PHYSICS

BOOKS - S CHAND PHYSICS (ENGLISH)

WAVES

Worked Out Examples Module 1

1. The frequency of sound is 100 Hz and wavelength is 3m. Calculate the velocity of the wave.

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2. The wavelength of the radiowaves transmitted by a broadcasting station is 422.54m. What is the frequency of the wave? Velocity of the wave $= 3 \times 10^8 ms^{-1}$.

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3. Find the number of vibrations made by a tuning fork of frequency 480Hz during the time the sound travels a distance 220m. Velocity of sound $= 330 ms^{-1}$.

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4. The equation of a transverse wave travelling along +x axis is given by y=0.15 sin (1.57x-31.4t) where y and x are

represented in m and t in s. Find the amplitude, frequency velocity and wavelength of the wave.

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5. A plane progressive wave is given by, $y = 0.30\sin(40t - 0.30x)$. Find the wavelength and the phase difference between two points at x=2 and x-7.232m. Also find the maximum particle velocity.

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6. The frequency of a transverse wave is 800Hz and its velocity is 200m/s. (i) How far apart are two points 30°

out of phase? (ii) What is the phase difference between two displacements at a certain point at times 10^{-3} s apart.

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7. The equation of a transverse wave travelling in a rope is given by $y = 7\sin(4.0t - 0.02x)$

where y and x are in cm and the time is in second. Calculate (i) the maximum transverse speed and (ii) the maximum particle acceleration?

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8. Check whether the following equation is a solution to one dimensional wave equation. $y - 4x - 7t$

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9. The equation of a wave travelling in a rope is given by $y = 10\sin(2.0t - 0.04x)$ where y and x are expressed in cm and time t in second. Calculate the intensity of the wave if the density of the material of the rope is $1.3 \times 10^3 kg/cm^3$.

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10. The frequency of the sound emitted by a musical instrument is 512Hz. The instrument emits plane wave of amplitude $10^{-4}m$. Calculate the energy flux, if the speed of sound in air in 332 m/s and the density of air is $1.29kg/m^3$.

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11. The pressure amplitude is $0.4N/m^2$ for a plane harmonic sound wave of frequency 680Hz in air. What are its displacement and velocity amplitudes? Atmospheric pressure $= 1.01 \times 10^5 N/m^2$

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12. The maximum variation in pressure P that the ear can tolerate in loud sound is about $28N/m^2$. What is the corresponding maximum displacement for a sound of frequency 500Hz imart? Density of air is $1.22kg/m^3$ and velocity of sound =330m/s.

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Worked Out Examples Module 2

1. A steel wire 75cm long has mass of 5.5 $10^{-3}kg$. If the wire is under a tension of 65N, what is the speed of transverse waves on the wire?

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2. Calculate the time taken for a disturbance to pass through a string of length I and of mass per unit length m when the tension in the string is mI^2gN.

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3. Two strings A and B of equal thickness are made of the same material. The length of A is 1/3rd that of B while tensions in A is thrice that in B. Compare the velocities of the transverse wave on them.

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4. The density of aluminium is $2.7 \times 10^3 kg/m^3$ and its Young's modulus is $7.0 \times 10^{10} N/m^2$. Calculate the velocity of sound wave in the bar.

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5. Longitudinal waves of frequency 400Hz are produced in a rod of material of density $8000 kg/m^3$ and Young modulus $7.2 \times 10^{10} N/m^2$. What is the wavelength of the wave?

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6. Calculate the velocity of sound in air at STP by using (i) Newton equation (ii) Laplace's equation. The mass of 1 mole of air $= 29.0 \times 10^{-3} kg$?

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7. The speed of sound in water is 1.5km/s. If density of water is $1.0 \times 10^3 \mathrm{kg/m}^3$, calculate the bulk modulus of of elasticity of the liquid?

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8. The planet Jupiter has an atmosphere of a mixture of ammonia and methane at a temperature $-130^\circ C$.

Calculate the velocity of sound on this planet assuming γ for mixture to be 1.3. Molar mass of the mixture is $1.65 \times 10^{-3} kg$. $R = 8.3 \ \text{J mol}^{-1} K^{-1}$.

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9. Show that the velocity of sound in a gas, for which $\gamma = 1.41,$ is 0.68c, where c is the root-mean-square velocity of the molecules.

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10. Sound travels in a gas with a speed of 1286 m/s at 273K. If the molar mass of the gas is $2 \times 10^{-3} kg$, what

can you say about the gas?

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11. Find the temperature at which the velocity of sound in air will be $1\frac{1}{2}$ times of the velocity at $27^\circ C$.

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Worked Out Examples Module 3

1. Given that the density of air is 1.6 times density of aqueous vapour. Calculate the velocity of sound in

damped air containing 10% vapour by volume. Velocity of sound in dry air at the same temperature is $340ms^{-1}$.

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Solved Examples

1. The equations for two sinusoidal waves propagating through a string are given by, $y_1 = 4\sin(20x - 30t)$

$y_2 = 4\sin(25 - x - 40t)$

where y and x are in centimeters and t is second.

(i) What is the phase difference between these two waves at the points x=5.0 cm and at t=2.0 s?

(ii) When these two waves interface what is the maximum and minimum value of the intensity?

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2. Two wave pulses travelling along the same string are represented by the equation, $y_1 = \frac{10}{(5x - 6t)^2 + 4}$ and $y_2 = \frac{-10}{(5x + 6t - 6)^2 + 4}$ (i) In which direction does each wave pulse travel (ii) At what time do the two cancel each other?

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3. The distance between the two identical speakers shown in Fig. 14.3.3 are 4.00m. They are driven by the same osicllator. Initially a listner stays at L at a distance 8.0 m from the centre of the line connecting the two

speakers. The listner then walks to the point A where AL=0.4m. The first minium is sound intensity in heard just the listener reaches the point A. Find the frequency of the oscillator. Speed of sound in air is 340 m/s.

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4. A tunning fork of unknown frequency gives 4 beats per second when sounded with a fork of frequency 320Hz. When loaded with a little wax it give 3 beats per second. Find the unknown frequency.

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5. The frequency of the funing fork B is 512Hz. It is sounded with another tuning fork. A and 4 beats per sec are heard. A is filled and it is found that beats occur at shorter intervals. Find the frequency of A?

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6. Calculate the velocity of sound in a gas in which two waves of wavelength 50 cm and 50.5cm, produce 6 beats per second.

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7. A note produces 5 beats per second with a tuning fork of frequency 480Hz. What is the frequency of the note given that it produces 7 beats with 482Hz?

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8. What will be the frequency of the note emitted by a wire 100cm long when stretched by a weight of 100kg, if 2m of wire has a mass of 12.25gm?

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9. A string vibrates with a frequency 200Hz. Its length is doubled and its tension is altered until it begin to

vibrate with frequency 300Hz. What is the ratio of the new tension to the original tension?

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10. A wire of length 108 cm produces of fundamental note of 256Hz when stretched by a weight of 1kg. By how much its length should be increased so that its pitch is raissed by a major tone, if it is now stretched by a weight of 4kg?

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11. In Melde's experiment if there are two loops for one meter length in the longitudinal position, calculate the tension in the string. [Frequency of the fork is 128Hz and mass per unit length of the string is $5 \times 10^{-6} kg$]. What will happen if the fork's is rotated through 90°].

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12. In Melde's experiment it was found that the string vibrated in 3 loops when 8gm were placed in a pan. What mass must be placed in the pan to make the string vibrate in 5 loops? (Neglect the mass of the string an the pan).

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13. Calculate the frequency of the fundamental note of 0.35m long open and closed pipes? Velocity of sound is $340ms^{-1}$.

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14. An open organ pipe emitts sound of frequency 480Hz. When temperature was $47^{\circ}C$. Calculate the frequency of sound emitted if the temperature falls to $27^{\circ}C$, assuming that there is no change in the length of the pipe.

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15. In an experiment to determine the velocity of sound in air using resonance column apparature, the first and resonating length measured to be 25.4 and 78.5cm respectively. Calculate the velocity of sound in air and the end correction of frequency of the turning fork is 320Hz.

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16. Clamped at the middle a metal rod of length 1m and density $7.5 \times 10^3 kg/m^3$ gives dust heaps at intervals of 8cm. Calculate the Young's modulus of the material of the rod. Velocity of sound in the gas used in 400m/s.

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17. In Kundt's tube experiment the following observations : Length of the brass rod is 100cm, average length of loop in air is 10.3 cm and in carbon dioxide =8.0 cm. Calculate the velocity of sound in brass and in CO_2. What is the frequency of the note? (Given the velocity of sound in air at the temperature of the experiment is 350m/s).

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Additional Solved Problems

1. A car moving at a speed of 72km/hr sounds its whistle which has a frequency of 550Hz, Find the frequencies

heard by a stationary observer as the car approaches and then recedes from the observer, velocity of sound =340m/s.

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2. The speed of an ambulence on a highway is 34m/s. The frequency of the sound emitted by its siren is 500Hz. Calculate the frequency heard by the driver in a car travelling at 72km/r in the opposite direction, (i) before crossing and (ii) after crossing (V=340m/s)

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3. A tunning fork of frequency 512Hz approaches a wall with a velocity of $4ms^{-1}$. How many beats are produced between the direct and the reflected sound if the velocity of sound is $332ms^{-1}$?

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4. The frequency of an octave is 576Hz. Find the 5th note of major diatomic scale.

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5. Find the sound level in decibel of a sound wave which has an intensity of $10^{-4}Wm^{-2}$ if $I_0 = 10^{-12}Wm^{-2}$.

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6. Calculate the various frequencies in a diatomic scale if the keynote is taken to be 300Hz.

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7. Obtain the equation of a harmonic wave travelling is the +ve x-direction and has the characteristics given below. Amplitudes is 4cm, speed is 2m/s and frequency is 8Hz.

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8. The equation of a transverse wave propagating through a stretched string is given by $y = 2\sin 2\pi\left(\frac{t}{0.04} - \frac{x}{40}\right)$ where y and x are in centimeter and t in seconds. Find the velocity of the wave, maximum velocity of the string and the maximum acceleration.

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9. The graph below shows that instantaneous displacements due to progressive iongitudinal wave travelling with a velocity $50ms^{-1}$ along the direction ABCD. [Fig 14.4.8 (b)].

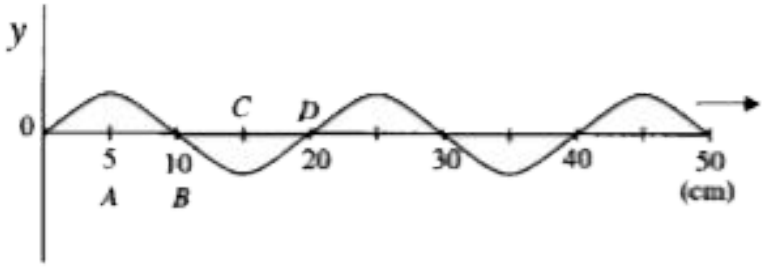
(a) What is the frequency of the wave ?

(b) What is the phase difference between the vibrations

at C and D?

(c) At which of the points A,B,C,D is the instantaneous particle velocity maximum forward?

(d) At which of the points, A,B,C,D is there a rarefraction?



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10. Find the phase difference betwee the two progressive wave.

$$y_1 = A\sin\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right) \text{ and } y_2 = A\cos\left(\frac{2\pi}{T}t - \frac{2\pi}{\lambda}x\right)$$

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11. Plane harmonic waves of frequency 500Hz are produced in air with displacement amplitude $10^{-3}cm$. Deduce (i) the pressure amplitude (ii) the energy density and (iii) intensity of the wave. Speed of sound in air =300m/s. Density of air $= 1.29\text{kg}/\text{m}^3$.

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12. Spherical wave are emitted from 2 watt point source in an isotropic non-absorbing medium. Calculate the wave intensity 1m from the source?

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13. The intensities of two sound waves, one in air and the second one in water are equal (i) What is the ratio of the pressure amplitude of the wave in water to that of the wave in air? If the pressure amplitudes are equal instead, what is the ratio of the intensities of hte waves? Density of air is $1.293 kg/m^2$. Velocity of sound in air and water are $330 ms^{-1}$ and $1450 ms^{-1}$ respectively.

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Sound Waves

1. The frequency of the fourth harmonic in a stretched string of length 20 cm is 500 Hz. (i) Calculate the velocity

of the wave in the string? (ii) For what value of tension, will the velocity in the string be 100 ms^{-1}?

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2. The velocity of sound in air at 324k is $360ms^{-1}$. If the pressure is halved and temperature is raised to 400K, what will be the new velocity?

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3. The velocity of sound in hydrogen at $0^{\circ}C$ is 1.28kms^{-1}. Calculate the velocity of sound in a

mixture of 4 parts by volume of hydrogen and one part of oxygen at the same temperature?

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4. A narrow sound pulse (for example, a short pip by a whistle) is send across a medium. (a) Does the pulse have a definite (i) wavelength (ii) frequency (iii) speed of propagation? (b) If the pulse rate is 1 after every 20s. (i.e, by a whistle equal to 1/20 Hz?

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5. The ratio of the intensities of two interfering waves is 81:1. What is the ratio of the maximum to minimum intensity?

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6. Two sinusoidal wave having the same frequency and travelling in the same direction are combined. What is the amplitude of the resultant motion if their amplitudes are 3cm and 4cm and they differ in phase by $\pi/2$ radian?

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7. Fig. 144.9 shops to wave pulses travelling along a string in the opposite directions. The velocity of the wave is 3 m/s and the pulses are 9cm apart. Find what has happened to the energy at t=1.5s.

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8. Three sinusodal waves having amplitudes a, a/2 and a/3 are superposed. They have the same period and thelr phase are 0, $\pi/2$ and respectively. Find (i) The resultant amplitude and phase (ii) Draw a sketch to show the resultant wave.

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9. A set of 24 tuming forka is arranged in series of Locrening frequencies. If each tuning fork gives 4 beats/sec with the preceding one and the last fork is found to be the octave of the first, calculate the frequences of the first and the last.

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10. Calculate the velocity of sound in a gas in which two waves of lengths one metre and 1.01 m produce 16 beats in 4 seconds.

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11. A tuning fork and a siren produce 18 beats in 3 seconds. The siren has 16 holes and is making 960 revolutions per minute. If the velocity of the siren is reduced, the two notes will be in unison. Find the pitch of the tuning fork.

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12. A tuning fork is in unison with a sonometer wire 80 cm long. If 2 beats are heard on shortening the wire by one centimeter find the frequency of the fork?

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13. Tivo sitar strings A and B playing the note 'Ga'are slightly out of tunc and produce bedis of frequency 6 Hz. The tension in the string A is slightly reduced and the bear 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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14. A musical scale that is not based on any one key-note but has the same character independent of the starting note is known as an equally tempered scale. If in this scale, an octave is divided into 12 half tones, what are the frequencies of the successive half-tones between a note of frequency 256 Hz and its octave ?

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15. A steel rod 100 cm long is dampled at into middle.Then fundamental frequnecy of longitudinal vibrations of the rod are given to be 2.53 kHz.What is the speed of sound in sound is steel?

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16. Explain how the bridges should be placed in order to divide a wire 1.1m. Long into three segments whose fundamental frqeuencies are in the ratio 1:2:3.

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17. A bridge is placed under the string of a sonometer at a point near the middle when the two are plucked simultaneously 3 beats per second are produced with a stretching load of 4kg. Find the number of beats per second when the load is increased to 16kg.

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18. Two organ pipes of the same diameter, one closed at one end and the other open at both ends are respectively 0.75m and 1.56 m long. When sounded together, the number of beats heard is 4 per second. Find the velocity of sound in air.

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19. A stretched wire is kept near the open end of a closed pipe 0.75 m long. The wire is 0.3 m long and has a mass of 0.01 kg. The wire is made to vibrate in its fundamental node, after Ixing at both ends. It sets the air column in the tube hito vibration at its fundamental frequency by resonance. Find (a) the frequency of oscillation of the air column and 6) the tension in the wire. Velocity of sound =330 m/s.

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20. Clamped at the middle a metal rod of length 1m and density $7.5 \times 10^3 kg/m^3$ gives dust heaps at intervals of

8cm. Calculate the Young's modulus of the material of the rod. Velocity of sound in the gas used in 400m/s.

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21. A load of 20kg is suspended by a steel wire. Its frequency when rubbed with a resigned cloth is found to be 20 times its freqency when plucked. Find the area of cross section of the wire. Young's modulus of steel is $19.6 \times 10^{10} N/m^2$.

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22. In Melde's experiment a loaded string of lenyek Im weighing 0.5 gm khanging from a coming fork of thegoency 200 and is vibrating in four loops. Calculate the tension in string?

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23. A train stands at a platform, blowing a whistle of frequency 400 Hz in still aIr: What is the frequency of the whistle heard by a man running (a) towards the engine at $10ms^{-1}$ (b) away from the engine at 10 ms^{-1}?

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24. A train standing in a station-yard blows a whistle of frequency 400 Hz in still air. A wind starts blowing in the direction from the yard to the station wit a speed of 10 ms^{-1}?. What are the frequeney, wavelength and speed of sound foran observer standing on the station's platform ? Is the situation exactly equivalent to the case when the air is still and the observer runs towards the yard at the speed of 10 ms^{-1}?

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25. A sonar system fixed in a submariene operatres at a frequency 40KHz. An enemey submarine moves towards the sonar with a speed of $360kmh^{-1}$. What is the

frequency of sound reflected by the submarine? Speed of sound in water $1450 ms^{-1}$?

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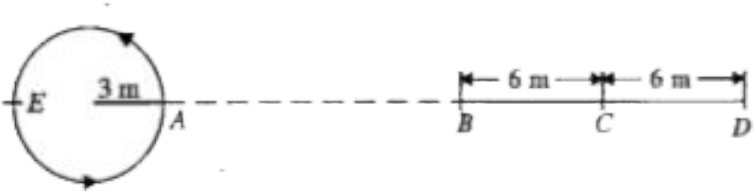
26. A source of sound is moving along a circular orbit of radius 3 m with an angular velocity of 10 rad/s. A sound detector located far away from the source is executing linear S.H.M. along the line BD (see Fig. 14.4.13) with an amplitude BC = CD=6m. The frequency of oscillation of the detector is $5/\pi$ 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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27. The 6563 Ã... H_α line emitted by hydrogen in a star is found to be red-shifted by 15 Ã.... The speed with which the star is receding from the earth is

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28. Explain how sound is propagated as a longitudinal wave .

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29. What are the primary components of a sound source ?

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30. What are (i) audible frequency, (ii) infra-sonics and (iii) ultra-sonics ?

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31. Cite an experiment to show that sound needs a material medium for its propagation.

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32. Which property of sound is used in whispering galleries.

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33. Mention the properties of sound.

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34. Which sound travels faster, infrasonics or ultrasonics ?

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35. What are the conditions for sound to interfere ?

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36. Name the factors on which the velocity of transverse wave in a string depends.

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37. Write down the Newton's formula for the velocity of sound in a gas. Why did his formula give wrong results ?

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38. How did Laplace's correct Newton's formula ?

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39. Velocity of sound in a gas does not depend on the pressure of the gas. Why?

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40. Show that the velocity of sound in air increases by $0.6ms^{-1}$ for every $1^{\circ}C$ rise in temperature.

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41. In which medium the speed of sound is more : humid air or dry air ? Give a reason to your answer.

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42. What is the effect of wind on the velocity of sound ?

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43. Explain why you can predict the arrival of a train by placing your ear on the rails without seeing

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44. What is the effect of frequency and amplitude on the velocity of sound?

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45. Suppose you set your watch by the sound of a distance siren, will it go fast or slow?

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

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47. If one sound wave has twice the pressure amplitude of the another sound in the same medium, find the ratio of the intensities of the two sounds ?

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48. When sound wave travels from one medium into another what possible changes could occur to (i) velocity, (ii) frequency and (iii) wavelength ?

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49. Can an object vibrating transversely produce a sound wave ? Explain.

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50. Why does the speed of sound increase with increase in temperature?

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Musical Sound

1. A sound produced by one musical instruments is 20dB more intense as compared to the sound by another instrument. What are their relative powers?

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2. 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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Conceptual Short Answer Questions With Answers

1. "In a sound wave, a displacement node is a pressure antinode and vice versa'. Why?

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2. "Bats can ascertain distances, directions, nature and size of the obstacles without any eyes". How ?

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3. "The reverberation time is larger for an empty hall than a crowded hall". Why?

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4. If the same note is being played on two different musical instruments, our ears can distinguish between the two sounds.

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5. Both transverse and longitudinal mechanical waves can propagate through a solid, but only longitudinal wave can propagate through a gas. Explain.

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6. "Ocean waves hitting a beach are always found to be nearly normal to the shore." Why?

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7. "The shape of a pulse getr distorted during propagation in a dispersive medium." Why?

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8. Given below are some examples of wave motion. State in each case if the wave motion is transverse, longitudinal or a combination of both

(i) Motion of a kink in a long coil spring, produced by displacing one end of the spring sideways.

(ii) Waves produced in a cylinder containing a liquid, by moving its piston back and forth.

(iii) Waves produced by a motor-boar sailing in water.

(iv) Light waves travelling from the sun to the earth.

(v) Ultrasonic waves in air, produced by a vibrating quartz crystal.

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

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10. The velocity of sound in air at 324k is $360ms^{-1}$. If the pressure is halved and temperature is raised to 400K, what will be the new velocity?

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11. "We cannot hear the explosions on other planets." Why?

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12. "During thunder, we can hear a rolling sound." Why?

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13. "The bells are made of metals and not of wood." Why?

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14. "When one person hammers at one end of a metal pipe, ifa listener places his ear at the other end of the pipe, two distinct sounds are heard." Why?.

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15. “During the filling of an empty bottle with water, the pitch of the sound heard goes on changing." Why?

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16. At which point of a stationary wave the sound heard is maximum, at the node or the antinode ?

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17. Why does an empty vessel produce more sound than a filled one?

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18. When a tuning fork (vibrating) is held close to ear, one hears a faint hum. The same (vibrating tuning fork) is held such that its stem is in contact with the table surface, then one hears a loud sound. Explain.

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

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20. The frequency of a sonometer wire is f . When the weight producting the tensions are completely. Immersed in water the frequency becomes $f/2$ and on immersing the weight in acertain liquid the fequency becomes $f/3$. The specific gravity of the liquid is

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21. Two organ pipes of same length, open a bosh ends, produce sound of different frequencies if their radii are different. Why?

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22. A whistle is rotated in a horizontal circle. Is there any change in the sound of the whistle, heard by a person standing (i) at the centre of the circle (ii) outside the circle ?

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23. How will you distinguish between a note and its echo?

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24. Give the relationship between the fundamental note and overtone in an open pipe.

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25. Give the relationship between the fundamental note and overtone in an open pipe.

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Long Answer Questions

1. (a) What are the characteristics of wave motion ?

(b) Explain the difference between longitudinal wave and transverse wave.

(c) Draw diagram to show the formation of a transverse. Show the position of the vibrating particles at time

$t = 0, t = \frac{T}{4}, t = 2\frac{T}{4}, t = 3\frac{T}{4}$ and $t = 3\frac{T}{4}$, on a graph.

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2. (a) What is a harmonic wave? Write down the general expression for a harmonic wave.

(b) Show that the phase of a wave changes (i) with time and (ii) with distance.

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3. (a) Obtain the relation connecting particle velocity and wave velocity.

(b) What is wavefunction? What is its significance ?

(c) When a longitudinal wave passes through a medium (liquid or gas) write down the expression for the pressure amplitude of the wave.

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4. (a) Explain the terms energy density and intensity of wave.

(b) Show that the intensity of a wave is proportional to the square of the amplitude.

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5. State the speed of sound in air ?

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6. (a) What happens when two sound waves of equal frequencies and amplitude travelling in the same direction are superposed ?

(b) Draw a diagram to show the formation of beats,

(c) Derive an expression for the beat frequency.

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7. (a) What are standing waves or stationary waves ?

(b) Show that when a transverse wave travels from a

rarer to a denser medium it gets reflected with a phase change of πt. Also prove that wien a transverse wave travels from a denser to rarer medium it gets reflected from the surface separating the two media without any phase change.

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8. (a) What are the characteristics of stationary wave?

(b) Derive an expression for the stationary wave using the expression prove that there is no transfer of energy in a stationary wave.

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9. (a) A string of length L is stretched between two rigid supports. It is plucked at the centre. What type of wave is formed in it? What is its frequency?

(b) Obtain expressions for the frequency of higher harmonics of vibrations of a stretched string,

(c) State the laws of vibrating string-

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10. Describe an experiment to verify the laws of reflection of light.

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11. (a) Draw diagrams to show the longitudinal mode of vibration and transverse mode of vibration of an electrically maintained tuning fork in the Melde's experiment.

(b) Indicate with the help of a diagram the positions of nodes and antinodes on a vibrating tuning fork.

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12. A vibrating toning fork is held at the mouth of (i) a closed pipe and (ii) an open pipe. Draw diagrams to show the formation of various modes. Obtain the frequency of the fundamental mode and

(ii) higher harmonics, in each case.

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13. Describe an experiment to estimate the speed of sound in air.

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14. (a) Explain the formation of stationary waves on a rod fixed at the middle.

(b) How is the speed of sound in (i) a liquid and (ii) a gas determined using a Kundt's tude.

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15. (a) Distinguish between transverse wave and longitudinal wave. Give one example of each type.

(b) A stretched string of length I and under a tension T, emits a note of fundamental frequency n. The tension is now reduced to T/2 and the vibrating length changed so that the frequency of the second harmonic is equal to n. Find out the new length of the string in terms of its original length.

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16. (a) What is Dappler effect?

The frequency r of a source of sound appears to be n' to a stationary listener when the source is moving with

velocity V_s away from him. The velocity of sound is V. Write an expression for n' in terms of r, V and V_s.

(b) Distinguish between the characteristics of progressive and stationary waves. Use diagrams to distinguish.

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Short Answer Questions

1. Give an example of a wave in one dimension.

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2. “Sound is an example of a wave in three dimensions." Why?

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3. What is a wave ? What are elastic waves ?

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4. What is the difference between a sound wave and a T. V. wave ?

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5. What is meant by (i) rarefaction (ii) condensation ?

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6. What are the characteristics of wave motion ?

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7. Is it possible to produce longitudinal wave and transverse wave in the same medium? Explain with an example.

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8. How are the wavelength and frequency of a sound wave related to its speed?

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9. Distinguish between Transverse and Longitudinal waves

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10. Using suitable diagram explain how sound wave propagates through air from a vibrating tuning fork?

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11. Draw diagrams to show the instantaneous positions of the vibrating particles of a medium at time t=0, T/4, T/2 and T when a transverse wave propagates through it.

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12. Explain the terms crest and trough in relation to a transverse wave.

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13. Is it possible to represent a longitudinal wave using crests and troughs ?

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14. Draw the displacement-time graph of a longitudial wave. On the diagram mark the region of compression and region of rarefaction.

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15. Draw the pressure-distance graph of a longitudinal wave. Compare it with the displacement-graph. What can you conclude from the graph ?

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16. What do we represent a wave using the equation, $y = A\sin(\omega t + \triangle\phi)$? What is the meaning of each symbol ?

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17. For a wave propagating in the positive x direction the instantaneous displacement of the particle is $y = A\sin\frac{2\pi}{T}\left(t - \frac{x}{v}\right)$. What is the significance of the negative sign ? If positive sign is used, what does it represent?

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18. What is meant by phase of a wave ?

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19. If $\triangle \phi$ denotes phase difference, then explain the meaning of the following two equations.

(i) $\triangle \phi = \frac{2\pi}{T} \triangle t$ and $(ii) \triangle \phi = \frac{2\pi}{\lambda} x$

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20. Write down the wave equation in four different forms.

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21. State any two characteristics of a plane progressive wave.

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22. What is meant by (i) particle velocity and (ii) wave velocity. How are they related ?

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23. Write down the differential equation of a plane progressive wave.

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24. What is meant by wave-function? What is its significance ?

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25. Write down the equation for the excess pressure when a wave propagates through a medium.

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26. What is meant by the intensity of a wave ?

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27. Show that the intensity of a wave is proportional to the square of the amplitude.

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28. Is it possible to have a wave which is neither longitudinal nor transverse ?

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29. Name one property of waves that do not change when the wave passes from one medium to another.

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30. Obtain an expression for the volume strain in a medium when a longitudinal wave propagates through the medium.

Watch Video Solution

31. Name a property common to both longitudinal and transverse wave.

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32. The ratio of the densities of oxygen and nitrogen is 8:7. In which gas the intensity of sound heard is maximum?

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Superposition Of Waves Beats Stationary Waves

1. State the principle of superposition ? Why do we use the phrase 'algebraic sum' in the statement ?

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2. How should two waves superpose each other such that there is (i) constructive interference and (ii) destructive interference.

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3. When a crest and trough of equal implitude and wavelength superpose there is destructive interference. What happens to the energy?

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4. When two waves of amplitudes A_1 and A_2 superpose each other what is the ratio of maximum intensity to the minimum intensity.

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5. What are beats? What is beat frequency?

Watch Video Solution

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6. What is the beat frequency which a human ear can distinguish?

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7. Draw diagrams to show the formation of beats?

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8. Mention the applications of beats,

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9. Draw a diagram to show the shape of a square wave pulse on a string when it gets reflected from (i) fixed boundary and (ii) a free end boundary.

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10. Can we apply the principle of superposition to both types of waves ?

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11. A longitudinal wave travels from a rarer medium to a denser medium and gets reflected. Draw a diagram to explain the reflection

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12. When a longitudinal wave travels from one medium to another, a compression is reflected as a rarefaction. What can you say about the medium ?

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13. What are normal modes?

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14. Assertion: Stationary waves are so called because particles are at rest in stationary waves.

Reason: They are formed by the superposition of two identical waves travelling in opposite directions.

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15. How much energy is carried by a standing wave?

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16. What are nodes and antinodes?

Watch Video Solution

17. What is the distance between (i) two consecutive nodes or antinodes (ii) a node and an antinode for a standing wave.

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18. Give the name of the points in a stationary wave at which (i) velocity is zero (ii) displacement is zero and (iii) strain is maximum.

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19. Write down the expression for the stationary wave.

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Watch Video Solution

20. In the stationary wave equation which part represents the variation in the amplitude.

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21. Nezne the points at which the phase of the vibrating particles in a stationary wave change suddenly.

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22. Explain the terms (i) fundamental frequency (ii) harmonics and (iii) overtones.

Watch Video Solution

23. Can we always call the second harmonic as the first overtone? Give examples.

Watch Video Solution

24. Draw a diagram to show the various modes of vibration of a stretched string.

Watch Video Solution

25. Write down the frequency of the nth harmonic of a stretched string.

Watch Video Solution

26. Why rubber strings are not preferred in a sonometer ?

Watch Video Solution

27. What are the frequencies heard when a stretched wire is plucked in the middle ?

Watch Video Solution

28. If the temperature of the wire in a sonometer is increased what happens to the frequency of the sound heard?

Watch Video Solution

29. "The strings used in a sitar are of different thickness and different materials." Why?

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30. The string in E sonometer is touched lightly at a point one-third of its length from one end. Which harmonics is produced ?

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31. "The weights used 10 stretch the wire in a sonometer is immersed in water." What happens to the frequency?

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32. If the weight suspended in a sonometer wire is made nine times. (assume the wire does not break). Will the frequency of vibration of the wire becomes exactly thrice? Give reasons.

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33. Four wires of identical lengths, diameters and materials are stretched on a sonometer box. What is the ratio of the tensions in the wires such that the ratio of their fundamental frequencies is 4:3:2:1?

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34. What is the fractional change in tension in a sonometer wire of constant length to produce a note one octave lower than the previous note?

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35. State the laws of vibrating strings.

Watch Video Solution

36. What is the ratio of the number of loops in a Meldes' string, when the string vibrates in longitudinal mode and transverse mode.

Watch Video Solution

37. Draw diagrams to show the loop formation in a vibrating tuning fork.

Watch Video Solution

38. When a tuning fork vibrates will there be any overtones present ?

Watch Video Solution

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

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40. What is the fundamental frequency of vibration of air in (i) an open pipe and (ii) a closed pipe.

Watch Video Solution

41. Write down the expression for the nth harmonic in (i) closed pipe (ii) an open pipe.

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42. What should be the ratio of the lengths of a closed pipe and an open pipe, so that the frequency of their First overtones are the same.

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43. What is meant by the end correction ?

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44. There are two similar organ pipes. When they are sounded together they produce the fundamental note of the same frequency. Now the length of one of the pipes is reduced and they are sounded together. What will happen?

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45. "The sound produced by an open pipe is sweeter than that from a closed pipe." Way ?

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46. What is the effect of temperature and pressure on the frequency of note emitted by an organ pipe ?

Watch Video Solution

47. Why we use air columns in musical instruments ?

Watch Video Solution

48. The frequeny of the fundamental note emitted from an organ pipe is 200 Hz. When sir is blown forcefully the frequency of the first overtone emitted is 600 Hz. Is the pipe open or closed ?

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49. There are two organ pipes of exactly the same length and material but of different diameters. Will their fundamental frequencies be equal ?

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50. An organ pipe has a frequency n. If its length is doubled what happens to the frequency?

Watch Video Solution

51. In the resonance column experiment, why do we use water ? Can we use any other liquid ?

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52. "In a resonance column experiment, when the length of the air column is increased by changing the water level sound heard becomes louder." Why?

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53. Write down the equation for finding the frequency of a fork, using another fork of known frequency.

Watch Video Solution

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54. How will you determine the velocity of sound in a gas using Kundts tube?

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55. Write down the expression for finding the velocity of sound in a liquid using a Kundts tube.

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Doppler Effect Musical Sound Noise

1. Name the factors on which Doppler effect depend.

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2. Is it possible that the apparent frequency of the sound heard by a moving listener is the same as the true frequency ? If so give an example,

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3. What is red shift? What does it signify?

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4. A source of sound moves towards an observer

Watch Video Solution

5. With what velocity a person should move so that he hears an octave of the note produced by a source at rest?

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6. Can we apply Doppler effect to a source of sound moving faster than the velocity of sound?

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7. Distinguish between music and noise.

Watch Video Solution

8. State three characteristics of musical sound.

Watch Video Solution

9. What is a decibel ?

Watch Video Solution

10. What is the loudness corresponding to the threshold of hearing ?

Watch Video Solution

11. What is Phon?

Watch Video Solution

12. How will you distinguish between two sounds of same pitch and loudness emitted from two different Sources ?

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13. What is meant by an octave.?

Watch Video Solution

14. What is meant by a diatonic scale ?

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15. Distinguish between major tone and minor tone.

Watch Video Solution

16. What is noise?

Watch Video Solution

17. What are noise sources?

Watch Video Solution

18. How will you classify the noise sources?

Watch Video Solution

19. State any two harmful effects of noise pollution on human health.

Watch Video Solution

20. State any two harmful effects of noise pollution on human health.

Watch Video Solution

21. Write a note on noise reduction and noise control.

Watch Video Solution

22. What are ultrasonics?

Watch Video Solution

23. Mention three applications of ultrasonic waves.

Watch Video Solution

24. What is supersonic speed?.

Watch Video Solution

25. What is Mach number?

Watch Video Solution

26. Distinguish between Mach 1 and Mach 2.

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Very Short Answer Questions

1. Name the properties which a material medium should have in order that a wave propagates through it.

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2. When a wave passes through a medium, what type of motion do the particles execute ?

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3. Is it possible to produce transverse in air ?

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4. What type of wave motion is observed by a person standing near the sea-coast ?

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5. When a wave propogates through a medium what is the direction of vibrations of the particles, if thewave is (i) transverse and (ii) longitudinal

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6. “Longitudinal waves are called pressure waves" Why?

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7. Compared to air sound heard is more in carbon dioxide why?

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8. What is the nature of wave produced in a lake, due to an explosion inside the lake ?

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9. A flute contains a number of holes of different positions Why?

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10. A sitar contains a number of wires of different thickness Why?

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11. 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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12. In sound, beats are heared when two independent sources are sounded together. Is it possible in the case of sources of light ?

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13. Why a stationary wave is called so ?

Watch Video Solution

14. The temperature of an organ pipe when it is in resonance with a tuning fork is increased. How does the resonant length change?

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Selected Problems From Wave Equation Intensity Energy Density

1. How far does sound travel in air when a tuning fork of frequency 480 Hz completes 50 vibrations. Velocity of sound is 348 ms^{-1}.

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2. A broadcasting station radiates at a frequency of 555 kHz. What is the wavelength ? Given velocity of wave is $3 \times 10^{8} ms^{-1}$.

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3. What is the amplitude, the wavelength and velocity of the wave represented by y(x, t)= 5 sin x and y are in metre?

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4. The equation of a transverse wave travelling along x-axis is given by y = 10 sin π = (0.01 x- 2.0t) where y and x are represented in centimeters and, in seconds. Find the amplitude, frequency velocity and wavelength of the wave.

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5. A plane progressive wave is given by $y = 0.3 \sin\left(\frac{220}{7}t - 25.12x\right)$

Find the wavelength and the phase difference between two points at r= 0.3 m and r=0.425 m. Also find the maximum particle velocity.

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6. A plane progressive wave is given by $y = 3 \times 10^{-7} \sin(8500t - 25x)$, where t is in second y is in m. Find the amplitude, and phase difference between two points separated by a distance 0.01m.

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7. The phase velocity of a wave of frequency 500 Hz is 400 m/s (i) How far apart are two points 61° out of phase? (ii) Calculate the phase difference between two displacements atá certain point at times 10^{-3} apart

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8. A wave has an amplitude of 0.02 m, frequency 660 Hz and velocity 330 m/s. If the wave propagates along the negative X-direction what is equation for the wave?

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9. A progressive wave of frequency 550 Hz is travelling with a velocity of 360 ms How far apart are the two points 60° out of phase ?

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10. Given $y = 0.8 \sin 6\pi \left[t + \frac{x}{40} \right]$ metre. Calculate the wavelength and velocity of the wave represented by this equation.

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11. The equation for the transverse wave travelling along a string is y = 4 sin $2\pi \left(\frac{t}{0.05} - \frac{x}{60} \right)$ lengths expressed

in cm and time period in sec. Calculate the wave velocity and maximum particle velocity.

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12. Obtain the equation of a harmonic wave travelling in the negative x-direction with the characteristics given below. Amplitude is 4.5 cm, wavelength is 20 cm, wåve velocity is $40ms^{-1}$?

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13. A broadcasting station radiates at a frequency of 710 kHz. What is the wavelength ? Velocity of light

$= 3 \times 10^8 \ \ \mathrm{m/s}.$

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14. How far does the sound travel in air when a tuning fork of frequency 500 Hz completes 25 vibrations ? Velocity of sound in air is 332 ms^{-1}.

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15. What is the wavelength of a wave frequency 262 Hz in water if the wave velocity is $1480ms^{-1}$ in water?

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16. A plane progressive wave propagating through air has an amplitude of $10^{-3}m$ and a frequency of 480 Hz. Calculate the energy density and intensity of wave. Given velocity of wave $= 340ms^{-1}$ and density of air $= 1.29\text{kg m}^{-3}$.

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17. The intensity of a wave propagating through air is $0.22Wm^{-2}$. If the frequency of the wave is 500 Hz calculate the displacement amplitude ? [Density of air$=1.29\text{ kgm}^3$, speed of sound in air= 340 m/s]

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18. The ratio of the velocity of a wave in two media (1) and (2) is 2:1 and the ratio of their density is 3:1. When the wave enters the second medium the intensity is reduced to half of its value in the first medium. Find the ratio of the amplitude of the wave in the two media ?

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19. The intensity of a wave emitted from a small source at a distance 10 m is $20 \times 10^{-3} \mathrm{Wm}^{-2}$. What is the intensity at a distance 100 m ?

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20. The amplitude of the sound wave emitted by a source is $10^{-3}m$. If the frequency of sound is 600 Hz, what is (i) the energy per unit volume and (ii) the intensity of sound ? Speed of sound = 340 m/s, Density of air $= 1.29\,\mathrm{kg/m^3}$.

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21. For a plane harmonic sound wave of frequency 1000 Hz in air, the pressure amplitude is $1\,\mathrm{N/m^2}$? What is the displacement amplitude ? Atmospheric pressure is $1.01 \times 10^5\ \ \mathrm{N/m^2}, \gamma = 1.4$. Velocity of sound in air is $340ms^{-1}$? .

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22. What is the frequency of a sound wave with a displacement amplitude $1.1 \times 10^{-5} m$ and pressure amplitude $28\ \mathrm{N/m^2}$?

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23. The intensity of a point source emitting sound at distance 3 from the source is 0.707 W/m^2? What is the average power output of the source ?

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24. A wave travelling along the length of a string is shown in Fig. 14.4.12. Using the scale on the given axis, find

(i) The amplitude of the wave

(ii) The wavelength of the wave

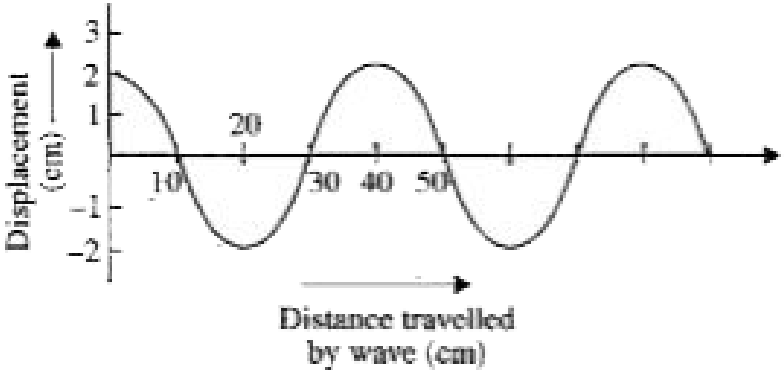
(iii) If the frequency of the wave is 10 Hz, What is the speed of the wave?

(iv) What is the initial phase of the wave ?

(v) What is the phase difference between two points separated by a distance 10 cm ?

(vi) If this wave is made to travel through water what is the wavelength of the wave, if the speed of, the waves in

water is 10 m/s.



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From Sound Wave Velocity

1. Find the velocity of sound in air at NTP. The density of air is $1.29 kgm^{-3}$, γ for this is 1.42?

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2. The density of a solid is $8930 kgm^{-3}$ and its young's modulus is 117GPa. What is the velocity of sound in the solid?

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3. A stone dropped from the top of a tower of height 300 m high splashes into the water of a pond near the base of the tower. When is the splash heard at the top ? Given that the speed of sound in air is $340 ms^{-1}$? $(g = 9.8 ms^{-2})$.

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4. The speed of a wave in a medium is $960ms^{-1}$. If 3600 waves are passing through a point in the medium in one minute then calculate the wavelength.

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5. The speed of a sound in an aluminiurn bar is 5.1 km/s If its density is 2700 kg/m^2. what is its Young's Modulus ?

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6. The bulk modulus of mercury is 2.8×10^{10} $\mathrm{N/m^2}$ and the density is 13600 $\mathrm{kg/m^2}$. What is the speed of sound in mercury ?

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7. Two persons stand near a railway line separated by a distance 2 km. A detonator is exploded by the first person. The second person 2 km away hears two sounds, one from the sound that has travelling through the rail and the other through the air. What is the interval between them? Given Young's modulus of steel $= 2 \times 10^{11} N/m^2$. Density of steel = 8000 kg/m^3. Density of air = 1.29 kg/m^3. Atmospheric pressure $= 1 \times 10^2 N/m^2$. y for air = 1.4

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8. The density of water at $29^{\circ}C$ is 996 kgm and an increase of pressure of $10^{6}\ \mathrm{N/m^{2}}$ diminishes the volume of 10^-3 m 3of water by $0.5 \times 10^{-6} m^{3}$. What is the velocity of sound in water at $29^{\circ}C$.

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9. What is the ratio of specific heats for hydrogen ? Given density of hydrogen at STP = 0.09 kg/m^{3}. Velocity of sound in hydrogen at STP= 1255 m/s.

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10. What is the percentage increase in the speed of sound when temperature increases from -5 $^{\circ}C$ 10 $32^{\circ}C$?

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11. Find the velocity of sound in O_2 at NTP. Given that the velocity of sound in the H_2 at NTP is $1880ms^{-1}$ the density of oxygen is 16 times the density of hydrogen $\gamma = 1.4$ for both the gases.

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12. Find the velocity of sound in O_2 at NTP. Given that the velocity of sound in the H_2 at NTP is $1880ms^{-1}$ the

density of oxygen is 16 times the density of hydrogen $\gamma = 1.4$ for both the gases.

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13. At normal temperature and pressure, the speed of sound in air is $332 ms^{-1}$. What will be the speed of sound in hydrogen (i) at normal temperature and pressure (ii) at $819^{\circ} C$ temperature and 4 atmospheric pressure. Given air is 16 times heavier than hydrogen.

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14. The speed of longitudinal waves in a mixture of He and Ne was found to be $760ms^{-1}$ at $30^{\circ}C$. Find the composition of the mixture. Both He and Ne ate monoatomic. Assume their molecular masses, Molar-mass of He=0.004 kg, Molar mass of ne=0.02 kg

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15. Speed of sound in gas x is $1270ms^{-1}$?. Calculate the speed of sound in the mixture of gas y and gas x in which they are mixed in 1: 8 ratio, given of ratio densities of the two gases is 6:1

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16. In a gas sound travels at a speed of $315ms^{-1}$ at NTP, If $R = 8.3Jmol^{-1}K^{-1}$ identify the gas.

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17. On a certain day sound is found to travel 1.4 km in 4 second in air. Calculate the average temperature of air. $V_0 = 331\ \mathrm{m/s}^{-1}$.

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18. Compare the velocities of sound in Argon and Oxygen. γ of O_2 and Argon are 1.4 and 1.67 respectively.

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19. Calculate the wavelength of sound emitted by a tuning fork which makes 240 vibrations per second at $27^{\circ} C$. Velocity of sound in air at 0° C is $330 \mathrm{~ms}^{-1}$.

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20. An observer saw a flash of lightning and after 8 seconds heard the thunder. If the average temperature of air is $17^{\circ} C$, how far away did the lightning occur ? Velocity of sound in air at $0^{\circ} C$ is $331 \mathrm{~ms}^{-1}$.

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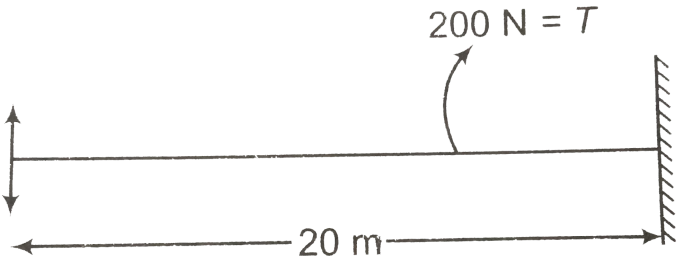
21. A string of mass 2.5 kg is under tenstion of 200N . The length of the stretched string is 20.0 . If the transverse jerk is struck at one end of the string, the disturbance will reach the other end in



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22. A steel wire has a length of 12.0 m and a mass of 2.10 kg. What should be the tension in the wire, so that the speed of transverse wave on the wire equals the speed of sound in dry air at $20^{\circ}C$? $\left(i.e, 343ms^{-1}\right)$?

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23. A wire of radius $10^{-3}m$ and length 2m is stretched by a force of 50 N. Calculate the fundamental frequency of the note emitted by it. Density of wire is $1.6. \times 10^{3} \ \mathrm{kg\,m^{-3}}$.

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24. A string of length 2m and mass 2 gmn is stretched by a certain tension so that it vibrates in 4 segments with a frequency of 600 Hz. What is the tension ?

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25. A string when stretched with a force of 18 kg it produces a note of frequency 652 Hz. What is the force required to produce an octave of the note?

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26. When the tension of a sonometer is increased by 4.5 kg the pitch of the note emitted by a given length of the wire increases in the ratio 4: 5. Calculate the original tension in the wire ?

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27. Two strings (1) and (2) of equal thickness are made up of the same material. The length of the first string (1) is half that of the second string (2), while tension is (1) is twice that in the string, (2). Compare the velocities of the transverse waves on them.

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28. A copper wire is held at the two ends by rigid supports. At $30^{\circ}C,$ the wire is just taut with negligible tension, Find the speed of transverse wave in the wave at $10^{\circ}C.$ Given : Coefficient of linear expansion is $1.7 \times 10^{-5} l^{\circ}C$ Young's modulus $= 1.3 \times 10^{11} \mathrm{N/m}^2$ Density $= 9 \times 10^3 \ \mathrm{kg\,m}^{-3}.$

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29. When the tension of a sonometer wire is increased by 25% the fundamental increases by 10 Hz. If its length is increased by 25 % what will be the new frequency?

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30. Explain how the bridges should be placed in order to divide a wire 1.10 m long into three segments whose fundamental frequencies are in the ratio 2:3:4.

Watch Video Solution

31. A wire stretched between two rigid supports vibrates in its fundamental mode with a frequency of 45 Hz. The mass of the wire is 3.5×10^{-2} kg an dits linear mass density is $4 \times 10^{-2} kg/m$. What its

(i) the speed of transverse wave in the wire and

(ii) the tension in the wire ?

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32. A sitar wire 1 m long emits a note of frequency 480 Hz. How far from the top it may be pressed to get a note of frequency 512 Hz.

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33. A tuning fork is in unison with 1.0 m length of sonometer wire. When the stretching weights are immersed in water, the length of the wire in unison with the same tuning fork is 0.934 m. Calculate the density of the material of the weights ?

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34. A wire 0.5 m long vibrates 100 times a second. If the length of the wire is shortened to 0.4 in and the stretching force is increased to 4 times its original value what will be the new frequency?

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35. The fundamental frequency of a wire of certain length is 400 Hz. When the length of the wire is decreased by 10 cm, without changing the tension in the wire, the frequency becomes 500 Hz. What was the original length of the wire ?

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36. Three strings of equal lengths but stretched with different tensions are inade to vibrate. If their masses per unit length are in the ratio 1:2:3 and the frequencies are the same, calculate the ratio of the tensions.

Watch Video Solution

37. What is the frequency of the fundamental note emitted by a wire of length 2 m and radius 1 mm under a tension of 200 N. Density of the wire is $1600\ \mathrm{kg/m^3}$.

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From Organ Pipes

1. An open end organ pipe is 0.50 m long. If the velocity of sound is $320 ms^{-1}$, find the frequency of the fundamental note.

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2. What will be the wavelength and pitch of the note emitted by a closed organ pipe 32.4 cm long at $0^{\circ}C$ if the velocity of sound in air at $0^{\circ}C$ is $332ms^{-1}$.

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3. A pipe 20 cm long is open at both ends. Which harmonic of mode of the pipe is resonantly excited by a 1.66 kHz Given : velocity of sound $= 332ms^{-1}$.

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4. The frequency of the fundamental note of a tube closed at one end is 200 Hz. What will be the frequency

of the fundamental note of a similar tube of the same length but open at both ends ?

Watch Video Solution

5. The fundamental frequency of an open organi pipe is 330 Hz. The first overtone of a closed organ pipe has the same frequency as the first overtone of the open pipe. How long is each pipe 2 Velocity of sound =330 m/s.

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6. An open organ pipe produces a note of frequency 512 Hz at $15^{\circ}C$. Calculate the length of the pipe. Velocity of

sound at $0^{\circ} C$ is $335 \mathrm{~ms}^{-1}$.

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7. The fundamental frequency of a vibrating organ pipe is 200 Hz.

Watch Video Solution

8. The frequency of the first overtone of an open pipe is 300 Hz. What is the fundamental frequency?

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9. A pipe closed at one end, produces a fundamental note 412 Hz. It is now cut into two pieces of equal length. What will be the frequency of the fundamental note produced by each piece?

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10. Show that an organ pipe of length 2l open at both ends has the same fundamental frequency as another pipe of length I closed at one end.

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11. What is the fundamental frequency of a closed pipe of length 25 cm filled with carbon dioxide. Velocity of sound in CO_2 is 266 ms^{-1}.

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12. A closed pipe of length 1 m emits the fundamental note. What is the percentage change in the frequency when the temperature is changed from $30^\circ C$ to $45^\circ C$.

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13. In a resonance column the first resonant length is 0.16 in using a tuning fork of frequency 512 Hz. If the diameter of the tube is 0.025 m, calculate the velocity of sound ?

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14. An excited tuning fork of frequency 512 Hz is held over the open end of a tall jar and water is slowly poured into it. Resonance was first observed at a level and then at a higher level. Calculate the difference in heights of the two levels. Velocity of sound in air at the time of experiment is 346 m/s.

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15. When a fork of frequency 512 Hz in sounded, the difference in level of water in tube between two successive positions of resonance is found to be 0.33 m. What is the velocity of sound in air ?

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16. In a resonance tube, using a tuning fork of frequency 325 Hz, two successive resonance lengths are observed at 25.4 m and 77.4 cm respectively. The velocity of sound is air is

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17. A fork of frequency 325 Hz is held over a resonance cube appartus and the shortest resounding length of the tube was 0.254 m. What is the next resounding length of the velocity of sound at that temperature was 325 m/s.

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18. A fork of frequency 250 Hz is held over a tube and maximum resonance is obtained when the column of air is 0.31 m or 0.97 m. Determine (i) the velocity of sound (ii) the end correction and (iii) the radius of the tube.

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19. A copper rod 1 m long and clamped at a point distant 25 cm, from its end is set in longitudinal vibrations and is used to produce stationary waves is a Kundt's tube containing air at $30^{\circ} C$. Heaps of lycopodium dust are found to be 4.95 cm apart. What is the velocity of longitudinal waves in copper ? Velocity of sound in air at $0^{\circ} C = 332\ \mathrm{m/s}$.

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20. A rod 100 cm in length and of material of density $8 \times 10^3\ \ \mathrm{kg/m^3}$ is clamped at the centre and attached to a Kundt's tube containing air. The distance between the first and the tenth node when the rod is stroked

longitudinally is 135 cm. If the velocity of sound in air is 330 m/s determine the Young's modulus of the material of the rod.

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21. In Melde's experiment it was found that the string vibrated in three loops wien 8 gm were placed on the scale pan. What mass must be placed on the pan to make the string vibrate in six loops? (Neglect the mass of the string and the scale pan]

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22. In Melde's experiment when the tension is 100 gm and the fork vibrates at right angles to the direction of the string, the latter is thrown in four segments. If now the fork is set to vibrate along the string, find what additional load will make the string vibrate in one segment ?

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From Beats

1. A tuning fork of unknown frequency produoed 4 beats per second when sounded with a standard fork of frequency 256 Hz. The beat frequency decreased when a

little wax was pot on a prong of the first fork. What was the frequency of the fork before loading it with wax ?

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2. Frequencies of two tuning forks are in the ratio 20:21. When sounded together 8 beats are heard per second. What are their frequencies :

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3. Two notes of wavelength 2.08 m and 2.12 m produce 180 beats per minute in a gas, Find the velocity of sound in the gas.

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4. 64 tuning forks are arranged in order of increasing frequency and any two successive forks give foor beats per second when sounded together. If the last fork gives the octave of the first, calculate the frequency of the latter.

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5. Wavelength of two notes in air are 68/176 m and 68/174 m each note produces five beats per second with a third note of fixed frequency. Calculate the velocity of sound in air?

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6. A tuning fork of frequency 256 produces 4 beats per second with another tuning fork B. When the prongs of B are loaded with 1 gm wt, the number of beats is 1 per second and when loaded with 2 gm wt, the number of beats becomes 2 per second. What is the frequency of B?

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7. Two similar sonometer wires of the same material under the same tension produces 3 beats per second. The length of one wire is 40 cm and that of the other is 40.1 cm. Calculate the frequency of the two wires ?

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8. When the wire of a sonometer is 73 cm long, it is in resonance with a tuning fork. On shortening the wire by 0.5 cm, it makes 3 beats per second with the same fork. Calculate the frequency of the tuning fork?

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9. Using a movable knife edge, the two parts of a sonometer wire with total length 4 m is divided into two parts, such that they differ in length by 8 mm and produce 4 beats per second when sounded together. Calculate their frequencies.

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10. Two perfectly identical wires are in unison. When the tension in one wire is increased by 1% then on sounding them together 3 beats are heard in 2 seconds. Calculate the intial frequency of each other?

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11. Using a tuning fork of frequency 512 Hz, the string of a sorcmeter has to be tuned. When they are vibrated together they produce 10 beats per second. By what percentage should the length of the string he altered to achieve tuning, the tension remaining the same.

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12. A tuning forke is in unison with a resonance column of length 17 cm. When the length is increased by 1 mm, three beats are heard in one second. What is the frequency of the fork? Neglect the end correction?

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13. Two open organ pipes of lengths 60 cm and 60.5 cm produce 2 beats per second. Calculate the velocity of sound in air.?

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14. When two closed organ pipes at $0^{\circ}C$ are sounded together 20 beats are heard in 4 seconds. How many beats will be heard per second when the temperature is $100^{\circ}C$. The increase in length of the pipes due to rise in temperature may be neglected.

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15. Two organ pipes of lengths 50cm and 50.5 cm long are sounded together, 3 beats per second are heard. Find their frequencies ?

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From Doppler Effect

1. A car moving with a speed of $30ms^{-1}$ is approaching a factory whistle having the frequency 700 Hz. Calculate the apparent pitch of the whistle as heard by the driver of the car ? (Velocity of sound = 350m/s)

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2. At what speed should a car approach a stationary observer if the hears the music of the car radio with a frequency 20% higher than it actully is ? The speed of sound is $340ms^{-1}$

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3. A source of sound of frequency 256 Hz moves rapidly towards a wall with a velocity of $5ms^{-1}$. How many beats per second will be heard if sound travels at a speed of 330 m/s?

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4. A train standing at the outer signal of a railway station, blows a whistle of frequency 400 Hz in stil air. (i) What is the frequency of the whistle for a platform observer when the train (a) approaches the platform with a speed of $10ms^{-1}$. (b) recedes from the platform

with a speed of 10 ms ? What is the speed of sound in each case? $\left(V = 340 ms^{-1}\right)$.

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5. A tunning fork of frequency 512Hz approaches a wall with a velocity of $4ms^{-1}$. How many beats are produced between the direct and the reflected sound if the velocity of sound is $332ms^{-1}$?

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6. A police woman blows a whistle of frequency 500 Hz. A car speeds past her with a velocity of $72kmh^{-1}$. Find

the charge in frequency heard by the driver of the car just as he passes the police woman. Velocity of sound = $350ms^{-1}$.

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7. A car B, with a hom of frequency 700 Hz moves with a velocity $90kmh^{-1}$. It approaches another car A, coming towards it with a velocity $72kmh^{-1}$. Calculate the apparent frequency of the sound heard by the driver in the car A (a) before crossing (b) after crossing ? Velocity of sound $= 350ms^{-1}$.

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8. A source and an observer is approaching closer with a relative velocity of $40ms^{-1}$. If the true frequency of the source is 1200 Hz calculate the observed frequency under these conditions: (i) the source alone is moving (ii) the observer alone is moving. Take velocity of sound in air to be $340ms^{-1}$.

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9. A policeman on duty detects a drop of 10% in the pitch of the hom of a motor car as it crosses him. If the velocity of sound is 330 m/s calculate the speed of car?

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10. A whistle of frequency 500 Hz is rotated in a circle of radius cne metre with an angular speed of 10 radian/sec. Calculate the lowest and the highest frequency heard by a listener at a long distance away at rest with respect to the centre of the circle ? (Velocity of sound = 340m/s)

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11. Afrain approaches a stationary observer, the velocity of train being (1/20)th of the velocity of sound. A sharp blast is blown with the whistle of the engine at equal intervals of a second. Find the interval between the successive blasts as heard by the observer.

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12. A whistle giving 700 Hz moves away from a stationary observer towards a wall with a velocity of 2 m/s. How many beats per second are heard by the observer ? [Velocity of sound = 348m/s]

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13. Two trains approach each other along pentiel tancks each moving with a velocity 2 m/s. A whistle of frequency 250 Hz is sounded on ench train. Find the frequency of hers between the two suces as heard by the listener on the other train. Velocity of sound is 332 ms.

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14. A and B are two identical sound sources cachemitting a note of frequency 1000 Hz. A person moves from A to B along the line joining the two sources. How fast should be move to that he has 7 beats per second. velocity of sound 330 m/s ?

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15. Is it possible for a observer to move towards a stationary source emitting red light so that the red light appears to be green for the observer ? Wavelength of green is 5400Å and that of red is 6200A. Velocity of light is $3 \times 10^8 \ \ \mathrm{m/s}$.

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16. Microwaves are reflected from a distant airplane approaching a stationary observer. It is found that when the reflected waves beat against the waves radiating from the source, the beat frequency is 900 Hz. Calculate the approach speed of the airplane if the wavelength of the microwave is 0.1 H. Velocity of microwave is $3 \times 10^8 \ \mathrm{m/s}$.

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From Musical Sound

1. Intensity level at a point is 100 dB. How much is the actual intensity of sound falling at that point ? Given threshold intensity of sound is $10^{-12}\mathrm{Wm}^{-2}$.

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2. The intensity of sound from a public loud speaker is $1\mu\mathrm{watt\ m}^{-2}$ at a distance of 5 m. What is the intensity at a distance of 100 m ?

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3. Find the sound level in decibels of a sound wave which has a intensity of $10^{-6}Wm^{-2}$, if $\mathrm{I}_0 = 10^{-12}Wm^{-2}$.

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4. A car sounding a horn producing a note of 500 Hz., approaches and then passes a stationary observer at a steady speed of $15ms^{-1}$?. Calculate the change in pitch of the note heard by the observer. (Velocity of sound $= 340ms^{-1}$).

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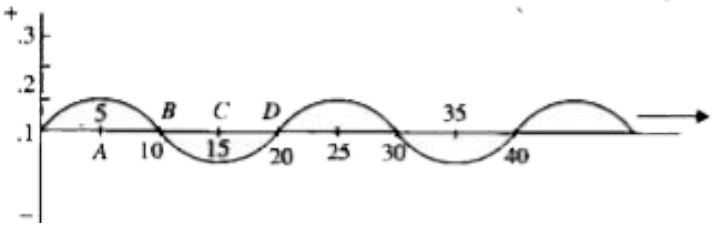
5. The graph below shows the instantaneous displacements due to a progressive longitudinal wave travelling with velocity $40ms^{-1}$. along the line ABCD. (See Fig. 14.4.13).



(a) What is the frequency of the particles of the medium ?

(b) What is the phase difference between vibrations at A and B ?

(c) At which of the points A, B, C, D is the instantaneous particle velocity maximum forward ?

(d) At which of the points A, B, C, D is there a compression ?

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6. A tuning fork of frequency 256 Hz produces 4 beats per second when sounded with a stringed instrument. What is the frequency produced by the instrument?

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7. A tuning fork produces resonance at length 27 cm of a pipe closed at one end. Calculate the length of the pipe open at both ends which will produce resonance with the same tuning fork.

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8. An open pipe is 85 cm long. If the velocity of sound is 340 ms^{-1}, find the frequency of the fundamental note of the pipe. What would be the length of a closed pipe which produces a fundamental note of the same frequency?

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9. An observer travelling with a constant velocity of $16.5ms^{-1}$, passes closes to a stationary source of sound and notices that there is a change of frequency of 50 Hz as he passes the source. Calculate the frequency of the source. $\left(\text{Speed of sound in air} = 330\ \text{ms}^{-1}\right)$.

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10. The equation below represents a progressive wave

$$y = 3 \times 10^{-7} \sin(8500t - 25x)$$

where t is in seconds x and y in metres. Calculate the speed of the wave and the direction of propagation.

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