PHYSICS

BOOKS - DHANPAT RAI & CO PHYSICS (HINGLISH)

WAVE MOTION

Others

1. A hospital uses an ultrasonic scanner to locate tumour in a tissue. What is the wavelength of sound in a tissue in which the speed of sound is $1.7 km / s$? The operating frequency of the scanner is $4.2 MHz$.

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2. A radio station broadcasts its programme at 219.3 metre wavelength. Determine the frequency of radio wave is velocity of radio waves be

$3 \times 10^8 ms^{-1}$.

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3. The audible range of a human ear is 20 Hz to 20 kHz. Convert this into corresponding wavelength range. The speed of sound at ordinary temperature is $340 m / s$.

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4. A bat emits ultrasonic sound of frequency 1000 kHz in air. If the sound meets a water surface, what is the wavelength of (i) the reflected sound, (ii) the transmitted sound ? Speed of sound in air is 340 ms^{-1} and in water $1486 ms^{-1}$.

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

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6. How far does sound travel in air when a tuning fork of frequency $560Hz$ makes 30 vibrations ? Speed of sound in air $= 336m/s$.

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7. A source of sound is placed at one end of an iron bar 2 km long. Two sounds are heard at the other end at an interval of 5.6s. If the velocity of sound in air is $330m/s$, find the velocity of sound in iron.

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8. Audible frequencies have a range 20 Hz to 20,000 Hz. Express this range in terms of (i) period T (ii) wavelength λ in air and (ii) angular frequency. Given velocity of sound in air is $330ms^{-1}$

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9. For aluminium , the modulus of rigidity is $2.1 \times 10^{10} Nm^{-2}$ and density is $2.7 \times 10^{3} kg/m^{3}$.Find the speed of transverse waves in the medium.

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10. The mass of a 4.0 m long wire is 0.01 kg, and it is stretched by a force of 400 N. What is the speed of transverse wave in the wire?

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11. A steel wire has a length of 12.0m and a mass of 2.10kg. What should be the tension in the wire so that speed of a transverse wave on the wire

equals the speed of sound in dry air at $20^{\circ}C = 343ms^{-1}$.

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12. A string of mass 2.50kg is under a tension os 200N. The length of the stretched string is 20.0m. If the transverse jerk is struck at one end of the string, how long does the disturbance take to reach the other end?

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13. 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 waves in the wire at $10^{\circ}C$. Given $\alpha = \left(1.7 \times 10^{-5}\right)^{\circ}C^{-1}$, $Y = 1.4 \times 10^{11}Nm^{-2}$ and $\rho = 9 \times 10^{3}kgm^{-3}$.

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14. In a sonometer experiment, the density of material of the wire used in $7.5 \times 10^3 kg/m^3$. If the stress of the wire is $3.0 \times 10^8 N/m^2$, find out the speed of transverse waves in the wire.

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15. For aluminium the bulk modulus and modulus of rigidity are $7.5 \times 10^{10} Nm^{-2}$. Find the velocity of longitudinal waves in the mediu. Density of aluminium is $2.7 \times 10^3 kgm^3$.

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16. For a steel rod, the Young's modulus of elasticity is $2.9 \times 10^{11} N/m^2$, and the density of steel is $8 \times 10^3 kg/m^3$.What is the velocity of longitudinal waves in steel?

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17. At a pressure of $10^5 N/m^2$, the volumetric strain of water is 5×10^{-5}. Calculate the speed of sound in water. Density of water is $10^3 kg/m^3$.

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18. Estimate the speed of sound in air at standard temperature and pressure. The mass of 1 mole of air is $29.0 \times 10^{-3} kg$, λ for air $= 7/5$.

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19. At what temperature will the speed of sound be double its value at 273K?

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20. By how much the wave velocity increases for $1^\circ C$ rise of temperature ?

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21. A tuning fork of frequency 220Hz produces sound waves of wavelength 1.5m in air at NTP. Calculate the increase in wavelength, when temperature of air in $27^\circ C$.

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22. Find the temperature at which sound travels in hydrogen with the same velocity as in oxygen at $1000^\circ C$. Density of oxygen is 16 times that of hydrogen.

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23. The speed of sound in air is $332 m/s$ at NTP. What will be its value in hydrogen at NTP, if density of hydrogen at NTP is $1/16th$ that of air ?

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24. At normal temperature and pressure, the speed of sound in air is 332 m/s. What will be the speed of sound in hydrogen at $546^\circ C$ and 2 atmospheric pressure ? Given air is 16 times heavier than hydrogen.

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25. What is the ratio of velocity of sound in hydrogen $(\gamma = 7/5)$ to that in helium $(\gamma = 5/3)$ at the same temperature?

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26. The ratio of densities of oxygen and nitrogen is 16 : 14. At what temperature, the speed of sound in oxygen will be equal to its speed in nitrogen at $14^\circ C$?

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27. Calculate the temperature at which sound travels in hydrogen with the same speed as in helium at N.T.P. The density of helium is twice that of hydrogen.

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28. A gas is a mixture of two parts by volume of hyprogen and part by volume of nitrogen at STP. If the velocity of sound in hydrogen at $0^\circ C$ is $1300 m/s$. Find the velocity of sound in the gaseous mixure at $27^\circ C$.

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29. The speed of sound in dry air at NTP is 332 metres /sec. Assuming air as composed of 4 parts of nitrogen and one part of oxygen, calculate velocity of sound in oxygen under similar conditions, when the densities of oxygen and nitrogen at NTP are in the ration of $16:14$ respectively.

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30. The equation of a plane progressive wave is give by equation

$y = 10 \sin 2\pi(t - 0.005x)$

where y and x are in cm and t is in seconds. Calculate the amplitude, frequency, wavelength and velocity of the wave.

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31. A transverse harmonic wave on a string is described by $y(x, t) = 3.0 \sin(36t + 0.018x + \pi/4)$ where x, y are in cm, t in second. The positive direction of x is from left to right . (i) Is this a travelling or stationary wave ? If travellying, what are the speed and direction of its propagation ? (ii) what are its amplitude and frequency ? (iii) what is the inital phase at the origing ? (iv) What is the least distance between two successive creests in the wave?

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32. For the travelling harmonic wave, $y(x, t) = 2.0 \cos 2\pi[10t - 0.0080x + 0.35]$. Where x and y are in cm and t is s, what is the phase difference between oscillatory motino at two points separated by a distance of (i) 4m (ii) 0.5m (iii) $\lambda/2$ (iv) $3\lambda/4$?

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33. A displacement wave is represented by

$\xi = 0.25 \times 10^{-3} \sin(500t - 0.025x)$

Deduce (i) amplitude (ii) period (iii) angular frequency (iv)wavelength (v) amplitude of particle velocity (vi) amplitude of particle acceleration . ξ, t and x are in cm, sec, and metre respectively.

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34. A travelling harmonic wave on a string is described by $y(x, t) = 7.5 \sin(0.0050x + 12t + \pi/4)$ (a) what are the displacement and velocity of oscillation of a point at $x = 1cm$, and $t = 1s$? Is this

velocity equal to the velocity of wave propagation ?

(b) Locate the point of the string which have the same transverse displacement and velocity as $x = 1cm$ point at $t = 2s, 5s$ and 11s.

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35. The speed of a wave in a streched string is $20ms^{-1}$ and its frequency is 50 Hz. Calculate the phase difference in radian between two points situated at a distance of 10 cm on the string.

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36. Write the equation of a progressive wave propagating along the positive x-direction, whose amplitude is 5cm, frequency 250Hz and velocity 500 m / s.

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37. For the plane wave $y = 2.5 \times 10^{-0.02x} \cos\left(800t - 0.82x + \frac{\pi}{2}\right)$, write down

(i) the general expression for phase ϕ

(ii) the phase at x=0, t=0

(iii) the phase different between the point separated by 20 cm along x-axis.

(iv) the change in phase at a given place 0.6 milli second and

(v) the amplitude at x=100m.

Take units of y,t,x as $10^{-5} cm$, s and m respectively.

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38. A simple harmonic wave train of amplitude 1 cm and frequency 100 vibration is travelling along positive x-direction with a velocity of $15 ms^{-1}$. Calculate displacement y , the particle velocity and particle acceleration at $x = 180 cm$ from the origin at $t = 5$ s.

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39. A certain spring has a linear mass density of $0.25 kgm^{-1}$ and is stretched with a tension of 25 N. One end is given a sinusoidal motion with frequnecy 5 Hz and amplitude 0.01 m. At time t=0, the other end has zero displacement and is moving in the positive y-direction.

(i) Find the wave speed, amplitude, angular frequnecy, period, wavelength and wave number.

(ii) Write a wave function representing the wave.

(iii) Find the position of the point at x=0.25m at time t=0.1s.

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40. A simple harmonic wave has the equation,

$\xi = 0.5 \sin(314t - 1.57x)$

where t, x and ξ are in second, metre and centimetres respectively. Find the frequency and wevelength of this wave. Another wave has the equation

$\xi = 0.1 \sin(314t - 1.57x + 1.57)$

Deduce the phase difference and ratio of intensities for the above two waves.

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41. For plane waves in the air of frequency 1000 Hz and the displace amplitude $2 \times 10^{-8} m$, deduc (i) the velocity amplitude, and (ii) the intensity. (Take p= $1.3 \frac{kg}{m^3}$, c=340 m/s)`

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42. A 5W source sends out waves in air at frequency $1000 s^{-1}$. Deduce the intensity at a 100 m distance, assuming spherical distribution. If $v = 350 m s^{-1}$ and $p = 1.3 kg m^{-3}$, deduce the displacement amplitude.

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43. Given that Avogadro's number is 6×10^{26} per kg-mole and at normal temperature and pressure one kg-mole of a gas occupies $22.4m^3$ volume, deduce the average distance between the gas molecules at NTP. Compare this with the amplitude of displacement wave when the intensity is 1 watt m^{-2} in air, taking effective frequency as 1000 Hz. Take $p = 1.3kgm^{-3}$ and $v = 350ms^{-1}$

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44. Show that the volume that the volume strain in any longitudinal wave is given by (-dy/dx), where y is the displacement at the plane x. Hence show that for a harmonic wave of amplitude A and wavelength λ in a medium of elasticity E, the excess pressure is given by

$$p = EA\frac{2\pi}{\lambda}\sin 2\pi\left(\frac{t}{T} - \frac{x}{\lambda}\right)$$

Deduce the pressure amplitude, if

$E = 1.6 \times 10^3 Nm^{-2}$, $A = 4 \times 10^{-7}m$ and $\lambda = 0.5m$.

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45. The constituent waves of a staionary wave have amplitude, frequency and velocity as 8 cm, 30 Hz and $180 cm s^{-1}$ respectively. Write down the equation of the stationary wave.

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46. Stationary waves are set up by the superposition of two waves given by

$y_1 = 0.05 \sin(5\pi t - x)$ and $y_2 = 0.05 \sin(5\pi t + x)$

where x and y are in metres and t is second. Find the displacement of a particle situated at a distance x=1m.

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47. The transverse displacement of a string (clamped at its two ends) is given by

$$y(x, t) = 0.06 \sin\left(\frac{2\pi}{3}\right) x \cos(120\pi t)$$

wherer x ,y are in m and t ini s. The length of the string is 1.5m and its

mass is 3×10^{-2} kg. Answer the following: (i) Does the function represent a travelling or a stationary wave ?

(ii) Interpret the wave as a superimposition of two waves travelling in opposite directions. What are the wavelength, frequency and speed of propagation of each wave ?

(iii) Determing the tension in the string.

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48. The transverse displacement of a string (clamped at its two ends) is given by $y(x, t) = 0.06 \sin\left[\frac{2\pi}{3}x\right] \cos 120\pi t,$

where x, y are in m and t is in s.

Do all the points on the string oscillate with theh same

(a) frequency (b) phase (c) amplitude

Explain your answer.

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49. A sonometer wire is under a tension of 40 N and the length between the bridges is 50 cm. A metre long wire of the sonometer has a mass of 1.0 g. Determine its fundamental frequency.

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50. Calculate the fundamental frequency of a sonometer wire fo length 20cm, tension 25N, cross sectional area $10^{-2}cm^2$ and density of material $= 10^4 kg/m^3$.

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51. A stretched wire emits a fundamental note of frequency 256Hz. Keeping the stretching force constant and reducing the length of the wire by 10cm, frequency becomes 320Hz. Calculate original length of the wire.

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52. A wire stretched between two rigid supports vibrates in its fundamental mode with a frequency of 45Hz. The mass of the wire is 3.5×10^{-2}kg and its linear mass density is $4.0 \times 10^{-2} kgm^{-1}$. What is (a) the speed of a transverse wave on the string , and (b) the tension in the string?

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53. Find the fundamental note emitted by a string of length $10\sqrt{10}$ cm under tension of 3.14 kg. Radius of string is 0.55 mm and density $= 9.8 gcm^{-3}$.

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54. A rope 5 m long has a total mass of 245g. It is stretched with a constant tension of 1 kg wt. If it is fixed at one end and shaken by hand at the other end, what frequency of shaking will make it break up into three vibrating segments? Take $g = 980 cms^{-2}$.

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55. In a experiment it was found that the string vibrated in three loops when 8 g were placed on the scale pan. What 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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56. A wire of length 108 cm produces a fundamental note of frequency 256 Hz, when stretched by a weight of 1 kg. By how much its length should be increased so that its pitch is raised by a major tone, if it is now stretched by a weight of 4 kg?

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57. The length of a wire between the two ends of a sonometer is 105 cm. Where should the two bridges be placed so that the fundamental

frequencies of the three segments are in the ratio of 1:3:15?

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58. Three strings of the same of the same length are subjected to equal tension, but are found to give notes with a frequency ratio 2:3:4. The tensions of the first two are altered equally until the first is in tune with the third. How much the length of the second be altered to make it in tune with the third?

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59. A sonometer resonates with a source of frequency 500 Hz when the length of the wire between the bridges is 31.5 cm. Now its tension is increased to 4 times. What will be the two possible frequencies of resonance for a length of 21.0 cm?

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60. The fundamental frequency of a sonometer wire increases by 5Hz, if its tension is increased by 21% .How will the frequency be affected if the length is increased by 10% .

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61. A stone hangs in air from one end of a wire, which is stretched over a sonometer. The wire is in unison with a certain tuning fork when the bridges of sonometer are 45 cm apart. Now the stone hangs immersed in water at $4^{\circ}C$ and the distance between the bridges has to be altered by 9cm to re-establish unison of the wire with the same fork. Calculate the density of the stone.

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62. A wire having a linear density of $0.05g/cm$is stretched between two rigid supports with a tension of $450N$. It is observed that the wire

resonates at a frequency of $420Hz$. The next higher frequency at which the same wire resonates is $490Hz$. Find the length of the wire.

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63. What should be minimum length of an open organ pipe for producing a note of 110 Hz. The speed of sound is $330ms^{-1}$.

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64. If the velocity of sound in air is 350 m/s . Then the fundamental frequency of an open organ pipe of length 50 cm, will be

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65. A pipe 20cm long is closed at one end. Which harmonic mode of the pipe is resonantly excited by a 430Hz source? Will the same source be in

resonance with the pipe if both ends are open? Take speed of sound in air $340 m / s$.

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66. Find the ratio of the length of a closed pipe to that of an open pipe in order that the second overtone of the former is in unison with fourth overtone of the latter.

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67. A metre-long tube open at one end, with a movable piston at the other end, shows resonance with a fixed frequency source (a tuning fork of frequency 340Hz) when the tube length is 25.5cm or 79.3cm. Estimate the speed of sound in air at the temperature of the experiment. The edge effects amy be neglected.

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68. A well with vertical sides and water at the bottom resonates at 7Hz and at no other lower frequency. The air in the well has density $1.10 kgm^{-3}$ and bulk modulus of water is $1.33 \times 10^5 N/m^2$. How deep is the well ?

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69. A resonance air column resonates with a tuning fork of 512 Hz at length 17.4 cm. Neglecting the end correction, deduce the speed of sound in air.

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70. A resonance tube is resonated with tuning fork of frequency 512 Hz. Two successive lengths of the resonated air column are 16.0 cm and 51.0cm. The experiment is performed at room temperature of $40^\circ C$. Calculate speed of sound at $0^\circ C$ and end correction.

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71. A steel rod 100 cm long is clamped at its middle. The fundamental frequency of longitudinal vibrations of the rod is given to be 2.53k Hz. What is the speed of sound in steel?

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72. A brass rod 1 metre long is firmly clampled in the middle and one end is stroked by a resined cloth. What is the pitch of the note you will hear ? Density of brass $= 9gcm^{-3}$ and Young's modulus of brass $= 10^{12}\text{dyne}/cm^2$.

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73. Determine the possible harmonics in the longitudinal vibrations of a rod clampred in the middle.

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74. The ends of the prongs of a tunning forks originally in unison with a fork B of frequency 512 are filled, and the forks produce 5 beat/s when sounded together. What is the pitch of A after filling ?

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75. A fork of unknown frequency gives 4 beats per second when sounded with another of frequency 256. The fork is now loaded with a piece of wax and again 4 beats per second are heard. Calculate the frequency of the unknown fork.

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76. A tuning fork of unknown frequency gives 4beats with a tuning fork of frequency 310 Hz. It gives the same number of beats on filing. Find the unknown frequency.

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77. A fork of unknown frequency when sounded with one of frequency 288 Hz gives 4 beats per second and when loaded with a piece of wax again gives 4 beats per second. How do you account for this and what was the unknown frequency ?

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78. Two tuning forks A and B produce 4 beats / sec. On loading B with wax, 6 beats / sec are heard. If quantity of wax is reduced, the number of beats per second again becomes 4.Find the frequency of B if the frequency of A is 256 Hz.

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79. A tunning fork produces 6 beast/s when sounded with a tuning fork of frequnecy 256 Hz. The same tunning fork when sounded with another tunning fork of frequency 252 Hz produces 2 beat/s. Find the frequency of the tunning fork.

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80. 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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81. Two sitar strings A and B playing the note 'Dha' are slightly out of tune and produce beats of frequency 5 Hz. The tension of string B is slightly increased and the beat frequency is found to decrease to 3 Hz. What is the original frequency of B, if the frequency of A is 427 Hz?

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82. A set of 24 tuning fork is arranged in a series of increasing frequencies. If each fork gives 4 beats per second with the preceding one

and the last sounds the ocatve of the first, find the frequencies of the first and the last forks.

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83. In an experiment, it was found that a tuning fork and sonometer wire gave 5 beats per second, both when the length of wire was 1m and 1.05m. Calculate the frequency of the fork.

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84. A tuning fork of frequency 200Hz is in unison with a sonometer wire. How many beats / sec will be heard if tension in the wire is increased by 2% ?

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85. The two parts of a sonometer wire divided by a movable knife edge , differ in length by $2mm$ and produce $1beat/s$, when sounded together . Find their frequencies if the whole length of wire is $1.00m$.

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86. Two similar sonometer wires of the same same material produce 2 beats per second. The length of one is 50 cm and that of the other is 50.1 cm. Calculate the frequencies of the two wires.

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87. A tuning fork of unknown frequency vibrates in unison with a wire of certain stretched under a tension of 5 kg f. It produces 6 beats per second with the same wire, when tension is changed to 4.5 kg f. Find the frequency of tuning fork.

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88. Calculate the speed of sound in a gas in two sound waves of wavelenths 1.00 m and 1.01 m that produce 24 beats in 6 seconds.

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89. Two air columns of resonance appatus, 100cm and 101 cm long give 17 beats in 20 second, when each is sounding its fundamental mode. Calculate the velocity of sound.

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90. Two tuning fork A and B give 5 beats / sec. A resounds with a closed column of air 15 cm long and B with an open column of air 30.5 cm long. Calculate their frequecies. Neglect end correction.

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91. At $16^{\circ}C$, two open end organ pipes, when sounded together produce 51 beats in 3 second will be produced, if the temperture rises to $88^{\circ}C$? Neglect the increase in length of the pipes.

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92. A column of air and a tuning fork produce 4 beats per second when sounded together. The tuning fork gives the lower note. The temperature of air is $15^{\circ}C$. When the temperature falls to $10^{\circ}C$, the two produce 3 beats per second. Find the frequency of the fork.

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93. A closed pipe and an open pipe produce simultaneously a sound with 5 beats per second. If the length of the open pipe is 30 cm, then determint the required change in the length of the closed pipe if both the pipes are to produce the sound of same frequency. Speed of sound is $330ms^{-1}$.

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94. A train, standing at the outer signal of a railway station blows a whistle of frequency 400Hz in still 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) receeds from the platform with a speed of $10ms^{-1}$? (ii) What is the speed of sound in each case ? The speed of sound in still air can be taken as $340ms^{-1}$

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95. A source and an observer are approaching one another with the relative velocity $40ms^{-1}$. If the true source frequency is 1200 Hz, deduce the observed frequency under the following conditions:

(i) All velocity is in the source alone.

(ii) All velocity is in the observer alone.

The source moves in air at $100ms^{-1}$ towards the observer, but the observer also moves with the velocity v_0 in the same direction.

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96. A railway engine and a car are moving on parallel tracks in opposite directinos with speeds of $144km/hr$ and $72km/h$ respectively. The engine is continously sounding a whistle of frequency 500Hz. The velocity of sound in $340ms^{-1}$. Calculate the frequency of sound heard in the car when

(i) the car and engineare approaching one another,

(ii) the two are moving away from one another.

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97. The sirens of two fire engines have a frequency of 600 Hz each . A man hears the sirens from two engines, one approaching him with a velocity of $36km/h$ and the other going away from him at a speed of $54km/h$. What is the difference in frequencies of sound heard ? Take velocity of sound in air $=340m/s$.

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98. On a quiet day, two persons A and B, each sounding a note of frequency 580 Hz, are standing a few metres apart. Calculate the number of beats heard by each in one second when A moves towards B with a velocity of $4ms^{-1}$. (Speed of sound in air $= 330ms^{-1}$.)

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99. Find the velocity of source of sound, when the frequency appears to be (i) double (ii) half the original frequency to a stationary observer. Velocity of sound $= 330ms^{-1}$.

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100. A source of sound produces wave of 60 cm wavelength. This source is moving towards north with a speed one-fifth the sound speed. Find the apparent wavelength of the waves in the north and south directions.

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101. A train, standing at the outer signal of a railway station blows a whistle of frequency 400Hz in still 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) receeds from the platform with a speed of $10ms^{-1}$? (ii) What is the speed of sound in each case ? The speed of sound in still air can be taken as $340ms^{-1}$

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102. A train, standing in a stationyard, blows a whistle of frequency 400Hz in still air. The wind starts blowing in the direction from the yard to the station at a speed of $10ms^{-1}$. What are the frequency, wavelength, and speed of sound for an observer standing on the station's platform ? Is the situation exactly identical to the case when the air is still and the observer runs towards the yard at a speed of $10ms^{-1}$? Th speed of sound in still air can be taken as $340ms^{-1}$.

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103. Consider a source moving towards an observer at the speed of $v_s = 0.95v$. Deduce the observed frequency if original frequency is 500Hz. What would happen if $v_s > v$? (Jet planes moving faster than sound are common). Here , v is velocity of sound in air.

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104. A supersonic jet travels with twice the speed of sound in air. What is the angle of the conical wavefront of the shock wave produced by the jet?

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105. A stationary source emits sound of frequency 1200 Hz. If would blows at the speed of 0.1 v. deduce

(a) The change in the frequency for a stationary observer on the wind side of the source

(b) Report the calculations for the case when there is no wind but the observer moves at 0.1 v speed towards the source (Given : velocity of sound = v)

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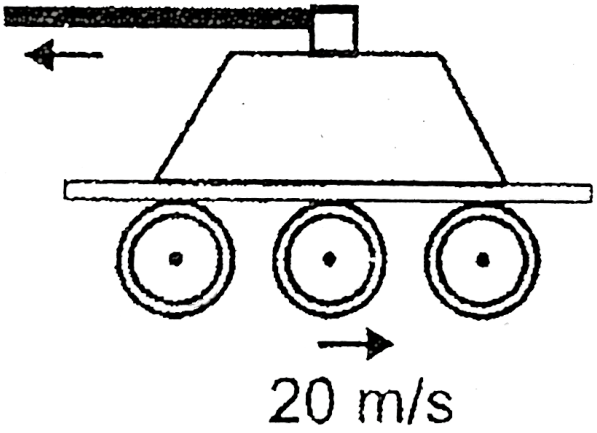
106. A machine gun is mounted on an armored car moving with a speed of $20ms^{-1}$. The gun point against the direction of motion of car. The muzzle speed of bullet is equal to speed of sound in air i.e., $340ms^{-1}$. The time difference between bullet actually reaching and sound of firing reaching at a target $544m$ away from car at the instant of firing is reaching at a target $544m$ away from car at the instant of firing is



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107. A SONAR system fixed in a submarine operates at a frequency 40.0kHz. An enemy submarine moves towards the SONAR with a speed of 360 kmh^{-1}. What is the frequency of sound reflected by the submarine ? Take the speed of sound in water to be 1450 ms^{-1}.

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108. An observer is moving towards a wall at $2ms^{-1}$. He hears a sound from source at some distance behind him directly as well as after reflection from the wall. Calculate the beat frequency between these two sound, if the true frequency of the source is 680 Hz. Velocity of sound $-340m/s$.

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109. A siren is fitted on as car going towards a vertical wall at a speed of 36 km/h. A person standing on the ground, behind the car, listens to the siren sound coming directly from the source as well as that coming after refelction from the siren to the person and b. coming after reflection. Take the speed of sound to be $340ms^{-1}$

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110. An observer on a railway platform noticed that when a train passed through the station, at a speed of $72kgh^{-1}$, the frequency of the whistle appeared to drop by 500 Hz. Calculate the actual frequency of the note produced by the whistle. Velocity of sound in air $= 340ms^{-1}$.

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111. A policeman on duty detects a drop of $10\,\%$ in the pitch of the horn of a moving car as it crosses him. If the velocity of sound is $330m/s$, the speed of the car will be

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112. Find the difference is the apparent frequencies (i) When the source approaches a stationary observer (ii) When observer is approaching the stationary source. Take b as relative velocity in each case and v as the velocity of the waves.

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113. Two aeroplanes A and B are approaching each other and their velocities are $108 kmh^{-1}$ and $144 kmh^{-1}$ respectively. The frequency of a note emitted by A as heard by the passangers in B is 1170 Hz. Calculate the frequency of the note heard by the passangers in A. Velocity of sound $= 350 ms^{-1}$.

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114. The wavelength of yellow sodium line (5896 Å) emitted by a star is red shifted to 6010 Å. What is the component of the star's recessional velocity along the line of sight? Speed of light $= 3 \times 10^8 ms^{-1}$.

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115. The spectral line for a given element in the light received from a distant star is shifted towards longer wavelength side by $0.032\,\%$. Deduce the velocity of star in the line of sight.

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116. star emitting light of wavelength 5896Å is moving away from the earth with a speed of 3600 km / sec . The wavelength of light observed on earth will

($c = 3 \times 10^8 m/\sec$ is the speed of light)

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117. A radar wave has a frequency of $7.2 \times 10^9 Hz$. The reflected wave from an aeroplane shows a frequency difference of $2.4 \times 10^3 Hz$ on the higher side. Calculate the velocity of the aeroplane in the line of sight.

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118. Find the intensity level of a sound wave in decibles of a sound wave whose intensity is $10^{-10} cm^{-2}$. Take zero level of intensity $= 10^{-12} Wm^{-2}$.

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119. Calculate the reverberation time for an auditorium measuring $30m \times 15m \times 6m$. Sound absorption coefficients: for walls = 0.03, for ceiling $= 0.36$, for floor = 0.26.

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120. Build a major diatonic scale of music with 320 as the key note.

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121. How many times intense is 80 dB sound than a 20 dB sound?

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122. The intensity of sound B is 500 times that of sound A. What is the difference in their intensity levels?

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123. 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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124. The intervals between the adjacent notes of a diatonic scale are as follow:

$$Sa \underset{9/8}{\downarrow} Re \underset{10/9}{\downarrow} Ga \underset{18/5}{\downarrow} Ma \underset{9/8}{\downarrow} Pa \underset{10/9}{\downarrow} Dha \underset{9/8}{\downarrow} Ni$$

If the frequency of the key note is 256 Hz, find the frequency of 'Pa'.

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125. An observer standing at the sea coast observes $54 waves$ reaching the coast per minute. If the wavelength of a wave is $10m$, find the wave velocity.

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126. A light pointer fixed to one prong of a tuning fork touches gnetly a smoked vertical plate. The fork is set vibrating and the plate is allowed to

fall freely. 8 complete oscilllations are counted when the plate falls through 10cm.What is the frequency of the tuning fork?

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127. From a cloud at an angle of 30° to the horizontal, we hear the thunder clap 8 s after seeing the lightening flash. What is the height of the cloud above the ground if the velocity of sound in air is $330m/s$?

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128. The extension in a string, obeying Hooke's law, is x. The speed of sound in the stretched string is v. If the extension in the string is increased to $1.5x$, the speed of sound will be

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129. A long wire PQR is made by joining two wires PQ and QR of equal radii. PQ has length $4.8m$ and mass $0.06kg$. QR has length $2.56m$ and mass $0.2kg$. The wire PQR is under a tension of $80N$. A sinusoidal wave-pulse of amplitude $3.5cm$ is sent along the wire PQ from end P. No power is dissipated during the propagation of the wave-pulse. Calculate,

(a) the time taken by the wave-pulse to reach the other end R of the wire, and

(b) the amplitude of the reflected and transmitted wave-pulse after the incident wave-pulse crosses the joint Q.

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130. A load of 20kg is suspended by a steel wire in a sonometer experiment. Velocity of waves when the wire is rubbed with a resined cloth along the length is 20 times the velocity of waves in the same string, when it is plucked. Find area of cross-section of the wire, if Y for steel is $19.6 \times 10^{10} N/m^2$ and $g = 9.8m/s^2$.

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131. A wire of $9.8 \times 10^{-3} k \frac{g}{m}$ passes over a frictionless light pulley fixed on the top of a frictionless inclined plane which makes an angle of 30° with the horizontal. Masses m and M are tied at the two ends of wire such that m rests on the plane and M hangs freely vertically downwards. the entire system is in equilibrium and a transverse wave propagates along the wire with a velocities of $100 m / s$.

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132. Calculate the ration of speed of sound in neon to that in water vapours at any temperature. Molecular weight on neon $= 2.02 \times 10^{-2} kg / mole$ and for water vapours, molecular weight is $1.8 \times 10^{-2} kg / mole$.

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133. Find the speed of sound in a mixture of 1 mole of helium and 2 moles of oxygen at $27^\circ C$. If the temperature is raised by 1K from 300K, find the percentage change in the speed of sound in the gaseous mixture.

Take $R = 8.31 Jmole^{-1}K^{-1}$.

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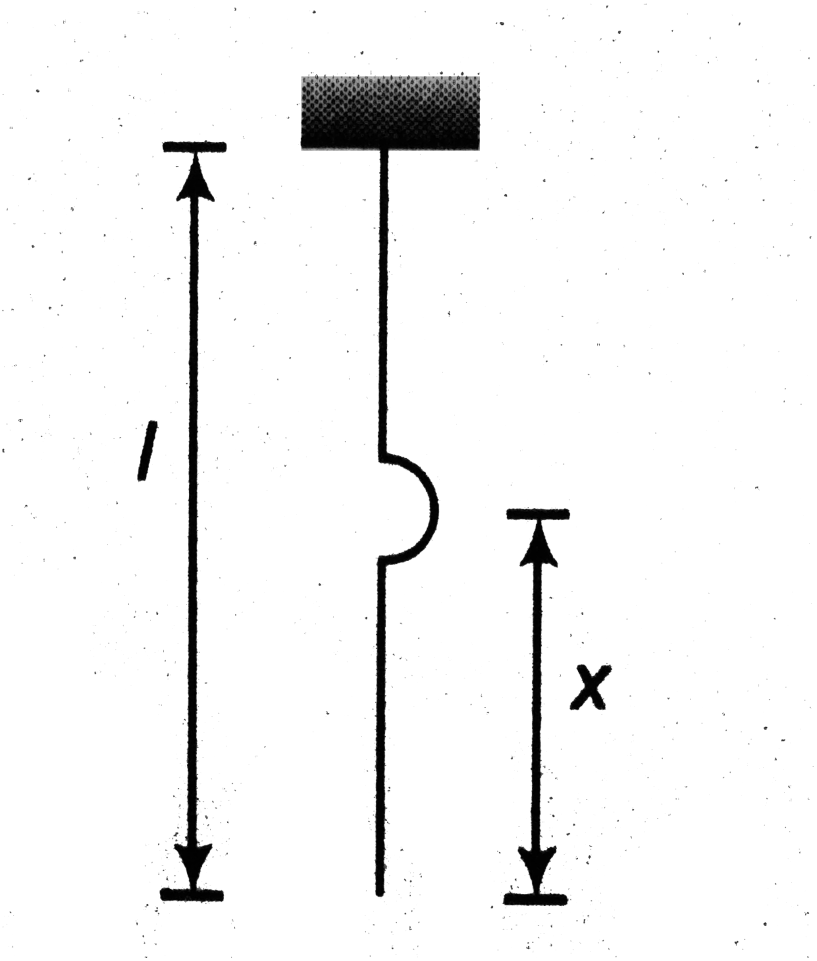
134. A uniform rope of mass $0.1kg$ and length $2.45m$ hangs from a ceiling.

(a) Find the speed of transverse wave in the rope at a point $0.5m$ distant from the lower end.

(b) Calculate the time taken by a transverse wave to travel the full length

of the rope.



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135. The equation of a travelling wave is

$y = 0.07 \sin(12\pi x - 500\pi t)$

where the distances are in metre and time is in second. Calculate the wavelength and velocity of wave.

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136. Write down the equation for a wave propagating with velocity $330m/s$ and having frequency 110Hz. The amplitude is 0.05m.`

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137. A progressive wave of frequency 500Hz is travelling with a velocity of 360 m/ s. How far part are two points 60° out of phase ?

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138. The length of a sonometer wire is $0.75m$, and density $9 \times 10^3 m$. It can bear a stress of $8.1 \times 10^8 N/m^2$ without exceeding the elastice limit. What is the fundamental frequency that can be produced in the wire?

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139. A transverse sinusoidal wave of amplitude a, wavelength λ and frequency f is travelling on a stretched string. The maximum speed of any point in the string is $v/10$, where v is the speed of propagation of the wave. If $a = 10^{-3}m$ and $v = 10ms^{-1}$, then λ and f are given by

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140. An open pipe is suddenly closed at one end with the result that the frequency of third harmonic of the closed pipe is found to be higher by $100Hz$ then the fundamental frequency of the open pipe. The fundamental frequency of the open pipe is

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141. The first overtone of an open orgen pipe beats with the first ouertone of a closed orgen pipe with a beat frequency of $2.2H_Z$. The

fundamental frequency of the closed organ pipe is $110H_Z$. Find the lengths of the pipes . Speed of sound in air $u = 330m/s$.

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142. A steel wire of length $1m$, mass $0.1kg$ and uniform cross-sectional area $10^{-6}m^2$ is rigidly fixed at both ends. The temperature of the wire is lowered by $20^\circ C$. If transverse waves are set up by plucking the string in the middle.Calculate the frequency of the fundamental mode of vibration. Given for steel $Y = 2 \times 10^{11}N/m^2$

$\alpha = 1.21 \times 10^{-5} per^\circ C$

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143. A metallic rod of length 1m is rigidly clamped at its mid point. Longirudinal stationary wave are setup in the rod in such a way that there are two nodes on either side of the midpoint. The amplitude of an antinode is $2 \times 10^{-6}m$. Write the equation of motion of a point 2 cm from the midpoint and those of the constituent waves in the rod,

(Young,s modulus of the material of the rod $= 2 \times 10^{11} Nm^{-2}$, density $= 8000 kg - m^{-3}$). Both ends are free.

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144. When a train is approaching the observer, the frequency of the whistle is 100 cps. When it has passed observer, it is 50 cps. Calculate the frequncy when the observer moves with the train.

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145. Two tuning forks with natural frequencies of $340 Hz$ each move relative to a stationary observer. One fork moves away form the observer, while the other moves towards him at the same speed. The observer hears beats of frequency $3 Hz$. Find the speed of the tuning fork.

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

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147. A band playing music at a frequency f is moving towards a wall at a speed v_b. A motorist is following the band with a speed v_m. If v is the speed of sound, obtain an expression for the beat frequency heard by the motorist.

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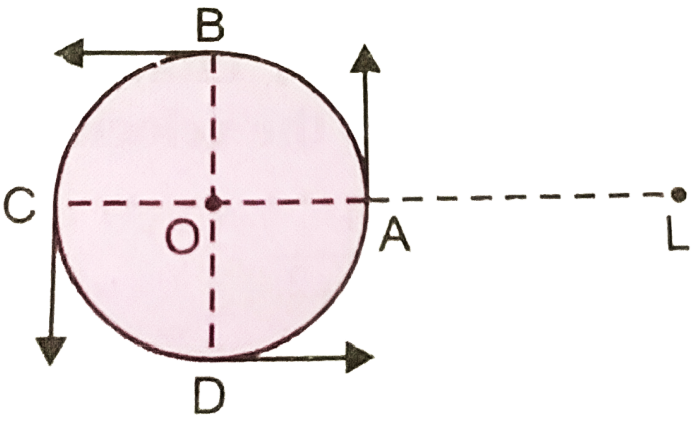
148. A whistle of frequency of 540Hz rotates ini a circle of radius 2m at an angular speed of 15rad/s. What is the lowest and highest frequency heard by a listener a long distance away at rest w.r.t centre of the circle. Can the apparent frequency be ever equal to the actuall frequency ? Take

$v = 330m/s$



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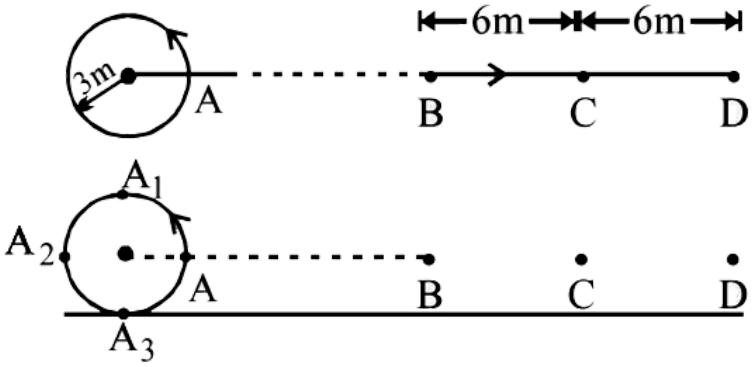
149. A source of sound is moving along a circular orbit of radius $3meter$ with an angular velocity of $10rad/s$. A sound detector located far away from the source is executing linear simple harmonic motion along the line BD with an amplitude $BC = CD = 6meters$. The frequency of oscillation of the detector is $\frac{5}{\pi}$ per second. The source is at the point A when the detector is at the point B. If the source emits a continuous sound wave of frequency $340Hz$, Find the maximum and the minimum

frequencies recorded by the detector.



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150. A train approaching a hill at a speed of $40km/hr$ sounds a whistle of frequency $580Hz$ when it is at a distance of $1km$ from a hill. A wind with a speed of $40km/hr$ is blowing in the direction of motion of the train Find

(i) the frequency of the whistle as heard by an observer on the hill,

(ii) the distance from the hill at which the echo from the hill is heard by the driver and its frequency.

(Velocity of sound in air $= 1,200km/hr$)

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151. A locomotive approaching a crossing at a speed of 80 mi/h sounds a whistle of frequency 400 Hz when 1 mi from the crossing. There is no wind, and the speed of sound in air is 0.200mi/s. What frequency is heard by an observer 0.60 mi from the crossing on the straight road which crosses the railroad at right angles?

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152. A train approachign a railway crossing at a speed of $120kmh^{-1}$ sounds a short whistle at frequency 640 Hz when it is 300 m away from the crossing. The speed of sound in air is $340ms^{-1}$. What will be the frequency heard by a person standing on a road perpendicular to the track through the crossing at a distance of 400 m from the crossing ?

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153. Buttets are fired at regular intervals of 10s from an armoured car A moving with a speed of $10ms^{-1}$towards B. At what interval will an officer seated in car B and dashing with a speed of $20ms^{-1}$ towards A hear the report ? Vleocity of sound $=340ms^{-1}$ and velocity of wind $=5ms^{-1}$ in the direction BA.

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154. A sonometer wire under tension of 64 N vibrating in its fundamental mode is in resonance with a vibrating tuning fork. The vibrating portion of the sonometer wire has a length of 10 cm and mass of 1 kg. The vibrating tuning fork is now moved away from the vibrating wire with a constant speed and an observer standing near the sonometer hears one beat per second. Calculate the speed with which the tuning fork is moved, if the speed of sound in air is 300 m/s.

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155. The wavelength of light coming from a distant galaxy is found to be $0.5\,\%$ more than that coming from a source on earth. Calculate the velocity of galaxy.

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156. Radio Ceylon broadcasts at $25m$. What is the frequency of the station ?

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157. A radio station broadcasts at 720 kHz. If the radio waves travel at a velocity of $3 \times 10^8 ms^{-1}$, calculate the wavelength of the radio waves.

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158. A tuning fork vibrates with a frequency of 256. If the speed of sound is $345.6ms^{-1}$., Find the wavelength and the distance, which the sound travels during the time, the fork makes 60 vibrations.

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159. Audible range of frequencies to which human car responds varies between 20 to 20,000 Hz.Express the range in terms of (i)wavelength in air and (ii)time period .

The speed of sound in air is $350ms^{-1}$.

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160. The speed of a wave in a certain medium is $960m/s$. If 3600 waves pass over a certain point of the medium in 1 min, the wavelength is

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161. If the splash is hear 4.23 seconds after a stone is dropped into a well, 78.4 metres deep, find the velocity of sound in air.

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162. A stone is dropped into a well and its splash is heard at the mouth of the well after an interval of 1.45 s.Find the depth of the well. Given that velocity of sound in air at room temperature is equal to $332ms^{-1}$.

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163. A body sends waves 100mm long through medium A and 0.25m long in medium B. If the velocity of waves in medium A is $80cms^{-1}$, calculate the velocity of waves in medium B.

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164. A steel wire 0.72 m long has a mass of 5.0×10^{-3} kg . If the wire is under a tension of 60 N, what is the speed of transverse waves on the wire ?

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165. A steel wire 70cm long has a mass of 7.0g. If the wire is under a tension of 100N, what is the speed of transverse waves in the wire?

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166. The length of stretched string is 2 m and its mass is 8×10^{-3} kg. If a tension of 2 kg f is applied to the wire, how long will a transverse wave take in reaching from one end of the wire to the other end ?

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167. The speed of a transverse wave in a stretched string is 348 ms^{-1}, when the tension of the string is 3.6 kg wt. Calculate the speed of the transverse wave in the same string . If the tension in the string is changed to 4.9 kg wt ?

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168. Calculate the velocity of transverse wave in a copper wire 1 mm^2 in cross-section, under the tension produced by 1 kg wt. The density of copper =$8.93kgm^{-3}$

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169. A wave pulse is travelling on a string of linear mass density $1.0gcm^{-1}$ under a tension of 1 kg wt. Calculate the time taken by the pulse to travel a distance of 50 cm on the string.Given $g = 10ms^{-2}$.

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170. The diameter of an iron wire is 1.20 mm. If the speed of transverse waves in the wire is $50.0 m / s$, what is the tension in the wire? The density of iron is $7.7 \times 10^{3} kg / m^{3}$

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171. Calculate the velocity of sound in steel given Young's modulus of steel $= 2 \times 10^{11} Nm^{-2}$ and density of steel $= 7800 kgm^{-3}$.

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172. The speed of sound in a liquid is $1500 ms^{-1}$.The density of the liquid is $1.0 \times 10^{3} kgm^{-3}$.Determine the bulk modulus of elasticity of the liquid.

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173. The longitudinal waves starting from a ship return from the bottom of the sea to the ship after 2.64 s. If the bulk modulus of water be $220mm^{-2}$ and the density $1.1 \times 10^3 kgm^{-3}$.calculate the depth of the sea. Take g =$9.8Nkg^{-1}$.

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174. At $10^5 Nm^{-2}$ atmospheric pressure the density of air is $1.29kgm^{-3}$.If $\gamma = 1.41$ for air, calculate the speed of sound in air.

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175. At normal temperature and pressur, 4g of He occupies a volume of 22.4 litre. Determine the speed of sound in helium. Take 1 atmospheric pressure $= 10^5 N/m^2$ and γ for helium $= 1.67$.

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176. The velocity of sound in air at N.T.P is $331ms^{-1}$.Calculate the velocity at $91^{\circ}C$.

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177. The velocity of sound in air is $332ms^{-1}$ at $0^{\circ}C$ .At what temperature will the velocity become 1/2 time that at $0^{\circ}C$?

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

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179. At what temperature will the speed of sound be double of its value at $0^{\circ}C$?

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180. The speed of sound waves in air at 300 K is $248ms^{-1}$. At what temperature will the speed be $402ms^{-1}$.

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181. What is the ratio of velocity of sound in hydrogen $(\gamma = 7/5)$ to that in helium $(\gamma = 5/3)$ at the same temperature?

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182. Calculate the increase in velocity of sound when the temperature changes from $-3^{\circ}C$ to $27^{\circ}C$.Velocity of sound at $-3^{\circ}C$ is $300ms^{-1}$ .Given $\sqrt{10} = 3.2$

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183. An observer sets his watch by the sound of a signal fired from a tower yet he finds that his watch is slow by 5 s. Find the distance of the tower from the observer.The temperature of air during the observation is $20^\circ C$ and the velocity of sound in air at $0^\circ C$ is $332 ms^{-1}$.

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184. A sound wave propagating in air has a frequency of 4000Hz. Calculate the percentage change in wavelength when the wavefront initially in a region where $T = 27^\circ C$ enters a region where temperature decreases to $10^\circ C$.

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185. At what temperature will the speed of sound in hydrogen be the same aas in oxygen at 100° ? Molar Masses of oxygen and hydrogen are in the ratio $16:1$.

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186. At what temperature, velocity of sound in oxygen is same as that in nitrogen at $10^{\circ} C$? Given their densities at $0^{\circ} C$ are in the ratio $16: 14$`.

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187. The velocity of sound in air at $14^{\circ} C$ is $340 ms^{-1}$.What will it be when the pressure is doubled and temperature is raised to $157.5^{\circ} C$?

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188. If velocity of sound in hydrogen at $0^{\circ} C$ is $1280 ms^{-1}$, what will be the velocity of sound at the same temperature in a mixture, 2 parts in volume of hydrogen to one part of oxygen. Density of oxygen is 16 times that of hydrogen.

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189. If the speed of sound in helium be $960ms^{-1}$, when will be the speed of sound in hydrogen at the same temperature ? The value of γ for He and H_2 are 1.67 and 1.40 respectively and the ratio of the molecular masses is 2:1.

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190. The equation of a transverse wave travelling along a coil spring is

$y = 4.0 \sin \pi(0.010x - 2.0t)$

where y and x are in cm and t in s. Find the (i)amplitude (ii)wavelength (iii)initial phase at the origin (iv)speed and (v)frequency on the wave.

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191. The equation of a transverse wave is given by

$y = 10 \sin \pi(0.01x - 2t)$

where x and y are in cm and t is in second. Its frequency is

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192. A wave on a string is described by $y(x, t) = 0.005 \sin(6.28x - 314t)$, in which all quantities are in SI units. Calculate its amplitude and wavelength.

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193. A harmonic wave travelling along the position direction of X-axis is represented by the equation : $\xi = 0.3 \times 10^{-4} \cos\left(\frac{220}{7}t - 1.57x\right)$, where ξ, t ant x are in cm , second and metre respectively.Deduce the (i)amplitude (ii)wavelength and (iii)time period.

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194. The equation of a transverse wave travelling along the X-axis is givey by

$\xi = 10 \sin \pi(0.01x - 2.00t)$

where ξ and x are expressed in cm and t in sec. Find the amplitude, frequency, velocity and wavelength of the wave.

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195. If the equation for the transverse wave in a string is given by

$$y = 5 \sin 2\pi \left(\frac{t}{0.02} - \frac{x}{50} \right)$$

with lengths expressed in cm and time period in seconds, calculate the wave velocity and maximum particle velocity.

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196. For a travelling harmonic wave , $y = 2.0 \cos(10t - 0.0080x + 0.818)$ where x and y are in cm and t is in sec. What is the phase difference between two points separated by (i) a distance of 0.5m (ii) time gap of 0.5s.

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197. The equation of simple harmonic wave is given by

x=4 cos (500 t-0.02 x)

where x, y and t are measured in metres, mm and seconds respectively. Find the values of (i)velocity of wave (ii)particle velocity amplitude (iii)the change in phase at a point in 1 millisecond and (iv)change in phase between two points separated by 10 m.

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198. Find the displacement of an air particle 3.5 m from the origin of disturbance at t=0.05 s, when a wave of amplitude 0.2 mm and frequency 500 Hz travels along it with a velocity $350ms^{-1}$.

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199. A simple harmonic wave-train is travelling in a gas in the positive direction of the X-axis.Its amplitude is 2 cm, velocity $45ms^{-1}$ and frequency $75s^{-1}$.Write down the equation of the wave Find the

displacement of the particle of the medium at a distance of 135 cm from the origin in the direction of the wave at the instant t=3 s.

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200. The phase difference between the vibrations of two medium particles due to the transmission of a wave is $2\pi/3$.The distance between the particles is 15 cm.Determine the wavelength of the wave.

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201. The distance between two points on a stretched string is 20 cm. A progressive wave of frequency 400 hertz travels on the string with a velocity of $100m/s$. Calculate phase difference between the points.

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202. A sound source of frequency 500 Hz is producing longitudinal waves in a spring.The distance between two consecutive rarefractions is 24 cm.If the amplitude of vibration of a particle of the spring is 3.0 cm and the wave is travelling in the negative x-direction, then write the equation for the wave.Assume that the source is at x=0 and at this point the displacement is zero at the time t=0.

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203. Spherical waves of frequency 1500 Hz are emitted from a 1.0 W source in an isotropic non-absorbing medium.What will the intensity and amplitude of the wave 1.0 m from the source if density of the medium be $1.3kgm^{-3}$ and wave velocity is $300ms^{-1}$.

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204. A drop of water 2 mm in diameter falling from a height of 50 cm in a bucket generates sound which can be heard from 5 m distance . Take all

gravitational energy difference equal to sound energy , the transformation being spread in time over 0.2 sec, deduce the average intensity. Take $g = 10ms^{-2}$

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205. The distance between two consecutive in a stationary wave is 25 cm . If the speed of the wave is $300ms^{-1}$, calculate the frequency.

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206. The equation of a longitudinal stationary wave produced in a closed organ pipe is

$$y = 6\frac{\sin(2\pi x)}{6}\cos 160\pi t$$

where x, y are in cm and t in second.Find (i)the frequency , amplitude and wavelength of the original progressive wave (ii)separation between two successive nodes and (iii)equation of the original progressive wave.

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207. Write the equation of a wave identical to the wave represented by the equation $y = 5\sin\pi(4.0t - 0.02x)$, but moving in opposite direction. Write the equation of stationary wave produced by the combination of these two waves. Determine the distance between two nearest nodes. All distances in the equations are in mm.

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208. A string 1 m long with mass 0.1 g cm^{-1} is under a tension of 400 N.Find is fundamental frequency of vibration.

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209. A string 50 cm long and weighing 1.0 g produces a note of 100 Hz on plucking in the middle.What is the tension in the string ?

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210. A cord 80 cm long is stretched by a load of 8.0 kg f.The mass per unit length of the cord is $4.0 \times 10^{-5} kgm^{-1}$.Find (i)speed of the transverse wave in the cord and (ii)frequency of the fundamental and that of the second overtone.

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211. The length of a stretched wire is 1 m and its fundamental frequency is 300 Hz.What is the speed of the transverse wave in the wire ?

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212. The mass of 1m long steel wire is 20 g. The wire is stretched under a tension of 800N. What are the frequencies of fundamental mode of vibration and next two higher modes ?

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213. If the tension in the string is increased by 5 kg wt, the frequency of the fundamental tone increases in the ratio 2:3.What was the initial tension in the string ?

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214. A sonometer wire has a length of 114 cm between its two fixed ends. Where should the two bridges be places so as to divide the wire into three segments, whose fundamental frequencies are in the ratio $1:3:4$?

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215. Two wires of the same material are stretched with the same force. Their diameters are 1.2 mm and 1.6mm, while their lengths are 90 cm and 60cm respectively. If the frequency of vibrations of first is 256 Hz, find that of the other.

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216. The frequency of the note emitted by a silver wire 1 mm in diameter and 50 cm in length is 256 Hz.Find the tension in the wire, if density of silver is 10.5 g cm^{-3}.

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

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218. The ratio of frequencies of two wires having same length and same tension and made of the same material is 2:3.If the diameter of one wire be 0.09 cm , then determine the diameter of the other.

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219. A 50 cm long wire is in unison with a tuning fork of frequency 256, when stretched by a load of density $9gcm^{-3}$ hanging vertically . The load is then immersed in water.By how much the length of the wire be reduced to bring it again in unison with the same tuning fork ?

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220. A string vibrates with a frequency of 200Hz. Its length is doubled and its tension is altered till it begins to vibrate with a frequency of 300Hz. What is the ratio of new tension to the original tension ?

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221. In Melde's experiment , a string vibrates in 3 loops when 8 grams were placed in the pan.What mass must be placed in the pan to make the string vibrate in 5 loops ?

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222. 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 $335ms^{-1}$.

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223. Find the frequencies of the fundamental note and first overtone in an open air column and a closed air column of length 34 cm. The velocity of sound at room temperature is $340ms^{-1}$

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224. Prove that a pipe of length 2l open at both ends has same fundamental frequency as another pipe of length l closed at the other end. Also, state whether the total sound will be identical for two pipes.

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225. The funadamental frequency of a closed organ pipe is equal to the first overtone frequency of an open organ pipe. If the length of the open pipe is 60 cm, what is the length closed pipe?

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226. The fundamental tone produced by an organ pipe has a frequency of 110 Hz. Some other frequencies produced by the pipe are 220, 440, 550, 660 Hz. Is this pipe open or closed?Calculate effective length of the pipe. Speed of sound is 330m / s.

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227. An open organ pipe has a fundamental frequency of $300H_Z$. The first overtone of a closed organ pipe has the same frequency as the first overtone of this open pipe . How long is each pipe ? (Speed of sound in air = $330m / s$)

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228. Find the ratio of the length of a closed pipe to that of an open pipe in order that the second overtone of the former is in unison with fourth overtone of the latter.

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229. A pipe 30 cm long is open at both ends. Which harmonic mode of the pipe is resonantly excited by a 1.1 kHz source ? (Take speed of sound in air $= 330ms^{-1}$)

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230. A tuning fork of frequency 341 Hz is vibrated just over a tube of length 1m. Water is being poured gradually in the tube. What height of water colume will be required for resonance?Speed of sound in air is 341 m / s.

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231. A resonance air column shows resonance with a tuning fork of frequency 256 Hz at column lengths 33.4 cmand 101.8 cm. find (i) end-correction and (ii) the speed of sound in air.

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232. A metallic bar clamped at its middle point vibrates with a frequency v when it is rubbed at one end. If its length is doubled, what will be its natural frequency of vibration ?

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233. A brass rod (density $8.3g/cm^3$), 3m long is clamped at the centre. It is excited to give longitudinal vibrations and the frequency of the fundamental note is 600Hz. Calculate the velocity of sound in the rod and its Young's modulus.

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234. The points of the prongs of a tuning fork B originally in unison with a tuning fork A of frequency 384 are filed and the fork produces 3 beats per second, when sounded together with A. What is the pitch of B after filing ?

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235. When two tuning forks were sounded together , 20 beats were produced in 10 seconds. On loading one of the fork with wax, the number of beats increases. If the frequency of unloaded fork is 512Hz , calculate the frequency of other.

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236. A tuning forks when sounded together produce 3 beats per second, when sounded with another tuning fork B. when prongs of B are loaded

with 1 g of wax, the number of beats become 3 per second. What is the frequency of B ?

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237. A tuning fork produces 4 beats/s when sounded with a fork of frequency 512 Hz. The same tuning fork. When sounded with another fork of frequency 514 Hz produces 6 beats / second. Find the unknown frequency of the fork.

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238. Two tuning forks when sounded together produce 3 beats per second. On loading one of them with a little wax, 20 beats are heard in 4 seconds. Find its frequency if that of other is 386.

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239. A tuning fork produces 2 beats per second when sounded with another tuning fork of frequency 250 Hz. It gives the same number of beats per second when loaded with wax. The initial frequency of 1^{st} tuning fork is

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240. A tuning fork A makes 4 beats per second with a fork B of frequency 256 Hz. A is filed and the beats occur at shorter interval, find its original frequency.

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241. When two tuning forks were sounded together, 24 beats were produced in 8 seconds. After loading one of the tuning forks with a little wax, they produce 32 beats in 8 seconds. If the loaded fork had frequency 512 Hx, calculate the frequency of the other.

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242. 16 tuning forks are arranged in increasing order of frequency. Any two consecutive tuning forks when sounded together produce 8 beats per second. If the frequency of last tuning fork is twice that of first, the frequency of first tuning fork is :-

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243. A set of 25 tuning forks is arranged in order of decreasing frequency. Each fork gives 3 beats with succeeding one. The first fork is octave of the last. Calculate the frequency of the first and 16th fork.

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244. The string of violin emits a note of 440 Hz at its correct tension. The string is bit taut and produces 4 bets er second with a tunning fork of

frequency 440 Hz. Find the frequency of the note emitted by this taut string.

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245. A tuning fork when vibrating along with a sonometer produces 6 beats per second when the length of the wire is either 20 cm or 21 cm . Find the frequency of the tuning fork.

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246. A tuning fork produces 5 beats s^{-1} with a sonometer wire of length 78 cm. If the length of the wire iscreased byy 2 cm, then there is a resonance between the tuning fork and the wire. The frequency of the fork is

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247. Two tuning forks when sounded together produce 4 beats per second. The first produces 8 beats per second. Calculate the frequency of the other.

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248. Two instruments having stretched strings are being played in unison . When the tension in one of the instruments is increases by $1\ \%$, 3 beats are produced in $2s$. The initial frequency of vibration of each wire is

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249. A and B are two wires whose fundamental frequencies are 256 and 382 Hz respectively. How many beats in 2 seconds will be heard by the third harmonic of A and second harmonic of B?

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250. In an experiment, it was found that a tuning fork and sonometer wire gave 5 beats per second, both when the length of wire was 1m and 1.05m. Calculate the frequency of the fork.

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251. Two notes of wavelength 2.04 m and 2.08 m produce 200 beats per minute in a gas. Find the velocity of sound in the gas.

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252. Two tuning forks A and B are sounded together and $8 beats / s$ are heard . A is in resonance with a column of air $32 cm$ long in a pipe closed at one end and B is increased by one cm. Calculate the frequency of fork .

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253. Two organ pipes at $16^{\circ}C$ produces 40 beats in 2.5 seconds. What happens when temperature rises to $40^{\circ}C$? Coefficients of linear expansion of the pipes are negligible.

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254. Two open organ pipes give 5 beats per second when sounded together in their fundamental modes.The lengths of the pipes are 1 m and 1.03 m .Find the velocity of sound.

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255. At $16^{\circ}C$, two open organ pipes , when sounded together, produce 34 beats in 2 seconds. How many beats per second will be produced, if the temperature rises to $51^{\circ}C$? Neglect the increase in the length of the pipes.

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256. A tuning fork of frequency 300 Hz resonates with an air-column closed at one end at $27^{\circ}C$.How many beats will be heard in the vibrations of the fork and the air-column at $0^{\circ}C$.End-correction is negligible.

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257. A policeman blows a whistle with a frequency of 500 Hz.A car approaches him with a velocity of $15ms^{-1}$.Calculate the change in frequency as heard by the driver of the car as he passes the policeman.Speed of sound in air is $300ms^{-1}$.

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258. Calculate the apparent frequency of the horn of a car approaching a stationary listener with a velocity of $12ms^{-1}$. The frequency of horn is 500 Hz.The speed of sound is $332ms^{-1}$.

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259. A siren emitting a sound of frequency 1000 vibrations per second is moving with a speed of $10ms^{-1}$.What will be the frequency of sound, which a listener will hear when (i)the siren is moving towards him ? (ii)the siren is moving away from him ? Speed of sound in air =$340ms^{-1}$.

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260. A person is standing on a platform. As engine while approaching the platform blows a whistle , the frequency of which is 100 Hz.The speed of engine is $108kmh^{-1}$ and speed of sound is $340ms^{-1}$.Calculate the appearent frequency of the whistle as heard by the person.

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261. A man standing near a railway line hears the whistle of an engine, which has a velocity of $20ms^{-1}$ What frequency does the man hear ,

when the engine is coming towards and going away from him, if the true frequency of the whistle is 1000 Hz.Speed of sound in air =$340ms^{-1}$.

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262. Two engines pass each other in opposite directions with a velocity of $60kmh^{-1}$each . One of them is emitting a note of frequency 540.Calculate the frequencies heard in the other engine before and after they have passed each other.Given velocity of sound $= 316.67ms^{-1}$.

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263. A train approaches a stationary observer, the velocity of train being 1/20 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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264. When a source moves away from a stationary observer, the frequency is $\frac{6}{7}$ times the original frequency. Given: speed of sound $= 330\frac{m}{s}$. The speed of the source is

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265. A motor car is approaching towards a crossing with a velocity of $75kmh^{-1}$.The frequency of sound of its horn as heard by a policeman standing on the crossing is 260 Hz.What is the real frequency of the horn ? Speed of sound =$332ms^{-1}$.

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266. Two cars are approaching each other on a straight road and moving with a velocity of $30kmh^{-1}$.if the sound produced in a car is of frequency 500 Hz, what will be the frequency of sound as heard by the person sitting in the other car ? When the two cars have crossed each other and

are moving away from each other.what will be the frequency of sound as heard by the same person ? Speed of sound =$330ms^{-1}$.

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267. A source and a listener are approaching closer with a relative velocity of $40ms^{-1}$.If the true source frequency is 1200 Hz, calculate the observed frequency under these conditions : (i)The source along is moving (ii)The listener along is moving Take speed of sound in air $340ms^{-1}$.

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268. A railway engine and a car are moving on parallel tracks in opposite directinos with speeds of $144km/hr$ and $72km/h$ respectively. The engine is continously sounding a whistle of frequency 500Hz. The velocity of sound in $340ms^{-1}$. Calculate the frequency of sound heard in the car when

(i) the car and engineare approaching one another,

(ii) the two are moving away from one another.

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269. A source emitting sound of frequency 1000 Hz is moving towards an observer at speed $v_s = 0.90v$,(where v is the velocity of sound) . What frequency will be heard by the observer ?

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270. A policeman on duty detects a drop of $10\,\%$ in the pitch of the horn of a moving car as it crosses him. If the velocity of sound is $330m/s$, the speed of the car will be

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271. The whistle of an engine moving at $30km/h$ is heard by a motorist driving at $15km/h$ and he estimated the pitch to be 500. What would be the actual pitch if two are approaching each other ? Velocity of sound is 1220km//h .

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272. A car passing a check post gives sound of frequency 1000 c.p.s. If the velocity of the car is $72km/h$ and of sound is $350m/s$, find the change is apparent frequency as it crosses the post.

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273. The spectral line emitted by a star, known to have a wavelength of 6500 Å.What is the speed of the star in the line of sight relative to the earth ? Is the star approaching or receding ? Speed of light in air $= 3 \times 10^8 ms^{-1}$.

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274. The spectral line of wavelength $\lambda = 5000Å$ in the light coming from a distant star is observed as 5200 Å.Determine the recession velocity of the star.

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275. A given element in a star is giving out radiations of certain wavelength.The wavelength , when sighted on earth, has a shift of 0.025 % towards the longer wavelength side.What is the velocity of the star in the line the sight ? Given the velocity of light, $c = 3 \times 10^8 ms^{-1}$.

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276. Earth is moving towards a fixed star with a velocity of $30 kms^{-1}$. An observer on earth observes a shift of $0.58 Å$ in wavelength of light coming from star. What is the actual wavelength of light emitted by star ?

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277. Find the intensity level of a sound wave that has an intensity of $10^{-5} Wm^{-2}$.

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278. The intensity level of a sound of intensity of $10^{-12} watt/cm^2$ is 40 dB. What is the zero level of intensity ?

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279. The intensity of sound at a point A is $10^{-4} Wm^{-2}$ and that at point B is $10^{-8} Wm^{-2}$.What is the difference between the intensity levels at A and B ?

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280. The power output of a double speaker at a frequency of 60 Hz is 50 W.At a frequency of 90 Hz, the intensity of sound is 20 dB higher.What is the power output at 90 Hz ?

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281. A hall has a volume of $10000m^3$. Its total absorption is equivalent to 400sq. M of an open window. What will be the effect on a reverberation time if audience fills the hall and increases the absorption by another 400sq. Metre of an open window?

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282. Build up a musical scale of music with 288 Hz as the key note.

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283. Determine the frequency of the note F on the diatonic scale and on equally tempered scale if the key note C is 512 Hz.

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284. Calculate the sum of the intervals used in a major diatonic scale.

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285. The frequency of an octave is 576.Find the 5th note of the major diatonic scale.

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