (iv) is correct.

(3) For wave travelling towards right graph (i) and for wave travelling towards left graph (iii) is correct.

(4) For wave travelling towards right or left (ii) is correct.

PWV017

18. A firecracker exploding on the surface of a lake is heard as two sounds a time interval t apart by a man on a boat close to water surface. Sound travels with a speed u in water and a speed v in air. The distance from the exploding firecracker to the boat is

(1) $\frac{uvt}{u+v}$ (2) $\frac{t(u+v)}{uv}$ (3) $\frac{t(u-v)}{uv}$ (4) $\frac{uvt}{u-v}$

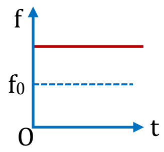
PWV018

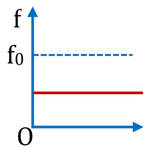
19. A student is experimenting with resonance tube apparatus in Physics lab to find the speed of sound at room temperature. He got resonating lengths of air column as 17 cm and 51 cm, using tuning fork of frequency 512 Hz. Find speed of sound at room temperature and specify, whether the side water reservoir was moved upward or downward to obtain the second resonance (51 cm)?

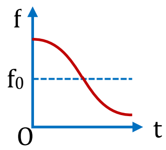
(1) 348 m/s, downwards (2) 348 m/s, upwards
(3) 332 m/s, downwards (4) 332 m/s, upwards

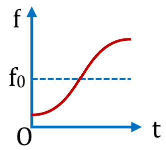
PWV019

20. Source and observer both start moving simultaneously from origin, one along x-axis and the other along y-axis with speed of source = twice the speed of observer. The graph between the apparent frequency observed by observer f and time t would approximately be :

(1) 

(2) 

(3) 

(4) 

PWV020

SECTION–B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4, if only correct answer is given.
Zero Marks : 0, if no answer is given.
Negative Marks : –1 for incorrect answer.

---

1. A copper wire is held at the two ends by rigid supports. At 30°C, the wire is just taut, with negligible. Find the speed of transverse waves (in m/s) in this wire at 10°C.
Given : Young modulus of copper = 1.3×10^{11} N/m^2.
Coefficient of linear expansion of copper = 1.7×10^{-5} °C^{-1}.
Density of copper = 9×10^3 kg/m^3.

PWV021

2. Two sound waves of frequencies 100 Hz and 102 Hz and having same amplitude 'A' are interfering. A detector which can detect waves of amplitude greater than or equal to A is kept at rest. In a time interval of 12 seconds, find the total duration (in sec) in which detector is active.

PWV251

3. A steel of wire of length 25 cm is fixed at its ends to rigid walls. Young's modulus of steel = 200 GPa, coefficient of linear thermal expansion = 10^{-5} $/°C$. Initially, the wire is just taut at 20$°C$ temperature. The density of steel = 8.0 g/cc. A tuning fork of frequency 200 Hz is touched to the wire, to execute oscillations. Simultaneously, the temperature is slowly lowered. At temperature T, resonance occurs corresponding to the third overtone, where $T = (1.5 + x)°C$. Then find the value of x.

PWV023

4. In a resonance-column experiment, a long tube, open at the top, is clamped vertically. By a separate device, water level inside the tube can be moved up or down. The section of the tube from the open end to the water level act as a closed organ pipe. A vibrating tuning fork is held above the open end, first and the second resonances occur when the water level is 24.1 cm and 74.1 cm respectively below the open end. Find the diameter of the tube in cm.

PWV024

5. A source of sound of frequency 256 Hz is moving rapidly towards wall with a velocity of 5 m/sec. How many beats per second will be heard if sound travels at a speed of 330 m/sec?

PWV025

6. A tuning fork of frequency 480 Hz resonates with a tube closed at one end of length, 16 cm and diameter 5 cm in fundamental mode. Calculate velocity of sound (in m/s) in air.

PWV026

7. 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.

PWV027

8. A sonometer wire under tension of 64 Newtons vibrating in its fundamental mode is in resonance with a vibrating tuning fork. The vibrating portion of the sonometer wire has a length of 10 cm and a mass of 1 gm. The vibrating tuning fork is now moved away from the vibrating wire with a constant speed and an observer standing near the sonometer hears one beat per second. The speed (in m/s) with which the tuning fork is moved is $\frac{v}{4}$. If the speed of sound in air is 300 m/s, then value of v will be ?

PWV028

9. Two tuning forks A and B lying on opposite sides of observer 'O' and of natural frequency 85 Hz move with velocity 10 m/s relative to stationary observer O. Fork A moves away from the observer while the fork B moves towards him. A wind with a speed 10 m/s is blowing in the direction of motion of fork A. Find the beat frequency measured by the observer in Hz.
(Take speed of sound in air as 340 m/s)

PWV029

10. A bus is moving towards a huge wall with a velocity of 5 ms^{-1}. The driver sounds a horn of frequency 200 Hz. The frequency of the beats heard by a passenger of the bus will be..... Hz.
(Speed of sound in air = 342 ms^{-1})

PWV030

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **TWO** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

1. In an organ pipe whose one end is at $x = 0$, the pressure is expressed by $p = p_0 \cos\left(\frac{3\pi x}{2}\right) \sin 300\pi t$ where x is in meter and t in sec. The organ pipe can be ;

(A) closed at one end, open at another with length = 0.5m
(B) open at both ends, length = 1m
(C) closed at both ends, length = 2m
(D) closed at one end, open at another with length = $\frac{2}{3}m$

PWV051

2. The shape of a wave propagating in the positive x or negative x- direction is given $y = \frac{1}{\sqrt{1+x^2}}$ at $t = 0$ and $y = \frac{1}{\sqrt{2-2x+x^2}}$ at $t = 1s$ where x and y are in meters. The shape the wave disturbance does not change during propagation. Find the velocity of the wave.

(A) 1 m/s in positive x direction
(B) 1 m/s in negative x direction
(C) $\frac{1}{2}$ m/s in positive x direction
(D) $\frac{1}{2}$ m/s in negative x direction

PWV052

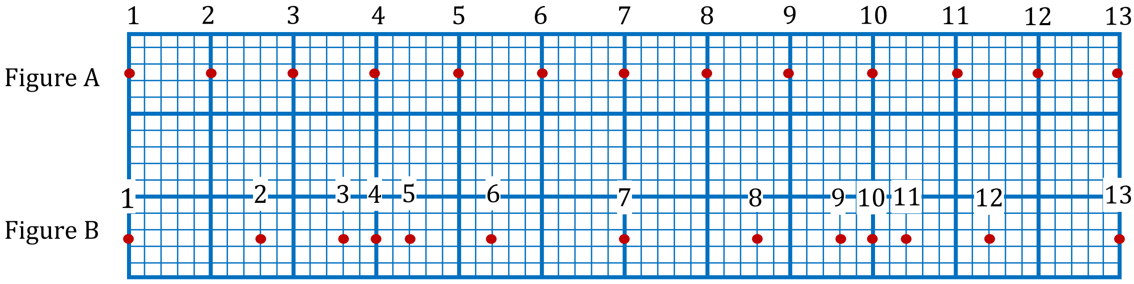
SECTION-II

- This section contains **NINE** questions.
- Each question has **FOUR** options for correct answer(s). **ONE OR MORE THAN ONE** of these four option(s) is (are) correct option(s).
- For each question, choose the correct option(s) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 if only (all) the correct option(s) is (are) chosen.
Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.
Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –2 in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

3. Figure A below shows the equilibrium positions of air particle 1, 2, 3 etc, and Figure B shows their positions at an instant when a longitudinal travelling wave moves through the air to the right. Which of the following statement(s) concerning the air particles in Figure B is/are correct.



(A) Particle 4 is at rest at this instant.

(B) Particle 3 and 5 are moving in same direction at this instant.

(C) Particle 3 will move to the right immediately after this instant of time

(D) Particle 7 will move to the left immediately after this instant of time

PWV252

4. Sound waves from different source are interfering and pressure at same point in space is given as–

$$P = P_0 \sin(200\pi t + \pi/2)\cos(3\pi t + \pi/3)$$

(A) The frequency of one source is above 100Hz and other source is below 100Hz.

(B) Beat frequency is 3 Hz

(C) Beat frequency is 200 Hz

(D) Beat frequency can be 3 Hz as well as 200 Hz

PWV253

5. Two sound waves, travelling in same direction can be represented as

$$y_1 = (0.02mm)\, sin\left[(400\pi rads^{-1})\left(\frac{x}{330ms^{-1}} - t\right)\right]$$

and $$y_2 = (0.02mm)\, sin\left[(404\pi rads^{-1})\left(\frac{x}{330ms^{-1}} - t\right)\right]$$

The wave superimpose.

(A) Distance between two nearest points where an intensity maximum is recorded simultaneously is 165 m.

(B) Distance between two nearest points where an intensity maximum is recorded simultaneously is 330 m.

(C) The time gap between two successive intensity maxima at a given point is 0.5 sec.

(D) The time gap between two successive intensity maxima at a given point is 1 sec.

PWV254

6. Which of the following statement(s) are TRUE about a stationary wave?

(A) No particle will move with same amplitude.

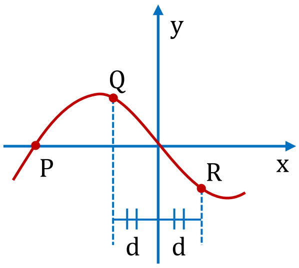
(B) All particles between two successive nodes reach their extreme position together in phase.

(C) Displacement and velocity nodes co-exist.

(D) Power can get transferred through nodes.

PWV255

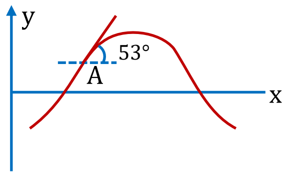
7. At a certain moment, the photograph of a string on which a harmonic wave is travelling to the right is shown. Then, which of the following is true regarding the velocities of the points P, Q and R on the string.



(A) v_P is upwards (B) $v_Q = -v_R$ (C) $|v_P| > |v_Q| = |v_R|$ (D) $v_Q = v_R$

PWV057

8. Curve 'y–x' at an instant for a wave travelling along x-axis on a string is shown. Slope at the point A on the curve, as shown, is 53°.



(A) Transverse velocity of the particle at point A is positive if the wave is travelling along positive x-axis.

(B) Transverse velocity of the particle at point A is positive if the wave is travelling along negative x-axis of the particle at point A

(C) Magnitude of transverse velocity of the particle at point A is greater than wave speed.

(D) Magnitude of transverse velocity of the particle at point A is lesser than wave speed.

PWV257

9. Two particles of medium disturbed by the wave propagation are at $x_1 = 0$ and $x_2 = 1cm$. The respective displacements (in cm) of the particles can be given by the equations:

$$y_1 = 2\sin 3\pi t \quad ; \quad y_2 = 2\sin(3\pi t - \pi/8)$$

(A) The wave velocity is 16 cm/sec

(B) The wave velocity is 24 cm/sec

(C) The displacement of particle at t = 1 sec and x = 4 cm is zero

(D) The displacement of particle at t = 1 sec and x = 4 cm is 2 cm

PWV258

10. Three coherent source kept along the same line produce intensity I_0 each at point P on this line. When S_1 and S_2 are switched on simultaneously, intensity at point P is $2I_0$. When S_2 and S_3 are switched on simultaneously, intensity at point P is $2I_0$. Then

(A) When S_1 and S_3 are switched on simultaneously, intensity at point P can be $2I_0$

(B) When S_1 and S_3 are switched on simultaneously, intensity at point P can be 0

(C) When all 3 sources are switched on simultaneously, intensity at point P can be I_0

(D) When all 3 sources are switched on simultaneously, intensity at point P can be $3I_0$

PWV060

11. A horizontal stretched string, fixed at two ends, is vibrating in its fifth harmonic according to the equation, $y(x,t) = (0.01m)\sin[(62.8\, m^{-1})x]\cos[(628\, s^{-2})t]$.

Assuming $\pi = 3.14$, the correct statement(s) is (are)

(A) The number of nodes is 5.

(B) The length of the string is 0.25 m.

(C) The maximum displacement of the midpoint of the string, from its equilibrium position is 0.01m.

(D) The fundamental frequency is 100 Hz.

PWV061

SECTION-III

- This section contains **ONE** paragraph.
- Based on each paragraph, there are **THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories :

Full Marks : +3 if only the bubble corresponding to the correct answer is darkened.

Zero Marks : 0 in all other cases.

PARAGRAPH FOR QUESTION NOS. 12 TO 14

A wave represented by equation $y = 2(mm)\sin[4\pi\,(\sec^{-1})\,t - 2\pi(m^{-1})x]$ is superimposed with another wave $y = 2\,(mm)\sin[4\pi\,(\sec^{-1})t + 2\pi(m^{-1})x + \pi/3]$ on a tight string.

$y = 2\,(mm)\sin[4\pi(\sec^{-1})t + 2\pi(m^{-1})x + \pi/3]$

12. Phase difference between two particles which are located at $x_1 = 1/7$ and $x_2 = 5/12$ is :-

(A) 0 (B) $\frac{5\pi}{6}$ (C) π (D) $\frac{5\pi}{3}$

PWV062

13. Which of the following is not a location of antinode?

(A) $\frac{2}{3}$ (B) $\frac{11}{12}$ (C) $\frac{5}{12}$ (D) $\frac{17}{12}$

PWV063

14. The location having maximum potential energy is

(A) 1/7 (B) 1/6 (C) 5/12 (D) 23/12

PWV064

SECTION-IV

- This section contains **FOUR** questions.
- Each question contains two columns, **Column-I** and **Column-II.**
- **Column-I** has **four** entries (A), (B), (C) and (D).
- **Column-II** has **five** entries (P), (Q), (R), (S) and (T).
- Match the entries in **Column-I** with the entries in **column-II.**
- One or more entries in **Column-I** may match with one or more entries in **Column-II.**
- The ORS contains a 4 × 5 matrix whose layout will be similar to the one shown below:

(A)	(P)	(Q)	(R)	(S)	(T)
(B)	(P)	(Q)	(R)	(S)	(T)
(C)	(P)	(Q)	(R)	(S)	(T)
(D)	(P)	(Q)	(R)	(S)	(T)

- For each entry in **column-I,** darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q), (R) and (T), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- For each question, marks will be awarded in one of the following categories :

For each entry in **Column-I**

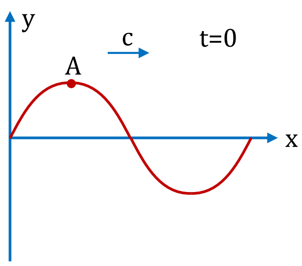
Full Marks : +2 if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.

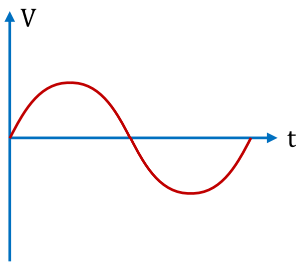
Zero Marks : 0 if none of the bubbles is darkened.

Negative Marks : –1 in all other cases.

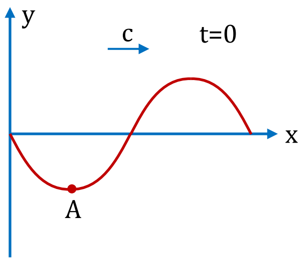
15. In column-I transverse waves travelling on a string at $t = 0$ is shown. Wave velocity is indicated by 'c'. Column-II describes variation of different parameters for particle A or for all the particles.

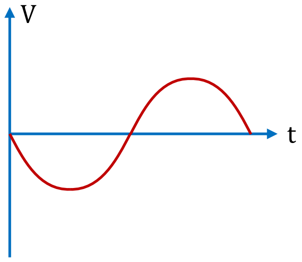
Column-I **Column-II**

(A) 

(P) 

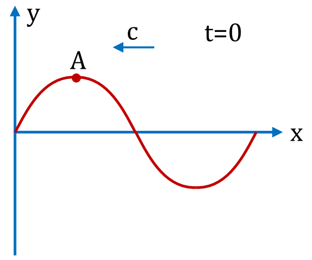
For particle A

(B) 

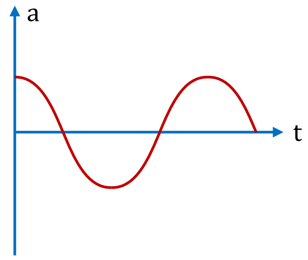
(Q) 

For particle A

(C)

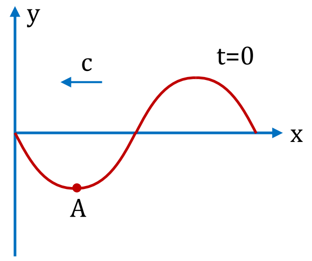


(R)

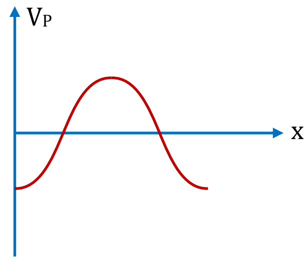


For particle A

(D)

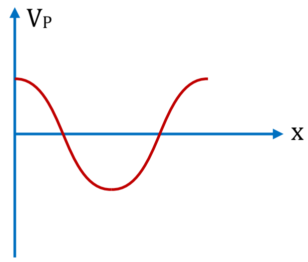


(S)



At t = 0 for all the particles

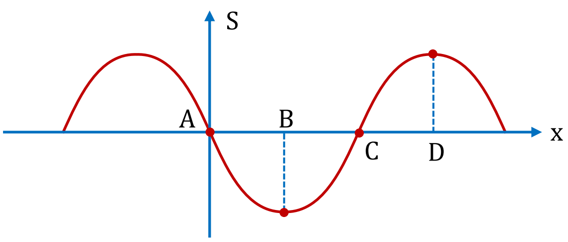
(T)



At t = 0 for all the particles

PWV065

16. Figure shows a graph of particle displacement function of x at $t = 0$ for a longitudinal wave travelling in positive x-direction in a gas. A, B, C, D denote position of particles in space.

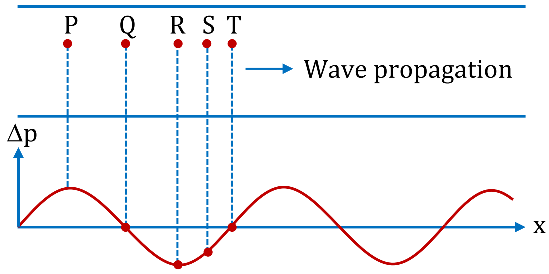


	Column-I		**Column-II**
(A)	Point A	(P)	Particle velocity is in direction of wave propagation
(B)	Point B	(Q)	Maximum magnitude of strain
(C)	Point C	(R)	Excess pressure is zero
(D)	Point D	(S)	Maximum density
		(T)	Maximum magnitude of excess pressure

PWV066

17. Sound is travelling in a long tube towards right and the graph of excess pressure variation versus position (at some instant) is given below.

Match velocities in column-I with column-II. P, Q, R, S, T are medium particles inside the tube.



	Column-I		Column-II
(A)	Velocity is towards right	(P)	P
(B)	Velocity is towards left	(Q)	Q
(C)	Velocity is zero	(R)	R
(D)	Speed is maximum	(S)	S
		(T)	T

PWV067

18. In a string a standing wave is set up whose equation is given as $y = 2A \sin kx \cos \omega t$. The mass per unit length of the string is μ.

	Column-I		Column-II
(A)	At $t = 0$	(P)	Total energy per unit length at $x = 0$ is $2\mu A^2\omega^2$.
(B)	At $t = \frac{T}{8}$	(Q)	Total energy per unit length at $x = \lambda/4$ is $2\mu A^2\omega^2$.
(C)	At $t = \frac{T}{4}$	(R)	Total energy per unit length at $x = \lambda$ is $2\mu A^2\omega^2$.
(D)	At $t = \frac{T}{2}$	(S)	Power transmitted through a point at $x = \lambda$ is 0.
		(T)	Power transmitted through a point at $x = \lambda/4$ is 0.

PWV068

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	C	D	B	A	D	B	C	B	C	A
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	D	D	B	B	B	C	B	A	B	D
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	B	C	B	B	B	C	B	B	A	C
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	A	A	A	A	B	A	C	C	D	B
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	D	B	B	A	D	B	A	A	C	D
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	B	D	C	A	B	A	A	C	B	B
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	A	D	B	B	C	B	A	C	A	B
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	A	D	B	A	A	D	A	B	B	C
Que.	81	82	83	84	85	86	87	88	89	90
Ans.	ABCD	ACD	ABD	AC	BCD	ABD	BD	BD	A	C
Que.	91	92	93	94	95	96	97	98		
Ans.	B	A	B	B	A	B	C	D		
Que.	99					100	101	102	103	104
Ans.	(A-Q,T), (B-P,S), (C-P), (D-S,T)					A	A	B	B	A
Que.	105	106								
Ans.	D	AC								

EXERCISE - S

1. π, 0

2. $0.2\cos[2\pi/5(x-10t)]$, (ii) $5n$ – (15/4)]

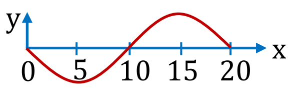
3. (a) 20 m/s; (b) 2 m; (c) $y(x, t) = 0.02\sin(\pi x - 20\pi t + \pi/6)$

4. $\dfrac{\pi}{\sqrt{2}\omega}$

5. (a) $M = \dfrac{\kappa L^2}{2}$ (b) $t = \sqrt{\dfrac{8\,ML}{9F}}$

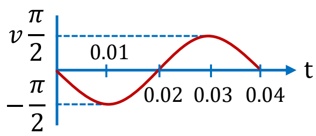
6. $L/9$

7. (i)



(ii) $25 \times 10^{-6}\ W$

(iii)



, solved

8. (a) Negative x ; (b) $y = 4\times10^{-3}\sin 100\pi\left(3t + 0.5x + \dfrac{1}{400}\right)$ (x , y in meter) ; (c) $144\pi^2 \times 10^{-5}\ J$

9. 300 **10.** 6 **11.** $1 \times 10^9\ Nm^2$ **12.** 8.0 *cm*

13. (a) 30 *Hz* (b) 3rd, 5th and 7th (c) 2nd, 4th and 6th (d) 48 ms^{-1}

14. 5 *cm* from the left end **15.** 180 *Hz*

16. (a) 80 *Hz* (b) 25 *cm* **17.** $E = \frac{A^2\pi^2 T}{4l}$ **18.** $\beta = 20Db$ **19.** $\beta = 3\ dB$

20. 40 *cm* **21.** 3.4 *kHz* **22.** $f = 200\ (2n + 1)$, where $n = 1, 2, 3..., 49$

23. 420 *Hz* **24.** 12.6 *cm* **25.** 0

26. $0, \frac{1}{3}, \frac{2}{3}$.......... and so on **27.** (a) $I_0/4$ (b) $I_0/4$

28. 2.5 *kHz*, 7.5 *kHz* **29.** (a) 2.116, (b) $\frac{3}{4}$

30. (a) $\frac{2\pi}{a}, \frac{b}{2\pi},$

(b) $y = -0.8\ A \cos(ax - bt)$ or $y = 0.8\ A \cos(ax - bt + \pi)$

(c) $1.8\ Ab, 0$

(d) $y = -1.6\ A \sin ax \sin bt + 0.2\ A \cos(ax + bt)$, $\left[n + \frac{(-1)^2}{2}\right]\frac{\pi}{a}$, $-X$ direction

OR

$y = 0.2\ A \cos(ax + bt) + 1.6\ A \cos ax \cos bt$, $x = \frac{n\pi}{a}$, $-X$ direction

31. 33 *cm* and 13.2 *cm*

32. (a) $\frac{15}{16}m$, (b) $\frac{\Delta P_0}{\sqrt{2}}$, (c) equal to mean pressure, (d) $P_0 + \Delta P_0$, $P_0 - \Delta P_0$

33. 1650 *Hz* **34.** 3400 m/s **35.** 478 *Hz* **36.** 252 *Hz*

37. 0.39 cm **38.** 345, 341 or 349 *Hz* **39.** $11f/9$

40. (a) 100696 *Hz* (b) 103038 *Hz* **41.** 5

42. 26.7 *cm*, 23.8 *cm*, 22.4 *cm* and 20.0 *cm* **43.** 10800 *Hz* **44.** 17.5°

45. 27.04 *N* **46.** 5.9 sec

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	2	4	1	4	3	4	3	3	3
Que.	11	12	13	14	15	16	17	18	19	
Ans.	2	2	4	7	1	2	1	2	2	

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	ACD	AD	A	D	3	ACD	6	5 [4.99, 5.01]	ABC	8.12 to 8.13
Que.	11	12	13	14						
Ans.	0.62 to 0.64	AD	648.00	8.00 to 8.40						

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	3	3	2	2	1	3	3	3	2	300
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	2	1	2	3	2	2	2	4	1	2
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	70	8	16	3	8	336	1	3	5	6

JEE (Advanced) Practice Paper

Section-I	Q.	1	2							
	A.	C	A							
Section-II	Q.	3	4	5	6	7	8	9	10	11
	A.	BCD	AB	AC	BC	CD	BC	BD	BC	BC
Section-III	Q.	12	13	14						
	A.	C	A	B						

Section-IV	Q.	15	16
	A.	(A-Q,S), (B-P,R,T), (C-Q,T), (D-P,R,S)	(A-P,Q,S,T), (B-R), (C-Q,T), (D-R)
	Q.	17	18
	A.	(A-P), (B-R,S), (C-Q,T), (D-P,R)	(A-P,R,S,T), (B-S,T), (C-Q,S,T), (D-P,R,S,T)