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PHYSICS

BOOKS - AAKASH SERIES

WAVE MOTION AND SOUND

Example

1. The equation for the displacement of a stretched string is given by $y = 4\sin 2\pi\left[\frac{t}{0.02} - \frac{x}{100}\right]$ where y and x are in cm and t in sec. Determine the (a) direction in which wave is propagating (b) amplitude (c) time period (d) frequency (e) angular frequency (t) wavelength (g)

propagation constant (h) velocity ofwave (i) phase constant and (j) the maximum particle velocity.

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2. A wave on a string is described by $y(x,t) = A\cos(kx - \omega t)$. (a) Graph $y, v_y,$ and a_y as function of x for time t=0. (b) consider the following points on the string: (i) x=0,(ii) $x = \pi/4k,$ (iii) $x = \pi/2k,$ (iv) $x = 3\pi/4k,$ (v)$x = \pi/k,$ (vi)$x = 5\pi/4k,$ (vii)$x = 3\pi/2k,$ (viii) $x = 7\pi/4k.$ For a particle at each of these points at t=0, describes in words whether the particle is moving and in what direction, and whether the particle is speeding up, slowing down, or instantaneously not acceleraring.

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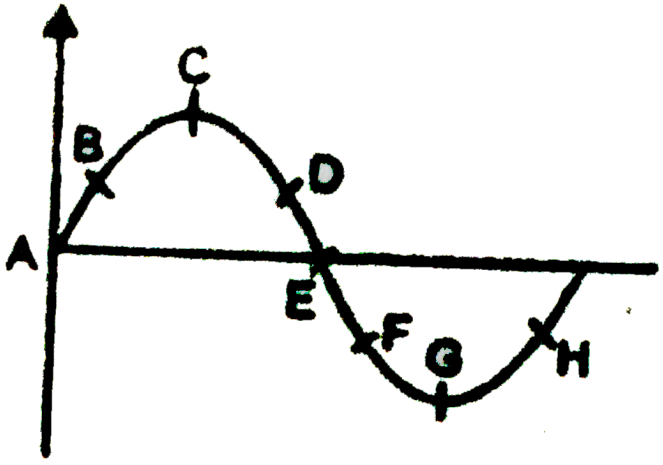
3. A transverse wave is traelling along a string from left to right. The fig. represents the shape of the string (snap-shot) at a given instant. At this instant

(A) Which points have an upward velocity , (B) which points have downward velocity

(C) which point have zero velocity , (D) which point have maximum magnitude of velocity.



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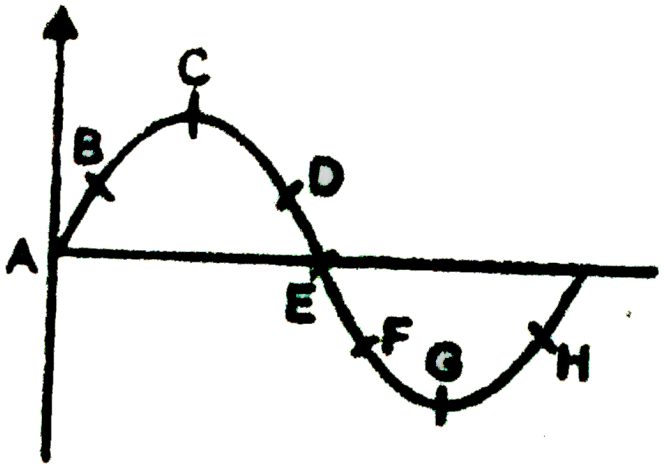

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5. A transverse wave is traelling along a string from left to right. The fig. represents the shape of the string (snap-shot) at a given instant. At this instant

(A) Which points have an upward velocity , (B) which points have downward velocity

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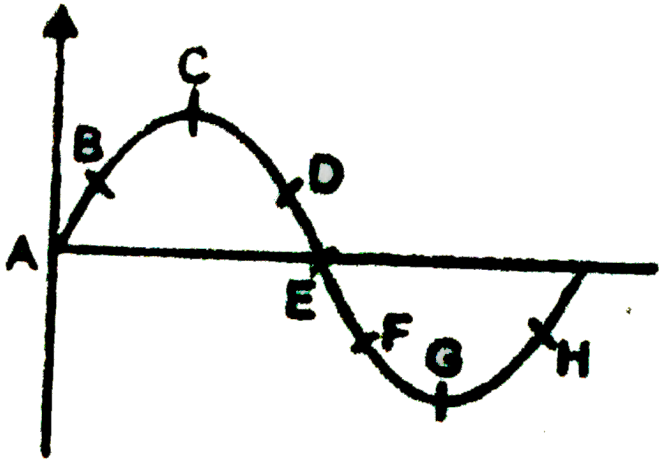

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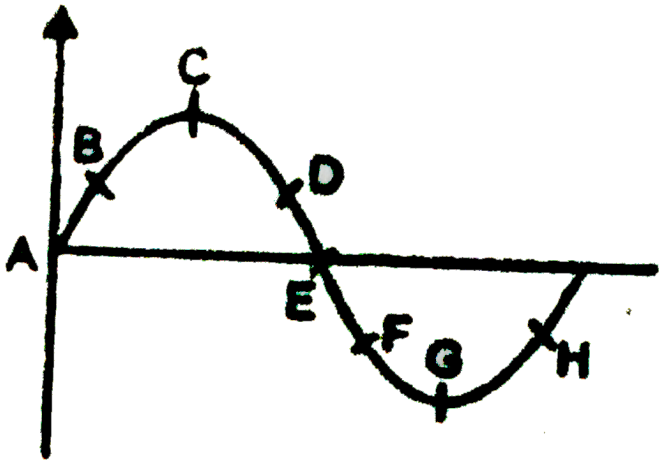
6. A transverse wave is traelling along a string from left to right. The fig. represents the shape of the string (snap-shot) at a given instant. At this instant

(A) Which points have an upward velocity , (B) which points have downward velocity

(C) which point have zero velocity , (D) which point have maximum magnitude of velocity.



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7. A sinusoidal wave trsvelling in the positive direction on a stretched string has amplitude $2.0cm$, wavelength $1.0m$ and velocity $5.0m/s$. At $x = 0$ and $t = 0$ it is given that $y = 0$ and $\frac{\partial y}{\partial t} < 0$. Find the wave function $y(x, t)$.

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8. Figure shows a snapshot of a sinusoidal travelling wave taken at $t = 0.3s$.The wavelength is $7.5cm$ and the amplitude is $2cm$. If the crest P was at $x = 0$at $t = 0$, write the equation of travelling wave. ,

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9. A wire of uniform cross-section is stretched berween two points I w apart. The wire is fixed at one end und u weight of 9 kg is hung over a pulley at the other end produces fundamental frequency of 750 Hz.

(a) What is the velocity of transverse waves propagating in

the wire ?

(b) If now the suspended weight is submerged in a liquid of density (5/9) that of the weight, what will be the velocity and frequency of the waves propagating along the wire ?

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(b) If now the suspended weight is submerged in a liquid of

density (5/9) that of the weight, what will be the velocity and frequency of the waves propagating along the wire ?

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11. A uniform thin rope of length 12 m and mass 6 kg hangs vertically from a rigid support and block of mass 2kg is attached to its free end. A transverse short wave-train of wavelength 6 cm is produced at the lower end of the rope. What is the wavelength of the wavetrain (in cm) when it reaches the top of the rope?

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12. A wave pulse starts propagating in the +x-direction along a non-uniform wire of length 10 m with mass per unit length given by $\mu = \mu_0 + ax$ and under a tension of 100 N. find the time taken by a pulse to travel from the lighter end (x=0) to the heavier end. $\mu_0 = 10^2 kg/m$ and a=9x10^(-3) kg/m^(2).

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13. A thin string is held at one end and oscillates so that,

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

Neglect the gravitattional force. The string's linear mass density is $0.2kg/m$ and its tension is $1N$. The string passes through a bath filled with $1kg$ water. Due to friction heat is transferred to the bath. The heat transfer efficiency is $50\ \%$

. Calculate how much time passes before the temperature of the bath rises one degree kelvin?

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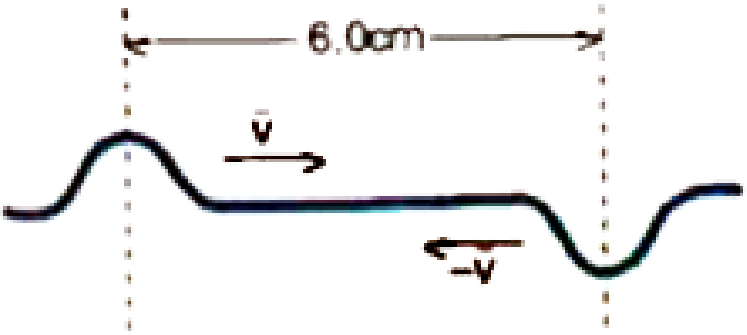
14. In Figure. two pulses travel along a string in opposite directions. The wave speed v is 2.0 mls and the pulses are 6.0 cm apart at t =0.



(a) Sketch the wave patterns when t is equal to 20 ms.

(b) In what form (or type) is the energy ofthe pulse at t= 15 ms?

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15. The vibrations of a string of length 60 cm fixed at both ends are represented by the equation $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$, where x and y are in cm and t in seconds.

(a)What is the maximum displacement of a point at $x = 5cm$?

(b)Where are the nodes located along the string?

(c)What is the velocity of the particle at x=7.5cm and t=0.25s?

(d)Write down the equations of the component waves whose superposition gives the above wave.

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(a)What is the maximum displacement of a point at $x = 5cm$?

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17. The vibrations of a string of length 60 cm fixed at both ends are represented by the equation $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$, where x and y are in cm and t in seconds.

(a)What is the maximum displacement of a point at $x = 5cm$?

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18. The vibrations of a string of length 60 cm fixed at both ends are represented by the equation $y = 4\sin\left(\frac{\pi x}{15}\right)\cos(96\pi t)$, where x and y are in cm and t in seconds.

(a)What is the maximum displacement of a point at $x = 5cm$?

(b)Where are the nodes located along the string?

(c)What is the velocity of the particle at x=7.5cm and t=0.25s?

(d)Write down the equations of the component waves whose superposition gives the above wave.

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19. A standing wave is formed by two harmonic waves, $y_1 = A\sin(kx - \omega t)$ and $y_2 = A\sin(kx + \omega t)$ travelling on a string in opposite directions. Mass density is 'ρ' and area of cross section is S. Find the total mechanical energy between two adjacent nodes on the string.

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20. A sonometer wire has a length 114 cm between two fixed ends. Where should two bridges be placed to so as divide the wire into three segments whose fundamental frequencies are in the ratio 1:3:4 .

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21. A string 120 cm in length sustains a standing wave, with the points of string at which the displacement amplitude is equal to $\sqrt{2}$ mm being separated by 5.0 cm, Find the maximum displacement amplitude. Also find the harmonic corresponding to this wave.

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22. An aluminium wire of cross-sectional area $\left(10^{-6}\right)m^2$ is joined to a steel wire of the same cross-sectional area. This compound wire is stretched on a sonometer pulled by a weight of 10kg. The total length of the compound wire between the bridges is 1.5m of which the aluminium wire is $0.6m$ and the rest is steel wire. Transverse vibrations are setup in the wire by using an external source of variable

frequency. Find the lowest frequency of excitation for which the standing waves are formed such that the joint in the wire is a node. What is the total number of nodes at this frequency? The density of aluminium is $2.6 \times \left(10^3\right) kg/m^3$ and that of steel is $1.04 \times 10^4 kg/m^2 \left(g = 10 m/s^2\right)$

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23. Determine the speed of sound waves in water, and find the wavelength of a wave having a frequency of 242 Hz. Take $B_{\text{water}} = 2 \times 10^9 Pa.$

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24. Three component sinusoidal waves progressing in the same directions along the same path have the same period but their amplitudes are A, $\frac{A}{2}$ and $\frac{A}{3}$. The phases of the variation at any position x on their path at time $t = 0 are 0$, $-\frac{\pi}{2}$ and $-\pi$ respectively. Find the amplitude and phase of the resultant wave.

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25. Two sources of intensity I and 4I are used in an interference experiment. Find the intensity at a point where the waves from two sources superimpose with a phase difference of (a) zero, (b) $\pi/2$, (c) π and (d) ratio of maximum and minimum intensity.

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26. In a Hali, a person recives direct sound waves from a source $120m$ away. He also receives wave from the same source which reach him after being reflected from the $25m$ high ceilling at a point half way between them. The two waves interface construtively for wave length (in meters).

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27. Two speakeer connected to the same source of fixed frequency are placed 2m apart in a box. A sensitive microphone placed at a distance of 4m from the midpoint alon the perpendicular bisector shown maximum response. The box is slowly rotated till the speaker are in line with the

microphone, The distance between the midpoint of the speakers and the microphone remains unchanged. Exactly 5 maximum responses (inculuding the initial and last one) and observed in the microphone in doing this. The wavelength of the sound wave is (o.x) meter. Find the value of x.

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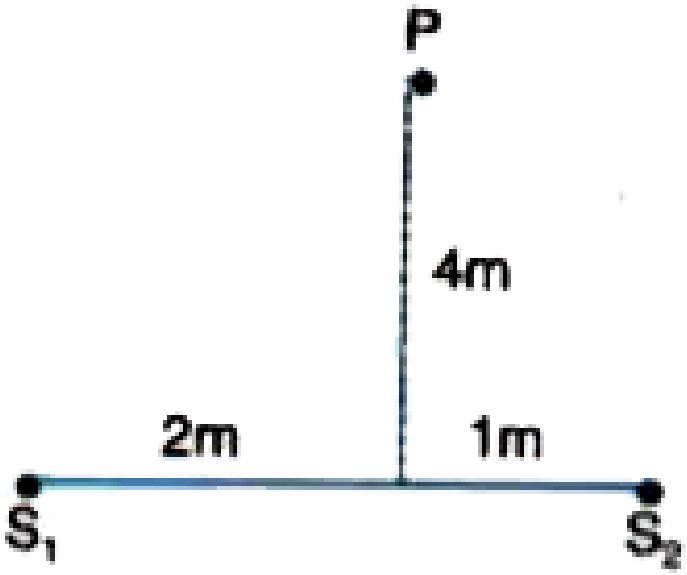
28. Two sound sources S_1 and S_2 emit pure sinusoidal waves in phase. If the speed of sound is 350 m/s,

(a) For what frequencies does constructive interference occur at P?

(b) For what frequencies does destructive interference

occur at P?



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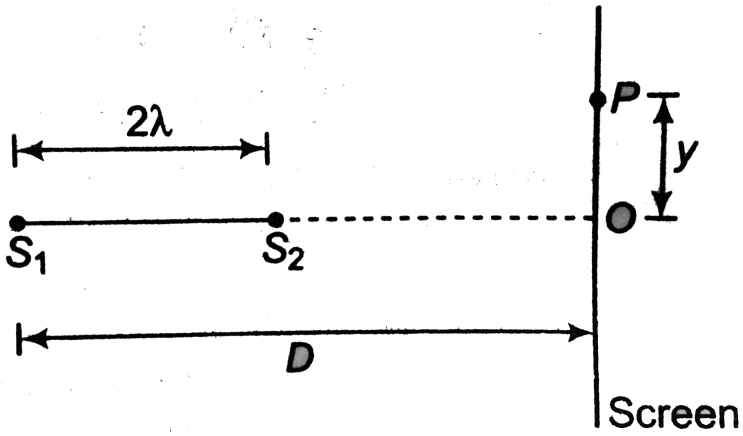
29. Two coherent narrow slits emitting sound of wavelength λ in the same phase are placed parallet to each other at a small separation of 2λ . The sound is delected by maving a delector on the screen at a distance $D(>>\lambda)$ from the slit S_1 as shows in figure. Find the distance y such

that the intensity at P is equal to intensity at O .



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30. If two sund waves $y_1 = 0.3 \sin 596\pi \left[t - \frac{x}{330}\right]$ and $y_2 = 0.5 \sin 604\pi \left[t - \frac{x}{330}\right]$ are superposed, what will be the

(a) frequency of resultant wave

b) frequency at which the amplitude of resultant waves varies

(c) Frequency at which beats are produced. Find also the ratio of maximum and minimum intensities of beats.

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31. 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 ?

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32. An engine approaches a hill with a constant speed. When it is at a distance of 0.9 km it blows a whistle, whose

echo is heard by the driver after 5 sec. If the speed ofsound in air is 330 m/s, calculate the speed of the engine.

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33. A person standing between two parallel hills fires a gun. He hears the first echo after $\frac{3}{2}$ s, and a second echo after $\frac{5}{2}$ s. If speed of sound is $332m/s$, Calculate the distance between the hills. When will he hear the third echo?

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34. For a certain organ pipe, three successive resonance frequencies are observer at 425, 595 and $765H_Z$ respectively. Taking the speed of sound in air to be $340m/s$

, (a) explain whether the pipe is closed at one or open at boyh ends. (b) determine the fundamental frequency and length of the pipe.

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35. A tube $1.0m$ long is closed at one end. A stretched wire is placed near the open end. The wire is $0.3m$ long and a mass of $0.01kg$. It is held fixed at both ends and vibrates in its fundamental mode. It sets the air column in the tube into vibration at its fundamental frequency by resonance. Find

(a) the frequency of oscillation of the air column and

(b) the tension in the wire.

Speed of sound in air = $330m/s$.

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36. Two open organ pipes 80 and 81 cm long found to give 26 beats in 10 sec, when each is sounding its fundamental note. Find the velocity of sound in air.

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37. A cylinder of length $1m$ is divided by a thin perfectly flexible diaphragm in the middle. It is closed by similar flexible diaphragams at the ends. The two chambers into which it is divided contain hydrogen and oxygen. The two diaphragms are set in vibrations of same frequency. What is the minimum frequency of these diaphragms for which

the middle diaphragm will be motionless? Velocity of sound in hydrogen is $1100 m / s$ and that in oxygen is $300 m / s$.

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38. Two tuning forks with natural frequencies 340 Hz each move relative to a stationary observer. One fork moves away from the observer, while the other moves towards the observer at the same speed. The observer hears beats of frequency 3 Hz. Find the speed of the tuning forks (speed of sound is $340 \frac{m}{s}$).

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39. When a train is approaching the observer, the frequency of the whistle is 100 cps. When it has passed the observer, it is 50 cps. The frequency when the observer moves with the train, is :

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40. A siren emitting a sound of frequency $1000 H_Z$ moves away from you towards a cliff at a speed of $10 m / s$.

(a) What is the frequency of the sound you hear coming directly from the sirven ?

(b) What is the frequency of sounds you hear reflected off the cliffb ?

(c) What beat frequency would you hear ? Take the speed of sound in air as $330 m / s$.

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41. A car approaching a crossing C at a speed of $20m/s$ sounds a horn of frequency $500H_Z$ when $80m$ from the crossing . Speed of sound in air is $330m/s$. What frequency is heard by an observer (at rest) $60m$ from the crossing on the straight road which crosses car road at right angles ?

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42. A whistle of frequency $540H_Z$ rotates in a circle of radius $2m$at a linear speed of $30m/s$. What is the lowest and highest frequency heard by an observer a long

distance away at rest with respect to the centre of circle ? Take speed of sound of sound in air as $330m/s$. Can the apparent frequency be ever equal to actual ?

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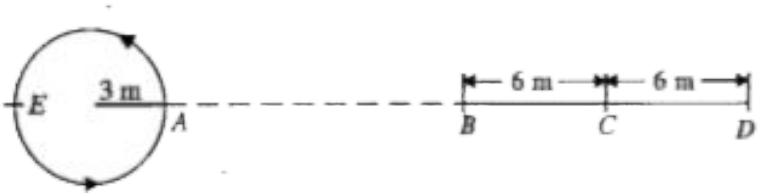
43. A source of sound is moving along a circular orbit of radius 3 m with an angular velocity of 10 rad/s. A sound detector located far away from the source is executing linear S.H.M. along the line BD (see Fig. 14.4.13) with an amplitude BC = CD=6m. The frequency of oscillation of the detector is $5/\pi$ per second. The source is at the point BA when the detector is at the point B. If the source epiits a continuous sound wave of frequency 340 Hz, find the

maximum and the minimum frequencies recorded by the detector.



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44. A galaxy moves with respect to us so that sodium light of 589.0 nm is observed at 589.6 nm. The speed of the galaxy is

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Exercise Long Answer Questions

1. Explain the formation of standing waves in a string clamped at both ends and discuss the various modes of vibration.

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2. What are Harmonics and Overtones? How are they formed in an open pipe? Derive the eqautions for the frequencies of the harmonic produced in an open pipe.

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3. How are stationary waves formed in a closed pipe? Explain the various modes of vibrations in a closed pipe

and establish the relation between their frequencies.

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4. What is Doppler effect? Find an expression for the apparent frequency heard when the source is in motion and the listener is at rest. What is the limitation of Doppler effect?

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5. What is Doppler effect? Find an expression for the apparent frequency heard when the source is in motion and the listener is at rest. What is the limitation of Doppler effect?

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Exercise Short Answer Questions

1. What are transverse waves? Explain with an example.

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2. What is a plane progressive simple harmonic wave ? Establish equation for this wave in two different forms.

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3. Explain the reflection of waves in string at fixed end and free end.

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4. State the laws of vibrating strings.

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5. Explain the harmonic on a stretched string with sutiable illustrations.

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6. What are forced vibrations ? Give one example to illustrate your answer.

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7. What are .beats. ? Explain their production. State the necessary conditions for the production of beats.

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8. What is resonance ? What is resonant frequency ?

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9. Explain the reflection of waves at closed and open ends.

Watch Video Solution

10. Draw diagrams to show the various modes of vibration in (i) an open pipe and (ii) a closed pipe.

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11. Explain the formation of standing waves in a string clamped at both ends and discuss the various modes of vibration.

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12. What are the applications of Doppler effect?

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13. Name the three characteristics of sound.

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Exercise Very Short Answer Questions

1. Name the parameters of a progressive wave?

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2. How are the wave velocity v, frequency n and wavelength λ of a wave related? Derive the relationship.

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3. State two differences between light and sound waves.

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4. What is the distance between two crests with a phase difference of 4π?

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5. What is the phase difference between a compression and next rarefaction?

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6. What type of mechanical waves do you expect to exist in (a) vacuum (b) air (c) inside water (d) rock (e) on the surface of a liquid.

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7. Is it possible to have longitudinal waves on a string? A transverse wave on a steel rod?

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8. How many times a particle will reach maximum displacement during the time taken by the wave to advance by one wavelength?

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9. How can you say that the equation $y = A\sin(\omega t = kx)$ represents a progressive wave?

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10. What is the significance of in the case of $\frac{\omega}{k}$ in the case of a progressive wave given by $y = A\sin(\omega t - kx)$?

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11. State the principle of superposition of waves.

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12. What are the conditions required for a wave to get reflected?

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13. What is the phase difference between the incident wave and the reflected wave in the following ?

1. Wave reflected from rigid boundary.

2. Wave reflected from free boundary.

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14. When sound waves travel from air to water which of these remains constant ?

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15. What is a stationary wave? What is the distance between a node and the succeeding antinode of a stationary wave?

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16. Which type of waves are formed due to vibrations of stretched strings?

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17. When stretched string vibrates in two segments, how many nodes and antinodes will be there?

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18. What is the frequency of 9^{th} overtone on a stretched string of length l and linear density 'm', when the tension is "T"?

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19. If a stretched string is plucked at the centre

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20. A wire of length 'l' is vibrating in three segments. What is the wavelength of the note emitted?

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21. What is the ratio of the frequency of fouth overtone to the fundamental frequency of a stretched string?

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22. What happens to the fundamental frequency of a stretched string when the tension is quadrupled?

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23. What happens to the fundamental frequency of a stretched string when its linear density becomes 1/4 of its intial value?

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24. Two identical wires on a sonometer, are stretched with the same tension 'T'. if their lengths are in the ratio 1:2 what is the ratio of their frequencies?

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25. When do the paper riders on a sonometer wire fly off?

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26. When temperature increases, the frequency of a tuning fork

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27. What happens to the frequency of a tuning fork.

When it is loaded with little wax.

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28. What happens to the frequency of a tuning fork.

When it is filled?

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29. At resonance, the amplitude of forced oscillations is

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30. State the condition for the resonance to occur.

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31. The soldiers marching on a suspended bridge are advised to go out of steps. Why ?

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32. Light can travel in vacuum but not sound, becaouse

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33. Discuss Newton's formula for velocity of sound in air medium and apply Laplace's correction.

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34. "The velocity of sound is generally greater in solids than in gas at N.T.P." Why?

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35. The velocity of sound in oxygen in lesser than in hydrogen.Explain.

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36. Use the formula $v = \sqrt{\frac{\gamma P}{\rho}}$ to explain why the speed of sound in air

(a) is independent of pressure,

(b) increases with temperature,

(c) increases with humidity.

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(a) is independent of pressure,

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38. Three identical sound waves pass through an air column, a brass rod and an oil pipe of same length. In

which of the three will it take the least time to reach the other end?

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39. Does the law of conservation of energy hold good in case of interference of waves? Explain.

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40. Two identical travelling waves, moving in the same direction are out of phase by $\pi/2$ rad. What is the amplitude of the resultant wave in terms of the common amplitude y_m of the two combining waves?

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41. What is the resultant displacement of the particles when a compression falls on a rarefaction?

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42. What happens when a crest falls on the crest during superposition of waves?

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43. What are beats? What is beat frequency?

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44. Mention the applications of beats,

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45. Distinguish between interference and beats.

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46. Two waves of frequencies 256 & 250 are forming beats.

What will be the beat frequency?

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47. A sound wave travelling along an air column of a pipe gets reflected at the open end of the pipe. What is the phase difference between the incident and reflected waves at the open end?

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48. What is the ratio of frequencies of harmonics in an air column of same length in a closed pipe.

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49. What is the ratio of frequencies of harmonics in an air column of same length in an open pipe.

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50. What is the distance between the closed end and open end of a pipe vibrating in the 7th harmonic?

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51. What is the distance between two ends of open pipe vibrating in the 3rd overtone?

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52. What is "End correction" in resonating air column?

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53. If oil of density higher than water is used in place of water in a resonance tube how does the frequency change?

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54. What is Doppler effect? Find an expression for the apparent frequency heard when the source is in motion and the listener is at rest. What is the limitation of Doppler effect?

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55. Why do we hear a higher frequency apparently when we approach a stationary sounding railway engine?

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56. What is the reason for listening a higher frequency when a source of sound moves towards a stationary listener?

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57. Write any two applications of Doppler effect.

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58. A : In Doppler's effect the value of apparent frequency depends on the relative motion between source and observer .

R : The change in frequency in Doppler effect is independent from the distance between source and observer .

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59. (a) Does the change in frequency due to Doppler effect depend on the distance between source (b)Does the change in frequency due to Doppler effect on the fact that source is moving towards the observer or observer is moving towards the source ?

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60. The characteristics of sound which is used to differentiate the sound of male and female

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Problems Level I

1. For the wave $y = 5\sin 30\pi[t - (x/240)]$, where x and y are in cm and t is in seconds, find the

(a) displacement when $t = 0$ and $x = 2cm$

(b) wavelength

(c) velocity of the wave and

(d) frequency of the wave

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2. For the wave $y = 5\sin 30\pi[t - (x/240)]$, where x and y are in cm and t is in seconds, find the

(a) displacement when $t = 0$ and $x = 2cm$

(b) wavelength

(c) velocity of the wave and

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3. For the wave $y = 5\sin 30\pi[t - (x/240)]$, where x and y are in cm and t is in seconds, find the

(a) displacement when $t = 0$ and $x = 2cm$

(b) wavelength

(c) velocity of the wave and

(d) frequency of the wave

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4. For the wave $y = 5 \sin 30\pi[t - (x/240)]$, where x and y are in cm and t is in seconds, find the

(a) displacement when $t = 0$ and $x = 2cm$

(b) wavelength

(c) velocity of the wave and

(d) frequency of the wave

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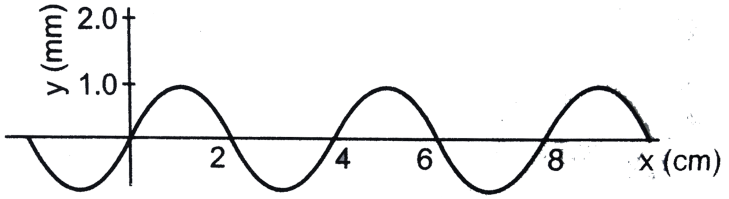
5. Figure shows a plot of the transverse displacements of the particles of a string at t = 0 through which a travelling wave is passing in the positive x-direction. The wave speed is $20 cm s^{-1}$. Find (a) the amplitude, (b) the wavelength, (c) the wave number and (d) the frequency of the wave.



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6. A wave of frequency $500 Hz$ has a wave velocity of $350 m / s$.

(a) Find the distance between two points which are $60 \circ$ out of phase.

(b) Find the phase difference between two displacement at a certain point at time $10^{-3}s$ apart.

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7. A sound wave of frequency 100 Hz is travelling in air. The speed of sound in air is $350ms^{-1}$ (a) By how much is the phase changed at a given point in 2.5 ms ? (b) What is the phase difference at a given instant between two points separated by a distance of 10.0 cm along the direction of propagation ?

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8. A sound wave of frequency 100 Hz is travelling in air. The speed of sound in air is $350ms^{-1}$ (a) By how much is the phase changed at a given point in 2.5 ms ? (b) What is the phase difference at a given instant between two points separated by a distance of 10.0 cm along the direction of propagation ?

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9. A progressive wave of frequency 500 Hz is travelling with a speed of 350 m/s. A compressional maximum appears at a place at a given instant. The minimum time interval after which of refraction maximum occurs at the same place is

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10. Calculate the speed of a transverse wave in a wire of $1.0mm^2$ cross-section under a tension of $0.98N$. Density of the material of wire is $9.8 \times 10^3 kg/m^3$

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11. Two wires of different densities but same area of cross-section are soldered together at one end and are stretched to a tension T. The velocity of a transverse wave in the first wire is double of that in the second wire. Find the ratio of density of the first wire to that of the second wire.

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12. A 4.0 kg block is suspended from the ceiling of an elevator through a string having a linear mass desity of $19.2 \times 10^{-3} kgm^{-1}$. Find the speed (with respect to the string) with which a wave pulse can proceed on the string if the elavator accelerates up at the rate of $2.0ms^{-2}. Takeg = 10ms^{-2}$.

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13. Transverse waves are generated in two uniform wires A and B of the same material by attaching their free ends to a vibrating source of frequency 200 Hz. The Area of cross section of A is half that of B while tension on A is twice than on B. The ratio of wavelengths of the transverse waves in A and B is

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14. Two progressive transverse waves given by $y_1 = 0.07 \sin \pi(12x - 500t)$ and $y_2 = 0.07 \sin \pi(12x500t)$ travelling along a stretched string form nodes and antinodes. What is the displacement at the nodes.

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15. Two progressive transverse waves given by $y_1 = 0.07 \sin \pi(12x - 500t)$ and $y_2 = 0.07 \sin \pi(12x500t)$ travelling along a stretched string form nodes and antinodes. What is the displacement at the antinodes.

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16. Two progressive transverse waves given by $y_1 = 0.07 \sin \pi(12x - 500t)$ and $y_2 = 0.07 \sin \pi(12x + 500t)$ travelling along a stretched string form nodes and antinodes.What is the wavelength ?

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17. A wave of length 2m is superposed on its reflected wave to form a stationary wave. A node is located at x = 3m. The next node will be located at x=

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18. The equation for the vibration of a string fixed at both ends vibrating in its second harmonic is given by $y = 2\sin\left(0.3cm^{-1}\right)x\cos\left(\left(500\pi s^{-1}\right)t\right)cm$. The length of the string is :

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19. Two wires are kept tight between the same pair of supports. The tensions in the wires are in the ratio 2 : 1, the radii are in the ratio 3 : 1 and the densities are in the ratio 1 : 2. Find the ratio of their fundamental frequencies.

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20. A one-metre long stretched string having a mass of 40 g is attached to a tuning fork. The fork vibrates at 128 Hz in a direction perpendicular to the string. What should be the tension in the string if it is to vibrate in four loops ?

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21. A somoneter wire resonates with a given tuning fork forming standing waves with five antindoes between the two bridges when a mass of 9 kg is suspended from the wire. Resonates with the same tuning fork forming three antindoes for the same postions of the bridges. the value of M is

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22. A guitar string is 90 cm long and has a fundamental frequency of 124 Hz. Where should it be pressed to produce a fundamental frequency of 186 Hz?

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23. the frequency of a sonometer wire is 10 Hz. When the weight producing th tensions are completely immersed in water the frequency becomes 80 Hz and on immersing the weight in a certain liquid the frequency becomes 60 Hz. The specific gravity of the liquid is

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24. When the tension in a string is increased by 44%. the frequency increased by 10Hz the frequency of the string is

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25. A steel wire of length 1 m, mass 0.1 kg and uniform cross-sectional area $10^{-6}m^2$ is rigidly fixed at both ends. The temperature of wire is lowered by 20°C. If transverse waves are set up by plucking the string in the middle, calculate the frequency (In S.I. units) of the fundamental mode of vibration. Young's modulus of steel $= 2 \times 10^{11} N/m^2$, coefficient of linear expansion of steel $= 1.21 \times 10^{-6} (degC)^{-1}$.

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26. A metallic wire with tension T and at temperature $30^\circ C$ vibrates with its fundamental frequency of $1kHz$. The same wire with the same tension but at $10^\circ C$ temperature vibrates with a fundamental frequency of $1.001kHz$. The coefficient of linear expansion of the wire is equal to $10^{-K}.^\circ C$. Find $2K$.

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27. 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 ?

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30. Three resonant frequencies of string with both rigid ends are 90, 150 and 210 Hz. If the length of the string is 80 cm, what is the maximum possible speed of the transverse wave in the string?

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31. The equation of a travelling sound wave is $y = 6.0\sin(600t - 1.8x)$ where y is measured in $10^{-5}m$, t in second and x in metre. (a) Find the ratio of the displacement amplitude of the particles to the wavelength of the wave. (b) Find the ratio of the velocity amplitude of the particles to the wave speed.

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32. The equation of a travelling sound wave is $y = 6.0\sin(600t - 1.8x)$ where y is measured in $10^{-5}m$, t in second and x in metre. (a) Find the ratio of the displacement amplitude of the particles to the wavelength

of the wave. (b) Find the ratio of the velocity amplitude of the particles to the wave speed.

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33. The height of a cloud above the earth is 100 m. If an observer hears the sound of thunder 0.3 s after the lightening is seen what is the velocity of sound on that day?

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34. In a liquid with density $900kg/m^3$, lonfitudinal waves with frequency $250H_Z$ are found to have wavelength $8.0m$. Calculate the bulk modulus of the liquid.

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35. The speed of sound as measured by a student in the laboratory on a winter day is $340\frac{m}{s}$ when the room temperature is $17^\circ C$. What speed will be measure another student repeating the experiment on a day when the room temperature is $32 \circ C$?

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36. At what temperature is the speed of sound in air double of its speed of at $0^\circ C$?

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37. The ratio of densities of nitrogen and oxygen is 14 : 16. The temperature at which the speed of sound in nitrogen will be same as that in oxygen at $55^{\circ}C$ is

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38. An organ pipe has two successive harmonics with frequencies 400 and $560H_Z$. The velocity of sound in air is $344m/s$.

(a) Is the an open or a closed pipe?

(b) What two harmonics are there?

(c) What is the length of the pipe?

Watch Video Solution

39. An organ pipe has two successive harmonics with frequencies 400 and $560 H_Z$. The velocity of sound in air is $344 m / s$.

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40. An organ pipe has two successive harmonics with frequencies 400 and $560 H_Z$. The velocity of sound in air is $344 m / s$.

(a) Is the an open or a closed pipe?

(b) What two harmonics are there?

(c) What is the length of the pipe?

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41. The fundamental frequency of a closed pipe is $220 H_Z$.

(a) Find the length of this pipe.

(b) The second overtone of this pipe has the same frequency as the third harmonic of an open pipe. Find the length of this open pipe. Take speed of sound in air $345 m / s$.

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42. The fundamental frequency of a closed pipe is $220 H_Z$.

(a) Find the length of this pipe.

(b) The second overtone of this pipe has the same

frequency as the third harmonic of an open pipe. Find the length of this open pipe. Take speed of sound in air $345m/s$.

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43. A source of frequency 10kHz when viberted over than mouth of a closed organ is in unison at 300K. The beats produced when temperature rises by 1K

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44. A closed organ pipe and an open organ pipe of same length produce 2 beats when they are set into vibrations simultaneously in their fundamental mode. The length of

open organ pipe is now halved and of closed organ pipe is doubled, the number of beats produced wil be

(A)8 (B)7 (C)4 (D)2

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

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46. Two tuning forks when sounded together produce 5 beats in 2 seconds. The time interval between two successive maximum intensities of sound is

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47. Two progressive waves $y_1 = 4\sin 400\pi t$ and $y_2 = 3\sin 404\pi t$ moving in the same direction superpose on each other producing beats. Then the number of beats per second and the ratio of maximum to minimum intensity of the resultant waves are respectively

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48. Calculate the frequency of beats produced in air when two sources of sound are activated, one emitting a wavelength of 32 cm and the other of 32.2 cm. The speed of sound in air is $350ms^{-1}$.

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49. Two sitar strings A and B playing the note 'Ga' are slightly out of tune and produce beats of frequency 6 Hz. The tension in the string A is slightly reduced and the beat frequency is found to reduce to 3 Hz. If the original frequency of A is 324 Hz, what is the frequency of B?

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50. The frequency of a tuning fork A is 2% more than the frequency of a standard tuning fork. The frequency of another fork B is 3% less than the frequency of standard tuning fork . If 6 beats s^{-1} are heard when the two tuning forks A and B are excited , the frequency of A is

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51. A man standing at some distance from a cliff hears the echo of sound after 2s. He walks 495 m away from the cliff. He produces a sound there and receives the echo after 5s. What is the speed of sound?

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52. A motor car approaching a cliff with a velocity of 90 kmph sounds the horn and the echo is heard after 20 seconds. Assuming the velocity of sound in air to be 332 ms, calculate the distance between the car and the cliff when the horn is sounded.

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53. A person standing between two parallel hills fires a gun. He hears the first echo after $\frac{3}{2}$ s, and a second echo after $\frac{5}{2}$ s. If speed of sound is $332m/s$, Calculate the distance between the hills. When will he hear the third echo?

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54. A tuning fork of unknown frequency makes 5 beats per second with another tuning fork which can cause a closed organ pipe of length 40 cm to vibrate in its fundamental mode. The beat frequency decreases when the first tuning fork is slightly loaded with wax. Find its original frequency. The speed of sound in air is $320ms^{-1}$

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55. A traffic policeman standing on a road sounds a whistle emitting the main frequency of 2.00 kHz. What could be the apparent frequency heard by a scooter driver approaching the policeman at a speed of $36.0kmh^{-1}$? Speed of sound in air $= 340ms^{-1}$.

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56. A person riding a car moving at $72 kmh^{-1}$ sounds a whistle emitting a wave of frequency 1250 Hz. What frequency will be heard by another person standing on the road (a) in front of the car (b) behind the car ? Speed of sound in air $= 340 ms^{-1}$.

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57. A person riding a car moving at $72 kmh^{-1}$ sounds a whistle emitting a wave of frequency 1250 Hz. What frequency will be heard by another person standing on the road (a) in front of the car (b) behind the car ? Speed of sound in air $= 340 ms^{-1}$.

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58. A car moving at 108 km/h finds another car in front of it going in the same direction at 72 km/h. The first car sounds a horn that has a dominant frequency of 800 Hz. What will be the apparent frequency heard by the driver in the front car? Speed of sound in air = 330 m/s.

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59. A tuning fork of frequency 328 Hz is moved towards a wall at a speed of $2ms^{-1}$. An observer standing on the same side as the fork hears two sounds, one directly from the fork and the other reflected from the wall. How many

beats per second can be heard ? (Velocity of sound in air 330 ms)

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Problems Level Ii

1. A wave is described by the equation $y = (1.0mm)\sin\pi\left(\frac{x}{2.0cm} - \frac{t}{0.01s}\right)$.

(a) Find time period and wavelength.

(b) Find the speed of particle at $x = 1.0cm$ and time $t = 0.01s$.

(c) What are the speed of the partcle at $x = 3.0cm$, $5.0cm$ and $7.0cm$ at $t = 0.01s$?

(d) What are the speeds of the partcle at $x = 1.0cm$ at $t = 0.011, 0.012$ and $0.013s$?

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2. A wave is described by the equation $y = (1.0mm)\sin\pi\left(\frac{x}{2.0cm} - \frac{t}{0.01s}\right)$.

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3. A wave is described by the equation $y = (1.0mm)\sin\pi\left(\frac{x}{2.0cm} - \frac{t}{0.01s}\right)$.

(a) Find time period and wavelength.

(b) Find the speed of particle at $x = 1.0cm$ and time $t = 0.01s$.

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4. A wave is described by the equation $y = (1.0mm)\sin\pi\left(\frac{x}{2.0cm} - \frac{t}{0.01s}\right)$.

(a) Find time period and wavelength.

(b) Find the speed of particle at $x = 1.0cm$ and time $t = 0.01s$.

(c) What are the speed of the partcle at $x = 3.0cm$, $5.0cm$ and $7.0cm$ at $t = 0.01s$?

(d) What are the speeds of the partcle at $x = 1.0cm$ at $t = 0.011, 0.012$ and $0.013s$?

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5. At t=0, transverse pulse in a wire is described by the function

$$y = \frac{6}{x^2 + 3}$$

where x and y are in metres. Write the function $y(x, t)$ that

describe this plus if it is travelling in the positive x-direction with a speed of $4.50 m / s$.

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6. A pulse travelling on a string is represented by the function $y = \frac{a^3}{(x - vt)^2 + a^2}$ where a = 5 mm and v = 20 cm/s where the maximum of pulse is located at t = 0.1s and 2s. Take x = 0 in the middle of the string

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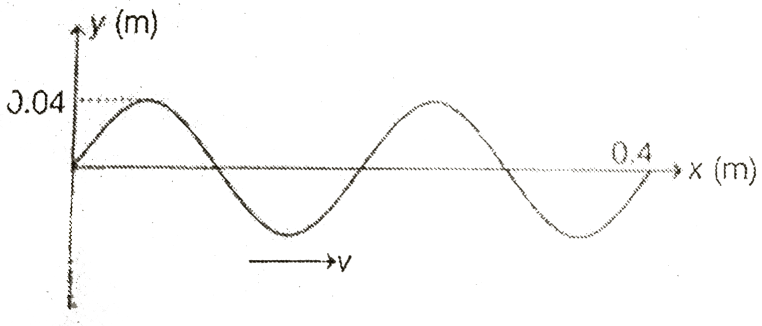
7. The position of a transverse wave travelling in medium along positive x-axis is shown in figure at time t=0. Speed of wave is v=200 m/s

Frequency of the wave is



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8. The position of a transverse wave travelling in medium along positive x-axis is shown in figure at time t=0. Speed of wave is v=200 m/s

Equation of the wave is (in SI unit)

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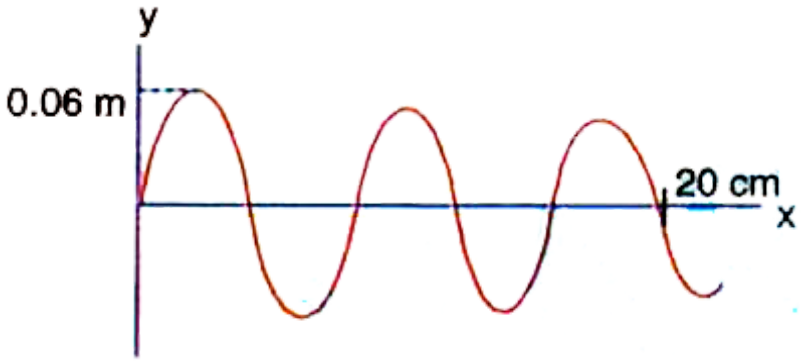
9. For the wave shown in figure, find its amplitude, frequency and wavelength if its speed is 300 m/s. Write the equation for this wave as it travels out along the negative x-axis if its position at t = 0 is as shown



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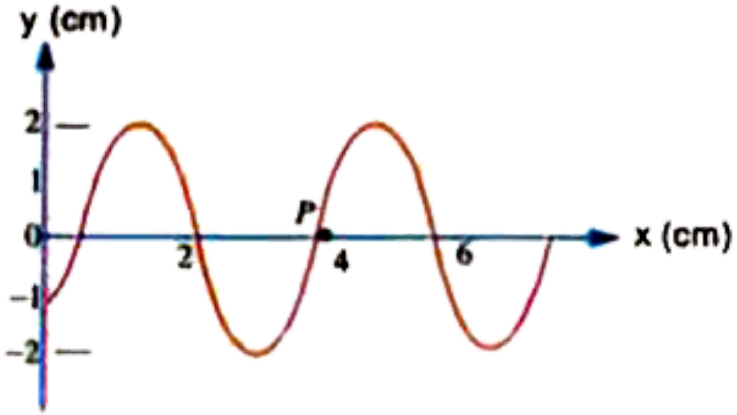
10. Consider a sinusoidal wave travelling in positive x direction as shown in figure. The wave velocity is 40 cm/s.Find

the frequency.



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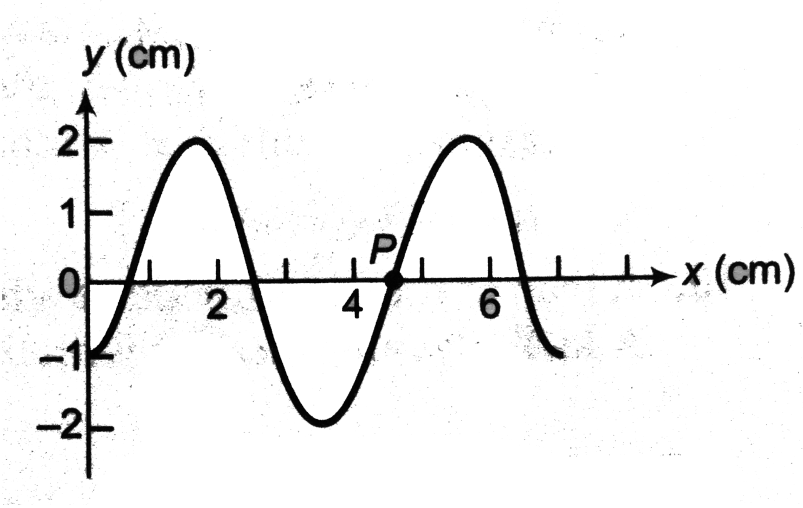
11. Consider a sinusoidal travelling wave shown in figure. The wave velocity is $+40cm/s$.

Find

(a) the frequency

(b) the phase difference between points $2.5cm$ apart

(c) the velocity of a particle at P at the instant shown.



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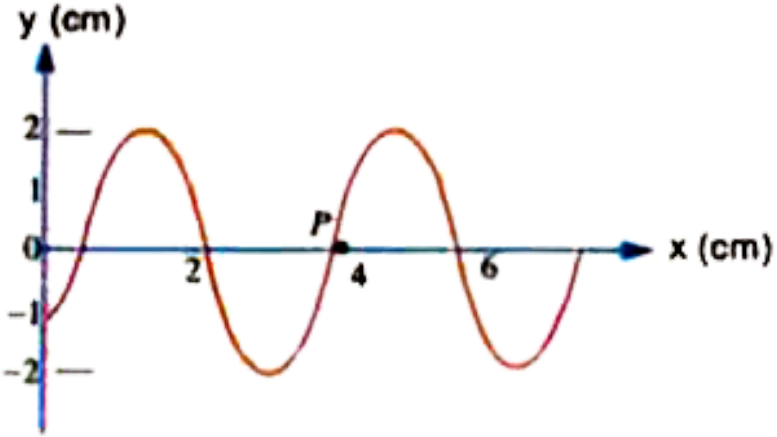
12. Consider a sinusoidal wave travelling in positive x direction as shown in figure. The wave velocity is 40 cm/s.



Find : How long it takes for the phase at a given position to change by 60°

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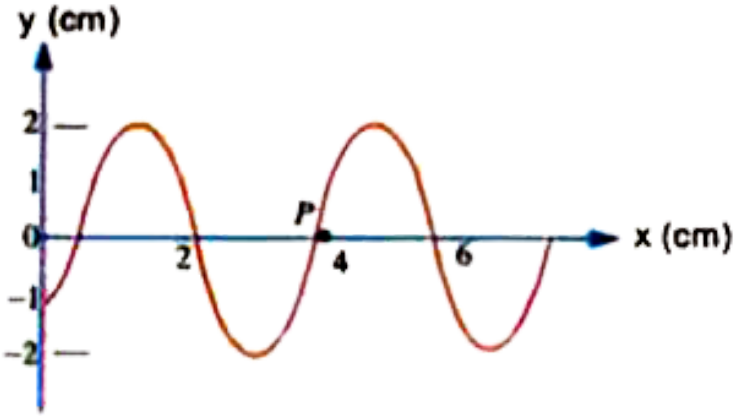
13. Consider a sinusoidal wave travelling in positive x direction as shown in figure. The wave velocity is 40 cm/s.



Find: The velocity of a particle at point P at the instant shown.

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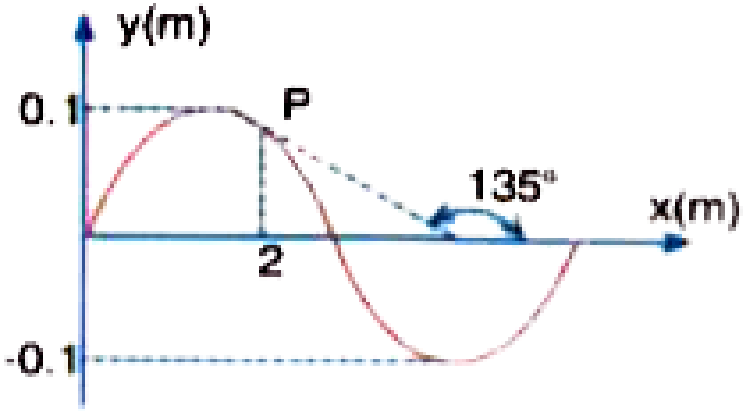
14. A wave is travelling along a string. Its equation is given as $y = 0.1 \sin 2\pi(100t + 10x)$ (All SI units) Position of different particles at some instant is shown in figure. What is velocity

of particle Pat this instant?



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15. A wave propagates on a string in positive x-direction with a speed of 40 cm/s. The shape of string at t = 2 s is $y=10\frac{\cos x}{5}$ where x and y are in centimeter. The wave equation is

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16. 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

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17. A heavy but uniform rope of lenth L is suspended from a ceiling. (a) Write the velocity of a transverse wave travelling on the string as a function of the distance from the lower end. (b) If the rope is given a sudden sideways jerk at the bottom, how long will it take for the pulse to reach teh celling ? (c) A particle is dropped from the ceiling at the instant the

bottom end is given the jerk where will the particle meet the pulse ?

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18. A heavy but uniform rope of lenth L is suspended from a ceiling. (a) Write the velocity of a transverse wave travelling on the string as a function of the distance from the lower end. (b) If the rope is given a sudden sideways jerk at the bottom, how long will it take for the pulse to reach teh celling ? (c) A particle is dropped from the ceiling at the instant the bottom end is given the jerk where will the particle meet the pulse ?

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19. A heavy but unifrom rope of length L is suspended from a celling . A particle is dropped from the celling at the instant when the bottom end is given a transverse wave pulse. Where will the particle meet the pulse.

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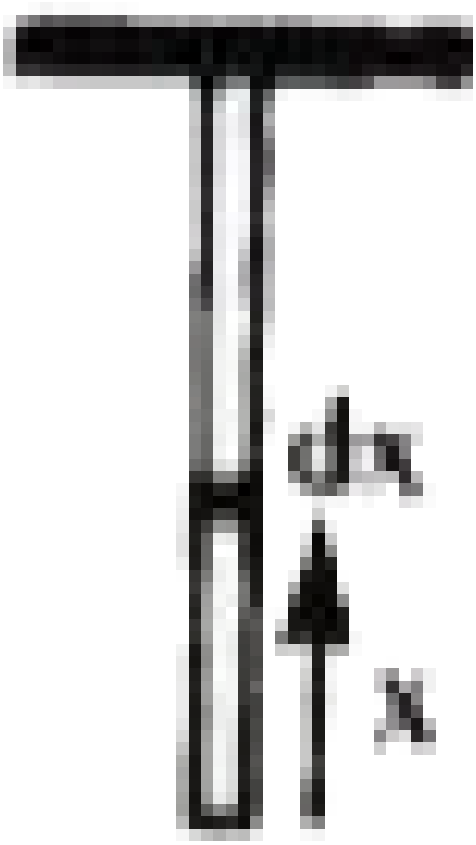
20. A wire of variable mass per unit length $\mu = \mu_0 x$, is hanging from the ceiling as shown in figure. The length of wire is l_0 . A small transverse disturbance is produced at its lower end. Find the time after which the disturbance will

reach to the other ends.



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21. Three pieces of string, each of length L, are joined together end-to-end, to make a combined string of length 3L. The first piece of string has mass per unit length μ_1, the second piece has mass per unit length $\mu_2 = 4\mu_1$ and the third piece has mass per unit length $\mu_3 = \mu_1 / 4$.

(a) If the combined string is under tension F, how much time does it take a transverse wave to travel the entire length 3L? Give your answer in terms of L,F and μ_1.

(b) Does your answer to part (a) depend on the order in which the three piece are joined together? Explain.

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22. Three pieces of string, each of length L, are joined together end-to-end, to make a combined string of length 3L.

The first piece of string has mass per unit length μ_1, the second piece has mass per unit length $\mu_2 = 4\mu_1$ and the third piece has mass per unit length $\mu_3 = \mu_1/4$.

(a) If the combined string is under tension F, how much time does it take a transverse wave to travel the entire length 3L? Give your answer in terms of L,F and μ_1.

(b) Does your answer to part (a) depend on the order in which the three piece are joined together? Explain.

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23. A certain $120Hz$ wave on a string has an amplitude of $0.160mm$. How much energy exits in an $80g$ length of the string?

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24. A transverse wave of amplitude 0.50 mm and frequency 100 Hz is produced on a wire stretched to a tension of 100 N. If the wave speed is $100ms^{-1}$, what average power is the source transmitting to the wire ?

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25. $y_1 = 8\sin(\omega t - kx)$ and $y_2 = 6\sin(\omega t + kx)$ are two waves travelling in a string of area of cross-section s and density rho. These two waves are superimposed to produce a standing wave.

(a) Find the energy of the standing wave between two consecutive nodes.

(b) Find the total amount of energy crossing through a node per second.

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26. $y_1 = 8\sin(\omega t - kx)$ and $y_2 = 6\sin(\omega t + kx)$ are two waves travelling in a string of area of cross-section s and density rho. These two waves are superimposed to produce a standing wave.

(a) Find the energy of the standing wave between two consecutive nodes.

(b) Find the total amount of energy crossing through a node per second.

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27. In a stationary wave that forms as a result of reflection of waves from an obstacle, the ratio of the amplitude at an antinode to the amplitude at node is 6. What percentage of energy is transmitted?

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28. In a stationary wave that forms as a result of reflection of wave from an obstacle, the ratio of this amplitude at an antinode to the amplitude at anode is n. The ratio of energy reflected to energy incident is

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29. 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.

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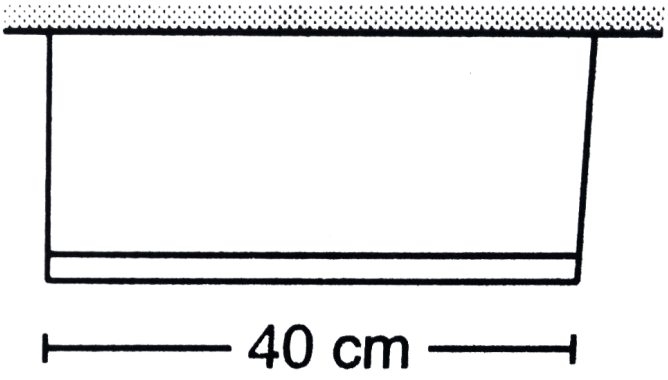
30. A uniform horizontal rod of length 40 cm and mass 1.2 kg is supported by two identical wires as shown in figure. Where should a mass of 4.8 kg be placed on the rod so that the same tuning fork may excite the wire on left into its fundamental vibrations and that on right into its first

overtone ? Take $g = 10ms^{-2}$



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31. Two wires of same material of radii 2r and r are welded together end to end The combination is used as a sonometer wire and is kept under tension T. The welded point lies midway between the bridges. What wil be the ratio of the number of loops formed in the wires, such that the joint is node when the stationary waves are set up in the wire?

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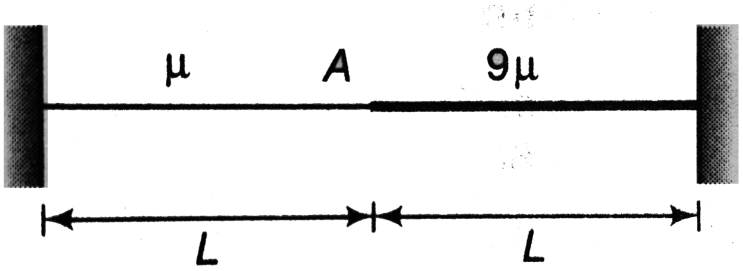
32. A light string is tied at one end to fixed support and to a heavy string of equal length L at the other end as shown in figure. Mass per unit length of the strings are μ and 9μ and the tension is T. Find the possible values of frequencies such that point A is a node/ antinode.



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33. the maximum pressure variation that the human ear can tolerate in loud sound is about $30N/m^2$. The corresponding maximum displacement for a sound wave ina air having a frequency of $10^3 Hz$is

take velocity of sound in air as 300 m/s and density of air $1.5kg/m^3$

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34. Calculate the bulk modulus of air from the following data about a sound wave of wavelength 35 cm travelling in air. The pressure at a point varies between $\left(1.0 \times 10^5 \pm 14\right)$ Pa and the particles of the air vibrate in simple harmonic motion of amplitude $5.5 \times 10^{-6} m$.

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35. The pressure variation in a sound wave in air is given by

$\Delta p = 12\sin(8.18X - 2700t + \pi/4)N/m^2$

find the displacement amplitude. Density of air $= 1.29kg/m^3$.

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36. A point sound source is situated in a medium of bulk modulus $1.6 \times 10^5 N/m^2$. An observer standing at a distance $10m$from the source writes down the equation for the wave as $y = A\sin(15\pi x - 6000\pi t)$. Here y and x are in meter and t is in second. The maximum pressure amplitude received to the observer's ear is (24π) pa, then find.

(a) the density of the medium,

(b) the displacement ampulitude A of the wave recived by the observer and

(c) the power of the sound source.

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(a) the density of the medium,

(b) the displacement ampulitude A of the wave recived by the observer and

(c) the power of the sound source.

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39. A tuning fork of frequency 440 Hz is attached to a long string of linear mass density $0.01 kgm^{-1}$ kept under a tension of 49 N. The fork produces transverse waves of amplitude 0.50 mm on the string. (a) Find the wave speed and the wavelength of the waves. (b) Find the maximum speed and acceleration of a particle of the string. (c) At what average rate is the tuning fork transmitting energy to the string ?

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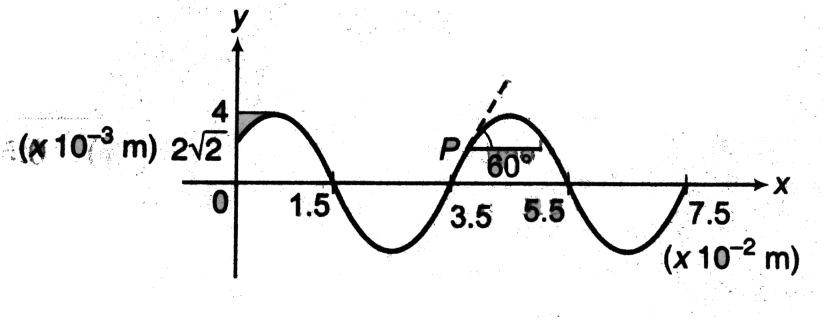
42. The figure shows a snap photograph of a vibrating string at $t = 0$. The particle P is observed moving up with velocity $20\sqrt{3}cm/s$. The tangent at P makes an angle 60° with x-axis.



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

(b) Write the equation of the wave.

(c) The total energy carries by the wave per cycle of the string.

Assuming that the mass per unit length of the string is $50g/m$.

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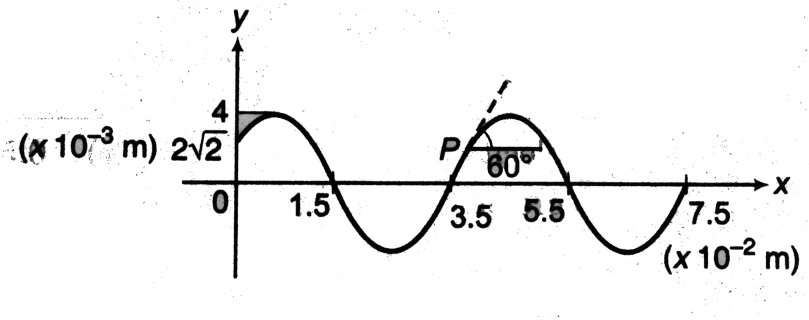


(a) Find the direction in which the wave is moving.

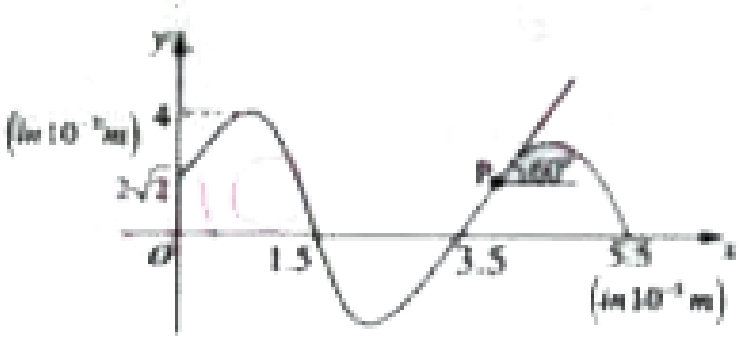
(b) Write the equation of the wave.

(c) The total energy carries by the wave per cycle of the string.

Assuming that the mass per unit length of the string is $50g/m.$

Watch Video Solution

44. The figure shows a snap photogaraph of a vibrating string at t = 0. The particle P is observed moving up with velocity $2\sqrt{3}$ cm/s. The tangent at P makes an angle 60° with x-axis. The mass per unit length of string is 50 g/m



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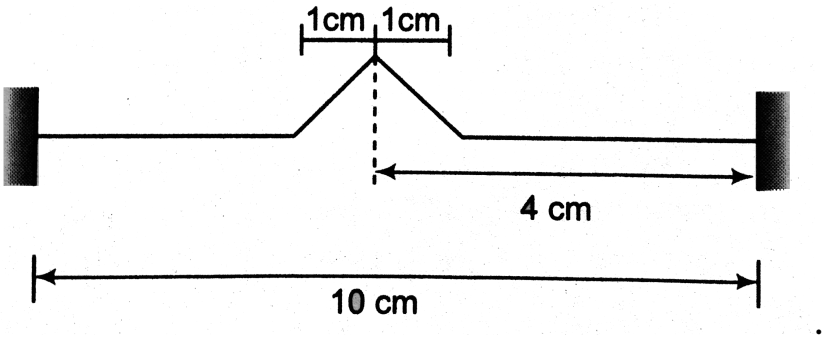
45. A string that is 10 cm long is fixed at both ends. At t=0, a pulse travelling from left to right at $1cm/s$ is 4.0 cm from the right end as shown in figure. Determine the next two times when the pulse will be at that point again. State in each case whether the pulse is upright or inverted .



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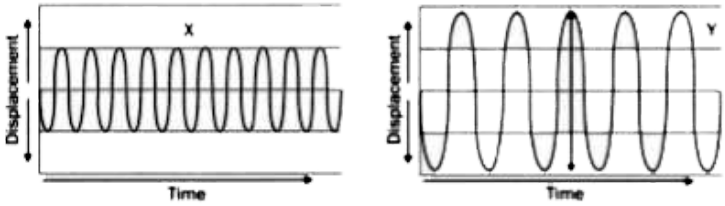
46. Look at the figure given and identify which sound wave is louder, X or Y?



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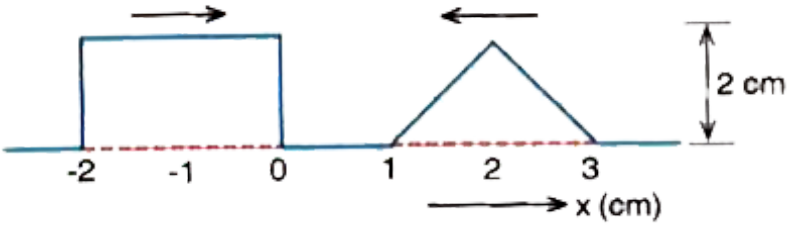
47. Figure shows a rectangular pulse and triangular pulse approaching each other. The pulse speed is 0.5 cm/s. Sketch the resultant pulse at t = 2s.



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48. Two wires of different densities are soldered together end to end then stretched under tension T. The waves speed in the first wire is twice that in the second wire.

(a) If the amplitude of incident wave is A, what are amplitudes of reflected and transmitted waves?

(b) Assuming no energy loss in the wire, find the fraction of the incident power that is reflected at the junction and fraction of the same that is transmitted.

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(b) Assuming no energy loss in the wire, find the fraction of the incident power that is reflected at the junction and fraction of the same that is transmitted.

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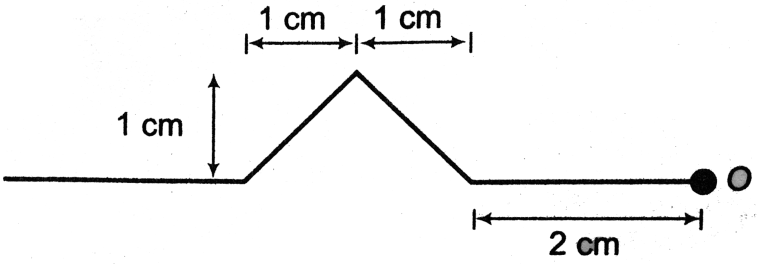
50. A wave pulse on a string has the dimensions shown in figure. The wave speed is $v = 1cm/s$.



(a) If point O is a fixed end, draw the resultant wave on the string at t=3 s and t=4 s.

(b) Repeat part (a) for the case in which O is a free end.

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51. A wave $y_i = 0.3\cos(2.0x - 40t)$ is travelling along a string toward a boundary at x=0. Write expressions for the reflected waves if .

(a) the string has a fixed end at x=0 and

(b) The string has a free end at x=0.

Assume SI units.

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(a) the string has a fixed end at x=0 and

(b) The string has a free end at x=0.

Assume SI units.

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53. The harmonic wave $y_i = \left(2.0 \times 10^{-3}\right) \cos \pi (2.0x - 50t)$ travels along a string towards a boundary at x=0 with a second string. The wave speed on the second string is $50m / s$. Write expressions for reflected and transmitted waves. Assume SI units.

Watch Video Solution

54. Three source 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 waye coming from S_2, is 120° ahead in phase of that from S_1. Also, the wave coming from S_3 is 120° a head of that from S_2. What would be the resultant intensity of sound at P?

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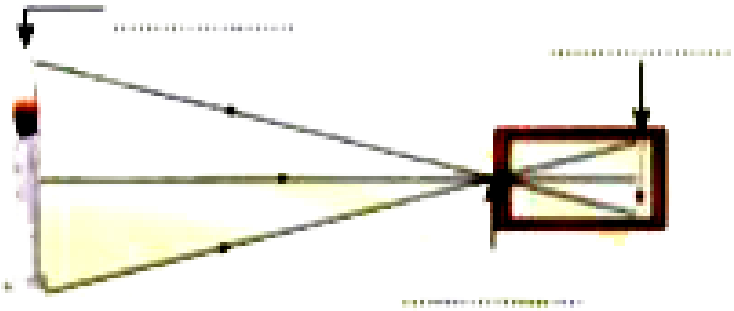

55.

Label the figure.

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56. Two audio speakers are kept some distanace apart and are driven by the same amplifier system. A person is sitting at a place 6.0 m from one of the speakers and 6.4 m from the other. If the sound signal is continuously varied from 500 Hz to 5000 Hz, what are the frequencies for which there is a

destructive interference at the place of the listener ? Speed of sound in air $= 320 m / s$.

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57. Two loudspeakers radiate in phase at $170 H_Z$. An observer sits at $8m$ from one speaker and $11m$ from the other . The intensity level from either speaker acting alone is $60 dB$. The speed of sound is $340 m / s$. Find the observer intensity when both speakers are on together.

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60. In a resonance tube experiment to determine the speed of sound in air, a pipe of diameter $5cm$ is used . The column in pipe resonates with a tuning fork of frequency $480H_Z$ when the minimum length of the air column is $16cm$. Find the speed in air column at room temperature.

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61. In a resonance column experiment, a tuning fork of frequency 400 Hz is used. The first resonance is observed when the air column has a length of 20.0 cm and the second resonance is observed when the air column has a length of 62.0 cm. (a) Find the speed of sound in air.(b) How much distance above the open end does the pressure node form ?

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63. A small source of sound oscillates in simple harmonic motion with an amplitude of 17 cm. A detector is placed along the line of motion of the source. The source emits a sound of frequency 800 Hz which travels at a speed of 340 m/s. If the

width of the frequency band detected by the detector is 8 Hz, find the time period of the source.

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64. A boy riding on his bike is going towards east at a speed of $4\sqrt{2}$ m/s. At a certain point he produces a sound pulse of frequency 1650 Hz that travels in air at a speed of 334 m/s. A second boy stands on the ground 45° south of east from him. Find the frequency of the pulse as received by the second boy.

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65. A source emitting sound at frequency 4000 Hz, is moving along the Y-axis with a speed of 22 m/s. A listener is situated

on the ground at the position (660 m, 0). Find the frequency of the sound received by the listener at the instant the source crosses the origin. Speed of sound in air = 330 m/s.

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66. A source of sound emitting a 1200 Hz note travels along a straight line at a speed of 170 m/s. A detector is placed at a distance of 200 m from the line of motion of the source.

Find the frequency of sound received by the detector at the instant when the source gets closest to it.

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67. A source of sound emitting a 1200 Hz note travels along a straight line at a speed of 170 m/s. A detector is placed at a distance of 200 m from the line of motion of the source.

Find the distance between the source and the detector at the instant it detects the frequency 1200 Hz. Velocity of sound in air = 340 m/s.

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68. A source emitting a sound of frequency f is placed at a large distance from an observer. The source starts moving towards the observer with a uniform acceleration a. Find the frequency heard by the observer corresponding to the wave emitted just after the source starts. The speed of sound in the medium is v.

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69. A whistle of frequency f_0 = 1300 Hz is dropped from a height H = 505 m above the ground. At the same time, a detector is projected upwards with velocity $v = 50ms^{-1}$ along the same line. If the velocity of sound is $c = 300ms^{-1}$ find the frequency detected by the detector after t = 5s.

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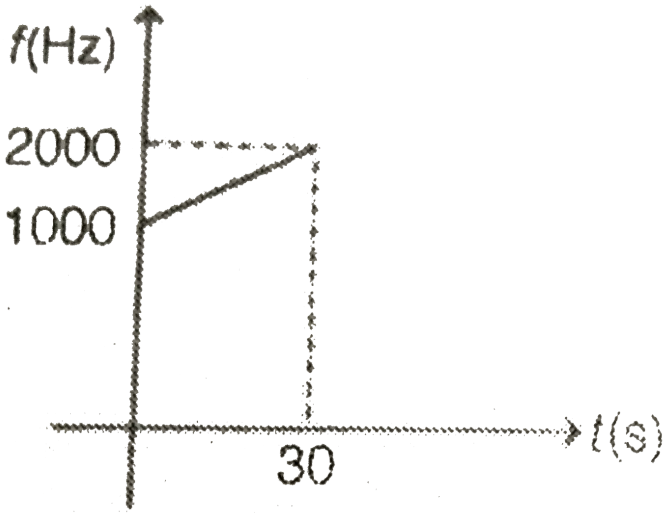
70. A detector is released from rest over a source of sound of frequency $f_0 = 10^3 Hz$. The frequency observed by the detector at time t is plotted in the graph. The speed of sound

in air is $(g = 10m/s^2)$



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71. A source S of acoustic wave of the frequency $v_0 = 1700Hz$ and a receiver R are located at the same point. At the instant $t = 0$, the source start from rest to move away from the receiver with a constant acceleration ω. The velocity of sound in air is $v = 340\frac{m}{s}$.

Q. If $\omega = 10\frac{m}{s^2}$, the apparent frequency that will be recorded by the stationary receiver at $t = 10s$ will be

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72. A sound source moves with a speed of $80m/s$ relative to still air toward a stationary listener. The frequency of sound is $200H_Z$ and speed of sound in air is $340m/s$. (a) Find the wavelength of the sound between the source and the listener. (b) Find the frequency heard by the listener.

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74. A railroad train is travelling at $30m/s$ in still air. The frequency of the note emitted by the node emitted by the locomotive whistle is $500H_Z$. What is the wavelength of the sound waves : (a) in front of the locomotive?

What is the frequency of the sound heard by a stationary listener (b) behind the locomotive? (c) in front of the locomotive ?

Speed of sound in air $344m/s$. (d) behind the locomotive ?

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78. Two identical tuning forks vibrating at the same frequency 256 Hz are kept fixed at some distance apart. A listener runs between the forks at a speed of $3.0ms^{-1}$ so that he approaches one tuning-fork and recedes from the other. find the beat frequency observed by the listener. Speed of sound in air $= 332ms^{-1}$.

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79. Two sound sources are moving in opposite directions with velocities v_1 and $v_2(v_1 > v_2)$. Both are moving away from a stationary observer. The frequency of both the sources is 900 Hz. What is the value of $v_1 - v_2$ so that the beat frequency aboserved by the observer is 6 Hz. speed of sound v= 300 m/s given ,that v_1 and $v_2 < < v$

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80. A 300 Hz source, an observer and wind are moving as shown in the figure with respect to the ground. What

frequency is heard by the observer?

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81. A person standing on a road sends a sound signal to the driver of a car going away from him at a speed of 72 km/h. The signal travelling at 330 m/s in air and having a frequency of 1600 Hz gets reflected from the body of the car and returns. Find the frequency of the reflected signal as heard by the person.

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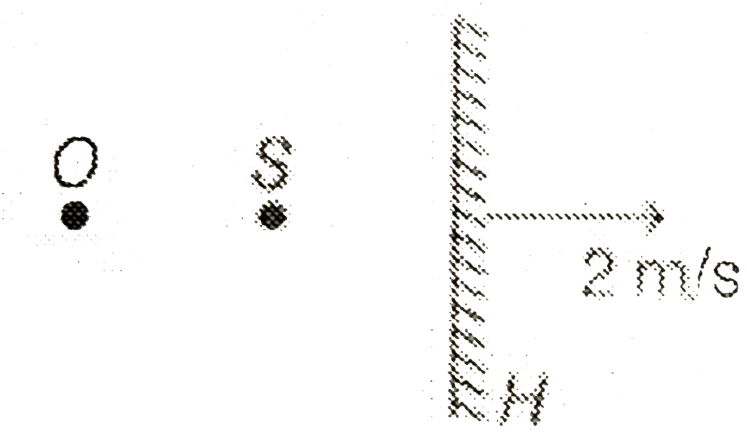
82. A stationary sound sound 's' of frequency 334 Hz and a stationary ovserver 'O' are placed near a reflecting suface moving away from the source with velocity 2 m/s as shown in the figure. If the velocity of the sound waves is air is v= 330 m/s the apparent frequency of the echo is



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83. Spherical waves are emitted from a $1.0W$ source in an isotropic non-absorbing medium. What is the wave intesity $1.0m$ from the source?

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84. The intensity of sound from a point source is $1.0 \times 10^{-8} Wm^{-2}$, at a distance of 5.0 m from the source. What will be the intensity at a distance of 25 m from the source ?

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85. Most people interpret a $9.0dB$ increase in sound intensity level as a doubling in loudness. By what factor must the sound intensity be increase to double the loudness?

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86. About how many times more intense will the normal ear perceiver a sound of $10^6 W/m^2$ than one of $10^9 W/m^2$?

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87. The explosion of a fire cracker in the air at the a heigth of $40m$ produced a $100dB$ sound level at ground below. What is

the instantaneous total radiated power? Assuming that it radiates as a point source.

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88. 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 ?

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

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90. 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 ?

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91. Two waves, each having a frequency of 100 Hz and a wavelength of 2.0 cm, are travelling in the same direction on a string. What is the phase difference between the waves if the second wave was produced 0.015 s later than the first one at the same place,

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92. Two waves, each having a frequency of 100 Hz and a wavelength of 2.0 cm, are travelling in the same direction on a string. What is the phase difference between the waves if the second wave was produced 0.015 s later than the first one at the same place,

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94. Three component sinusoidal waves progressing in the same directions along the same path have the same period but their amplitudes are $A, \frac{A}{2}$ and $\frac{A}{3}$. The phases of the variation at any position x on their path at time $t = 0 are 0, -\frac{\pi}{2}$ and $-\pi$ respectively. Find the amplitude and phase of the resultant wave.

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95. A soldier walks towards a high wall taking 120 steps per minute. When he is at a distance of 90 m from the wall he observes that echo of step coincides with the next step. The speed of sound must be

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96. A man stands before a large wall at a distance of 50.0m and claps his hands at regular intervals. Initially, the interval is large. He gradually reduces the interval and fixes it at a value when the echo of a clap merges with the next clap. If he has to clap 10 times during every 3 seconds, find the velocity of sound in air.

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97. A road runs midway between two parallel rows of buildings. A motorist moving with a speed of 36 Km/h sounds the horn. He hears the echo one second after he has sounded the horn: Then the distance between the two rows of buildings is. (Velocity of sound in air is 330 m/s)

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