PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

SUPERPOSITION OF WAVES

Example

1. The displacement of a periodically vibrating particle is $y = 4\cos^2\left(\frac{1}{2}t\right)$ sin (1000t) . Calculate the number of harmonic waves that are superposed .

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2. The displacement of a particle at the position x = 0 in a medium due to two different progressive waves are $y_1 = \sin 4\pi t$ and $y_2 = \sin 2\pi t$, respectively. How many times would the particle come to test in every second ?

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3. A sound wave of frequency 80 Hz gets reflected noumally from a large wall. Estimate the distance of the first node and the first antinode from the wall. Given , velocity of sound in air $= 320 m \cdot s^{-1}$.

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4. A wave represented by the equation y = A cos $(ks - \omega t)$ superposes on another wave to produce a stationary wave with a node at s = 0 . What is the equation of this second wave ?

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5. The equation of the vibration of a wire is $y = 5\cos\frac{\pi x}{3}\sin 40\pi t$, where x and y are given in cm and t is given in s. calculate the amplitudes and velocities of the two waves which on superposition, from the above-mentioned vibration,

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6. The equation of the vibration of a wire is $y = 5\cos\frac{\pi x}{3}\sin 40\pi t$, where x and y are given in cm and t is given in s. calculate the distance between two closest points of the wire that are always at rest,

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7. The equation of the vibration of a wire is $y = 5\cos\frac{\pi x}{3}\sin 40\pi t$, where x and y are given in cm and t is given in s. calculate the velocity of a particle at x = 1 . 5 cm at the instant $t = \frac{9}{8}s \cdot$

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8. Two stretched wires made of the same material have lengths, diameters and tensions, each in the ratio 1 : 2 . The first wire emits a fundamental tone of frequency 200 Hz . What is the funcamental frequency of the 2nd wire ?

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9. The lengths of two wires made of the same material are in the ratio 2 : 3 . Their diameters are equal and the fundamental of the shorter wire is one octave higher than of the longer wire. Find the ratio between the tensions in the two wires.

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10. A Wire of density $9g \cdot cm^{-3}$ is elongated by 0 . 05 cm when stretched between two clamps 100 cm apart. Find out the lowest frequency of transverse vibration in the wire. Given, Young's modulus of the material of the wire $= 9 \times 10^{11} dyn \cdot cm^{-2}$.

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11. A stationary wave having 5 loops is generated in a 10 m long wire . What is the frequency, if the wave velocity is 20 $m \cdot s^{-1}$?

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12. A uniform wire of length 12 m and mass 6 kg is suspended from a rigid support. A mass of 2 kg is a attached to the lower free end. A transverse wave of length 0 . 0 6 m is generated at the lower end of the wire . What is its wavelength when the wave reaches the upper end ?

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13. A wire is stertched with negligible tension at 30° C between two rigid supports. Find the velocity of the transverse wave in the wire at 20° C . Given, the coefficient of linear expansion, the Young's modulus and the density of the material of the wire of $\alpha = 18 \times 10^{-6 \circ} C^{-1}, Y = 12 \times 10^{11} dyn \cdot cm^{-2}$ and $\rho = 6 g \cdot cm^{-3}$ respectively.

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14. A Sonometer wire emits a tone of frequency 150 Hz . Find out the frequency of the fundamental tone emitted by the wire if the tension is increased in the ratio 9 : 16 and the length is doubled .

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15. The fundamental frequency of a 100 cm long sonometer wire is 330 Hz. Find out the velocity of transverse wave in the wire and the wavelength of the resulting sound waves in air . Given , velocity of sound in air = 330 $m \cdot s^{-1}$.

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16. A wire, kept between two bridges 25 cm apart, is stretched through a linear expansion of 0.04 cm . Find the fundamental frequency of vibration of the wire. Given, the density and the

Young's modulus of the material of the wire are 10 $g \cdot cm^{-3}$ and $9 \times 10^{11} dyn \cdot cm^{-2}$, respectively.

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17. The linear density of mass of a metal wire is $9.8 g \cdot m^{-1}$. It is kept between two rigid supports, 1 m apart, with a tension of 98 N. The mid-point of the wire is kept between the poles of an electromagnet driven by an alternating current. Find out the frequency of this alternating current that will produce resonance in the wire.

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18. A 1 m long wire is clamped at both ends. Find out the positions of two bridges that will divide the wire in three parts such that the fundamental frequencies are in the ratio 1 : 2 : 3 .

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19. The linear density of a wire is 0 . 0 5 $g \cdot cm^{-1}$. The wire is stretched with a tension of 4.5×10^7 dyn between two rigid supports . A driving frequency of 420 Hz resonates the wire. At the next higher frequency of 490 Hz , another resonance is observed. Find out the length of the wire .

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20. One end of a wire of radius r is sealed with the end of another wire of radius 2r . This is used as a sonometer wire with tension T , keeping the junction at the mid-point of the vibrating length . If a stationary wave having a node at the junction is generated, find out the ratio between the number of loops in the two portions .

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21. Find out the frequency of the first overtone emitted by a 1 . 25 m long organ pipe closed at one end. Given , velocity of sound in air $= 320m \cdot s^{-1}$

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22. Find out the frequencies of the fundamental and its nearest harmonic emitted by a 1 m long closed organ pipe. Given, velocity of sound in air $332m \cdot s^{-1}$.

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23. The length of an organ pipe closed at one end is 90 cm . Find out the frequency of the harmonic next to the fundamental . Velocity of sound in air $= 300m \cdot s^{-1}$.

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24. The length of an organ pipe open at two ends is twice that of another organ pipe closed at one end . If the fundamental frequency of the open pipe is 100 Hz , find out the frequency of the 3rd harmonic emitted by the closed pipe .

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25. Find out the fundamental frequency of a 125 cm long organ pipe closed at one end . Given, velocity of sound in air $= 350 m \cdot s^{-1}$.

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26. A 20cm long closed pipe emits a tone of frequency 400 Hz . Find out the length of an open pipe emitting a tone of frequency 600 Hz at the same time.

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27. The length of an open orgen pipe is twice the length of a closed organ pipe. If the fundamental frequency of the open pipe is 100 Hz , what is the frequency of the third harmonic of the closed pipe ?

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28. One end of an open pipe is suddenly closed. It is observed that the frequency of the 3rd harmonic from the closed pipe is 100 Hz higher than the fundamental frequency of the open pipe. Find out this fundamental frequency when both the ends are open .

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29. In winter, the frequency of a tone emitted at 10° C by an open organ tube is 400 Hz . What will be the frequency of this tone at 40° C in summer ?

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30. A 1 m long uniform cylindrical container is closed by two thin vibrating membranes A and B at its two ends [Fig . 4 . 15] . A third thin vibrating membrane C divides the container into two equal parts. The parts AC and BC are filled with haydrogen and oxygen gases, respectively . The membranes A and B are vibrated with the same frequency . Find out the minimum frequency of this vibration so that a node is formed at C . Given, velocities of sound in hydrogen and oxygen gases are 1100 $m \cdot s^{-1}$ and $300 m \cdot s^{-1}$, respectively .

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31. Find out the coefficient of linear expansion of the material of an open pipe so that the frequency of any tone emitted from it does not very with temperature .

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32. A tuning fork of frequency 384 Hz produces the 1st and the 2nd resonances with air columns of a pipe closed at one end at lengths 22 cm and 67 cm, respectively. Find out the velocity of sound in air, and the end error for the open end of the tube

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33. A tuning fork of frequency 256 Hz is held over the open upper end of a 200 cm long vertical tube filled with water. Then water is allowed to escape gradually through the lower end. Find out the positions of the water surface at the 1st and 2nd resonances. Neglect the end error. The velocity of sound in air = 320 $m \cdot s^{-1}$.

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34. When two tuning forks are vibrated simultaneously, 4 beats are heard per second. The fork is waxed slightly and then 6 beats are heard per second when both are vibrated again simultaneously . Find out the frequency of the second fork . Given the frequency of the first fork is 510 Hz .

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35. 2 wires of length 78 cm and 80 cm of a sonometer are kept at the same tension. A tuning fork produces 4 beats per second with each of them . Find out the frequency of the tuning fork .

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36. A 75 cm long stretched string is tuned with a tuning fork. If the length of the string is reduced by 3 cm, it produces 6 beats with the tuning fork per second. Find out the frequency of the tuning fork.

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37. A tuning fork of unknown frequency produces 5 beats per second with another tuning fork. The second fork can cause a closed organ pipe of length 40 cm to vibrate in its fundamental mode. The beat frequency decreases when a small amount of wax is dropped on the first fork. Find out the frequency of the first tuning fork. Given, speed of sound in air $= 320m \cdot s^{-1}$.

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38. Two tuning forks A and B, when vibrated simultaneously, produce 5 beats per second . 40 cm and 40.5 cm lengths of a sonometer wire, kept in the same tension, are tuned with the forks A and B respectively. Find out the frequencies of the two tuning forks .

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39. Two wires are tied on a sonometer. The tensions, the lengths, the diameters and the densities of the materials of the two wires are in the ratio 8 : 1 , 36 : 35 , 4 : 1 and 1 : 2 , respectively. Find out the number of beats produced per second when the two wires are vibrated simultaneously. Given, the frequency of the wire emitting a tone of higher pitch is 360 Hz .

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40. Two tuning forks A and B, when vibrated simultaneously, produce 5 beats per second. The forks produce resonances respectively with 36 cm and 37 cm long air columns of a tube closed at one end. What are the frequencies of the tuning forks ?

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41. A diver sends an audio signal from some depth under water. This signal produces 5 beats per second with the note emitted by a 20 cm long pipe whose one end is closed. Find out the frequency and the wavelength of the audio signal inside water. Given , velocity of sound in air $= 360 m \cdot s^{-1}$ and that in water $= 1500 m \cdot s^{-1}$.

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42. Two waves form 10 beats in 3 s in a gas. The wavelengths are 1 m and 1 . 0 1 m , respectively . Find out the velocity of sound in the gas .

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43. 24 tuning forks are arranged in the ascending order of their frequencies. Each fork produces 4 beats per second with its immediately preceding fork . The last fork emits an octave to that emitted by the first one. Find out the frequencies of the first and the last tuning forks.

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44. A wire of length 25 cm and mass 2 . 5 g is stretched with a fixed tension. The length of a pipe closed at one end is 40 cm . During vibrations, the first overtone of the wire produces 8 beats per second with the fundamental emitted by the pipe . The number of beats reduces with the decrease in tension in the wire. If the velocity of sound in air is 320 $m \cdot s^{-1}$, find the tension in the wire.

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45. A sonometer wire is stretched by hanging a 10 cm high brass cylinder vertically from one of its ends. The wire resonates with a tuning fork of frequency 256 Hz . Now the cylinder is partially immersed in water. If the wire and the tuning fork are vibrated simultaneously, 4 beats are heard per second. Calculate the length of the portion of the cylinder that was immersed in water. Given , density of brass $= 8.5 g \cdot cm^{-3}$.

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46. Two progressive waves $y_1 = 4 \sin 500\pi t$ and $y_2 = 2 \sin 506\pi t$ are superposed. Find the number of beats produced in one minute .

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47. Three transverse progressive waves are $z_1 = A\cos(kx - \omega t)$, $z_2 = A\cos(ks + \omega t)$ and $z_3 = A\cos(ky - \omega t)$. How may these be superposed to generate

(i) a stationary wave,

(ii) a wave propagating in a direction inclined at an angle of 45°

with both the positive x and y - axes ? In each case, find out the positions where the resultant intensity would always be zero .

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Higher Order Thinking Skill Hots Questions

1. When you sing in the shower why is the sound heard

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2. Which of the tones will be absent in the note emitted from a string clamped at both ends, when it is struck at a distance of one-third or its length from one end ?

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3. What would be the change in the fundamental frequency of a stringed Instrument if

(i) the length of the string is doubled,

(ii) the tension is doubled,

(iii) the diameter is doubled ?

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4. Compare the fundamental frequencies of the tones emitted by two pipes of equual length, one open at both ends and the other closed at one end.

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5. A closed pipe and an open pipe emit fundamental tones of the same frequency. Find out the ratio of their lengths.

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6. Would the frequencies of the tones emitted from a closed or an open pipe change if the temperature of the air column in the pipe increases ?

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7. How would the fundamental frequency emitted from an organ pipe, open at both the ends, change, if

(i) an open end is suddenly closed,

(ii) the length of the pipe is increased,

(iii) the diameter of the pipe is increased ?

(iv) what would happen if air is blown heavily through an open end ?

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8. Why is the musical sound emitted from an open pipe more pleasant than that emitted from a closed pipe ?

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9. A stretched vibrating string is touched at a distance of $\frac{1}{3}$ rd of its length from one end. What would happen to the musical sound emitted ?

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10. Two tuning forks, vibrating simultaneously, produce 6 beats per second. The first of them has a frequency of 312 Hz . Some amount of wax is added to one arm of the second tuning fork , the number of beats per second reduces to 3 . Find out the frequency of this second tuning fork . Is it possible to increase the beat frequency to 6 per second by adding some more wax to the second tuning fork ?

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11. Two identical wires of equal lengths are stretched in such a way that their simultaneous vibrations produce 6 beats per second. The tension in one of the wires is changed slightly and it is observed that the beat frequency remains the same. How is it possible ?

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12. Three tuning forks of frequencies n - x , n and n + x are vibrated simultaneously . If the amplitudes of vibration are equal , show that the forks would form beats .

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13. Three sources emitting sound waves of the same amplitude, have frequencies 400 Hz , 401 Hz and 402 Hz , respectively . Find out the number of beats heard per second .

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14. A 100 cm long stretched string is struck at a point 25 cm from one of its ends. Which of the overtones would be absent in the emitted notes ?

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15. In a particular vibrating mode of a stretched string of length l clamped at both the ends, n nodes are formed . What is the wavelength of the stationary wave formed in this mode ?

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16. The equations of two progressive waves superposing on a string are $y_1 = A\sin[k(x - ct)]$ and $y_2 = A\sin[k(x + ct)]$. What is the distance between two consecutive nodes ?

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17. Two waves represented as $y_1 = A_1 \sin \omega t$ and $y_2 = A_2 \cos \omega t$ superpose at a point in space. Find out the amplitude of the resultant wave at that point .

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18. The length of a stretched string between two rigid supports is 40 cm. What would be the maximum length of a stationary wave that can be formed in the string ?

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19. The equation of a transverse progressive wave is y = 0 . 02 sin (x + 40 t) m . Find out the tension in a wire of linear density $10^{-4} kg \cdot m^{-1}$, If the wave travels along it .

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20. The superposltion of two progresslve waves produce a stationary wave represented as y = a cos (0 . 0 1 x) sin (100 t) m . What is the velocity of the two component waves ?

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21. A uniform wire has length l and area of cross section α and the density of its material is ρ . If the wire is stretched with a tension T , what would be the velocity of a transverse wave travelling along it ?

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Multiple Choice Questions Based On Standing Wave

1. A wave $y = a\sin(\omega t - kx)$ being superposed with another wave produces a node at x = 0. The equation of the second wave should be

A. $y = a\sin(\omega t + kx)$

B. $y = -a\sin(\omega t + kx)$

C. $y = a\sin(\omega t - kx)$

D. $y = -a\sin(\omega t - kx)$

Answer: B

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2. At the instant when all the particles in the medium of a stationary wave are at their equilibrium positions the

A. kinetic energy becomes zero

B. potential energy becomes zero

C. net energy becomes zero

D. none of these becomes zero

Answer: B

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3. Which of the following remains constant in case of vibration of the particles in a stationary wave ?

A. velocity

B. acceleration

C. amplitude

D. phase

Answer: C

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4. When two identical sound waves superpose at a point with a phase difference of 180° .

A. the point will be a node

B. the intensity of sound will increase at that point

C. the point will be an antinode

D. beats will be heard

Answer: A

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5. The equation of a progressive wave is $y = A\cos(kx - \omega t)$. This wave superposes with another wave and produces a stationary wave try creating a node at x = 0 . Which of the following equations is correct for the other wave ?

A. $A\sin(kx + \omega t)$

B. $-A\sin(kx - \omega t)$

C. $-A\cos(kx + \omega t)$

D. $-A\sin(kx - \omega t)$

Answer: C

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Multiple Choice Questions Based On Trabsverse Vibration Of String And Sonometer

1. A fundamental tone of frequency n_1 is produced when a string stretched at both ends is vibrated. The frequency of the fundamental tone changes to n_2 when the tension in the string is double. What is the ratio of $n_1 \text{ and } n_2$?

A. $1:2$

B. $2:1$

C. $1:\sqrt{2}$

D. $\sqrt{2}:1$

Answer: C

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Multiple Choice Questions Based On Vibration Of Air Column

1. The waves genetated due to vibration of an air column in a pipe open at one end or a pipe open at both ends are

A. transverse progressive waves

B. transverse stationary waves

C. longitudinal progressive waves

D. longitudinal stationary waves

Answer: D

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2. When a fundamental tone is produced from a pipe of length l. open at both ends, the wavelength of the stationary wave is

A. $\frac{l}{2}$

B. l

C. 2l

D. 4l

Answer: C

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3. If the frequency of the fundamental tone emitted from a pipe closed at one end is 200 Hz, then the frequencies of the first three overtones will be

A. 400 Hz, 600 Hz, 800 Hz

B. 600 Hz, 1000 Hz, 1400 Hz

C. 400 Hz, 800 Hz, 1200 Hz

D. 600 Hz, 800 Hz 1000 Hz

Answer: B

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4. Fundamental tone is emitted from a pipe closed at one end. If the closed end is suddenly opened,

A. the pitch of the tone decreases

B. the intensity of the tone decreases

C. the pitch of the tone increases

D. the intensity of the tone increases

Answer: C

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5. When a fundamental tone is produced from a pipe of length l, closed at one end, the wavelength of the stationary wave is

A. $\frac{l}{2}$

B. l

C. 2l

D. 4l

Answer: D

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6. Due to the end error in stationary waves produced in a closed ar an open pipe

A. antinodes are not formed at the closed end

B. antinodes are formed inside the pipe very close to its open end

C. nodes are formed slightly outside the open end of the pipe

D. none of these

Answer: C

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7. When the temperature of air in a closed or an open pipe increases the frequency of stationary wave will

A. remain the same

B. increase

C. decrease

D. depend of other factors also

Answer: B

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8. The frequencies of the fundamental tones in a closed and an open pipe are the same . The ratio of the lengths of the two pipes is

A. $1:1$

B. $1:2$

C. $2:1$

D. $4:1$

Answer: B

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9. While measuring the speed of sound by performing a resonance column experiment, a student gets the first resonance condition at a column length of 18 cm during winte. Repeating the same experiment during summer. He measures the column length to be x cm for the second resonance. Then .

A. $18 > x$

B. $x > 54$

C. $54 > x > 36$

D. $36 > x > 18$

Answer: B

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10. A student is performing the experiment of resonance column. The diameter of the column tube is 4cm . The frequency of the tuning fork is 512 Hz . The air temperature is 38° c in which the speed of sound is 336 m /s . The zero of the meter scale coincides with the top end of the resonance column tube. When the first resonance occurs, the reading of the water level in the column is

A. 14 cm

B. $15.\ 2$ cm

C. 16 . 4 cm

D. 17 . 6 cm

Answer: B

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11. A student is performing an experiment unsing a resonance column and a tuning fork of frequency 224 s^{-1} . He is told that the air in the tube has been replaced by another gas (assume that the column remains filled with the gas) . If the minimum height at which resonace occurs is (0.350 ± 0.005) m , the gas in the tube is (using information : $1\sqrt{167RT} = 649J^{-1/2} \cdot mol^{-1/2}, \sqrt{140RT} = 590J^{1/2} \cdot mol^{-1/2}$.

The molar masses M in grams are given in the opeions . take the value of $\sqrt{\left(\frac{10}{M}\right)}$ for each gas as given there)

A. neon $\left(M = 20, \sqrt{\frac{10}{20}} = \frac{7}{10}\right)$

B. nitrogen $\left(M = 28, \sqrt{\frac{10}{28}} = \frac{3}{5}\right)$

C. oxygen $\left(M = 32\sqrt{\frac{10}{32}} = \frac{9}{16}\right)$

D. argon $\left(M = 36\sqrt{\frac{10}{36}} = \frac{17}{32}\right)$

Answer: D

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Multiple Choice Questions Based On Beats

1. What should be the frequency so that it is not audible to human ear ?

A. greater the 10 Hz

B. 10 Hz

C. 5 Hz

D. less than 5 Hz

Answer: A

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2. If n_1 and n_2 are the frequencies of two sound waves, the frequency of the beat produced due to superposition of these waves will be

A. $n_1 - n_2$

B. $n_1 + n_2$

C. $\frac{n_1 + n_2}{2}$

D. $2(n_1 - n_2)$

Answer: A

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3. Beats are not observed for light waves, because

A. there is no difference in velocities of two light waves

B. it is impossible to stabillise the frequency difference of two light waves below 10 Hz

C. it is impossible to keep the intensities of two light waves equal or nearly equal

D. none of these

Answer: B

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4. When two waves $y_1 A \sin 2000\pi t$ and $y_2 = A \sin 2008\pi t$ are superposed, the number of beats produced per second is

A. 0

B. 1

C. 4

D. 8

Answer: C

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5. A set of 25 tuning fork is arranged in a series of decreasing frequencies such that each fork gives 3 beats with succeeding one . The first fork is octave of the last. Frequency of the 10^{th} fork is

A. 120 Hz

B. 117 Hz

C. 110 Hz

D. 89 Hz

Answer: B

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Multiple Choice Questions Miscellaneous

1. The displacement of a particle in a medium at any instant due to the effect of more than one wave is

A. not dependent on the displacements due to the individual waves

B. equal to the vector sum of the displacements due to the individual waves

C. equal to the displacement due to any one of the waves

D. radom due to the effect of all the waves

Answer: B

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2. A sound wave of frequency 500 Hz advancing along positive x axis with a speed of $300 m \cdot s^{-1}$. Phase difference between two points x_1 and $x_2 is 60^\circ$. The least distance between those two points is

A. 1 mm

B. 1 cm

C. 10 cm

D. 1 m

Answer: C

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3. When two progressive waves $y_1 = 4\sin(2x - 6t)$ and $y_2 = 3\sin\left(2x - 6t - \frac{\pi}{2}\right)$ are superposed, the amplitude of the resultant wave is

A. 5

B. 6

C. $\frac{5}{3}$

D. $\frac{1}{2}$

Answer: A

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4. A hollow pipe of length 0. 8 m is closed at one end. At its open end a 0 . 5 m long uniform string is vibrating in its second harmonic and it resonates with the fundamental frequency of the pipe. It the tension in the wire is 50 N and the speed of sound is $320m \cdot s^{-1}$. the mass of the string is

A. 5 g

B. 10 g

C. 20 g

D. 40 g

Answer: B

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5. A sound of 20 dB is more intense than a sound of 10 dB by

A. 100

B. $\frac{1}{10}$

C. 10

D. 0.01

Answer: C

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Very Short Answer Type Question Based On Standing Wave

1. What type of wave is formed when two identical but oppositely directed progressive waves superpose ?

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2. Name the type of wave which does not transmit energy form one place to another.

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3. If λ is the wavelength of a stationary wave, what would be the distance between two consecutive nodes ?

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4. If λ is the wavelength of a stationary wave, what would be the distance between a node and the adjacent antionde ?

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5. How many times in each period all the paritcles in the medium for a stationary wave, come to rest simultaneously ?

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6. The phase is always the same for all particles between two consecutive nodes of a stationary wave . Is the statement ture or false ?

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Very Short Answer Type Question Based On Transverse Vibration Of String And Sonometer

1. The fundamental frequency of transverse vibration in a taut string is 200 Hz . What will be the fundamental frequency If the length of the string is doubled, with its tension unchanged ?

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2. The fundamental frequency of transverse vibration in a taut string is 200 Hz .keeping the length of the string unaltered, if tension is doubled, what will be the fundamental frequency ?

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3. How does the frequency of the fundamental tone of transverse vibration in a stretched string change when a comparatively thicker string of the same material is used ?

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Very Short Answer Type Question Based On Vibration Of Air Column

1. At the ends of an organ pipe open at both ends, what do we always get-nodes or antinodes ?

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2. If the fundamental frequency emitted by a pipe closed at one end is 200 Hz, what is the frequency of the first overtone ?

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3. If the fundamental frequency emitted by a pipe open at both ends is 200 Hz , what is the frequency of the first overtone?

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4. If the fundamental frequency of a closed pipe is 200 Hz . What would be the fundamental frequency of an open pipe of equal length ?

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5. Which harmonics are present in the note produced from a pipe closed at one end?

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Very Short Answer Type Question Based On Beats

1. What will be the beat frequency when two tuning forks of frequencies 256 Hz and 260 hz are vibrated simultaneously ?

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2. As in sound can beats be observed by two light sources ?

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3. The superposition of two progressive sound waves of equal speed and amplitude but of slightly different frequencies produces ____ . [Fill in the blank]

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4. beats are heard when two tuning forks of frequencies 256 Hz and 260 Hz are vibrated simultaneously . If some wax is dropped at one of the prongs of the first fork, how will the beat frequency change ?

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Shoet Answer Type Question I

1. If λ the wavelength of a stationary wave, discuss what will be the distance of the third antinode from a particular node .

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2. Discuss, in which of the cases given below, the pitch of the fundamental tone emitted from a taut string may increase :

(i) when length of the string in increased

(ii) when length of the string is decreased

(iii) when tension in the string is increased

(iv) when tension in the string is decreased

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3. In a sonometer, two adjacent wires of the same material are stretched under the same tension. The first wire is thicker than the other. The corresponding frequencies of length l_1 and l_2 of the sonometer wires are in unison with a tuning fork. Which of the following is correct ? Give reasons.

(i) $l_1 = l_2$

(ii) $l_1 < l_2$

(iii) $l_1 > l_2$

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4. One of two organ pipes has a diameter greater than the other. Even if the lengths of the two organ pipes are equal , the pitch of the fundamental tones differ. Why ?

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5. Two tuning forks produce 4 beats per second. If the prong of one fork is made a little heavy , 2 beats are produced per second. If the prong is made still heavier, again 4 beats are produced per second . How is this possible ?

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6. Two pipes of equal length, one open at one end and the other open at both ends, produce 5 beats per second with a tuning fork. How is this possible ?

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7. When a tuning fork of unknown frequency and another tuning fork of frequency 256 Hz are vibrated simultaneously . 4 beats are produced per second . If some wax is dropped on the prong of the first tuning fork, the number of beats produced per second is still 4 . How is this possible ?

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8. The velocity of sound is higher in medium B than that in medium A . In which medium will the antinodes be closer if a stationary wave is produced ?

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9. What will be the change in frequency of the fundamental tone if the temperature of a taut string is increased ?

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Shoet Answer Type Question Ii

1. Prove that the pitch of the fundamental tone emitted by an open pipe is one octave higher than that emitted by a closed pipe of equal length .

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2. Discuss the result of superposition of two waves $y_1 = A\sin\frac{2\pi}{\lambda_1}(Vt - x)$ and $y_2 = A\sin\frac{2\pi}{\lambda_2}(Vt - x)$

[here λ_1 is slightly greater than λ_2] .

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Problem Set I Based On Standing Wave

1. A sound wave of frequency 660 Hz is incident normally on a reflector. What is the distance of the nearest particle vibrating with the maximum amplitude, from the reflector ? Velocity of sound = 330 $m \cdot s^{-1}$.

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Problem Set I Based On Transverse Vibration Of String And Sonometer

1. A fundamental tone of frequency 200 Hz is emitted from a taut string. If the length of the string is increased by 10% , what will be the frequency ?

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2. Show that if $n_1, n_2, n_3, n_4....$ are the fundamental frequencies of the segments into which a string is divided by placing a number of bridges below it . The frequency of the string is given by

$$\frac{1}{n} = \frac{1}{n_1} + \frac{1}{n_2} + \frac{1}{n_3} + \dots$$

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3. Two strings of the same length and material are stretched under the same tension . If the ratio of their diameters is 4 : 3 , what is the ratio of the frquencies of their fundamental tones ?

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4. By what percentage should the tension in a stretched string be incerased or decreased,keeping its length intact, so that the frequency increases by 10% ?

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5. The mass of string (M) = 2 . 5 g , length (l) = 25 cm and tension (T) = 25 N . Determine the fundamental frequency of transverse vibration in the string .

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6. A 20 cm long string, having a mass of 1 . 0 g is fixed at both the ends. The tension in the string is 0 . 5 N . The string is set into vibration using an external vibrator of frequency 10 Hz . Find the separation (in cm) between the successive nodes on the string .

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7. The density of the material of sonometer wire $\rho = 8g \cdot cm^{-3}$, diameter d = 0 . 4 mm , mass suspended from its free end, M = 2 kg and the distance between two moving bridges, l = 50 cm. Determine the fundamental frequency of transverse bibration in the wire $(g = 980cm \cdot s^{-2})$.

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8. a 50 cm long string is clamped between two rigid supports. If the frequency of the fundamental tone emitted from the string is 200 Hz, what is the velocity of the transverse wave ?

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9. A 2 kg mass is suspended from the free end of a sonometer wire. The radius of the wire is 0 . 1 mm and the density of its meterial is 8 $g \cdot cm^{-3}$. What is the velocity of the transverse vibration in the string ?

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10. The velocity of transverse vibration is a 60 cm long taut string is $150m \cdot s^{-1}$. What is the frequency of the second overtone emitted by this string ?

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11. The ratios of lengths, diameters and masses suspended from the free ends of two sonometer wires of the same meterial are 2 : 3

, 2 : 3 and 1 , 4 , respectively. What is the ratio of their fundamental frequencies ?

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12. Two sonometer wires of the same sample having the same mass per unit length are made taut. One is twice as long as the other, but they are resonating with each other. Compare their tensions .

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13. The frequency of the fundamental emitted from a taut sonometer wire is $250s^{-1}$. Its length is doubled and the tension is increased in such a way that the fundamental frequency remains the same . Obtain the relation between the new and the original tensions .

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14. The second harmonic emitted by a sonometer wire is in unison with the third harmonic emitted by another sonometer wire of half the length. If the mass per unit length of the two wires is the same , what is the ratio of their tension ?

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Problem Set I Based On Vibration Of Air Column

1. The length of a pipe, open at one end is 30 cm . If the velocity of sound in air is 330 $m \cdot s^{-1}$, find out the fundamental frequency and the frequencies of the first two overtones formed due to vibration of the air column in the pipe .

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2. The third overtone of a closed organ pipe is found to be in unison with the first overtone of an open pipe . Find the ratio of the lengths of the pipes .

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3. By what percentage should the length of a pipe, closed at one end, be increased or decreased, so that the fundamental frequency of the pipe decreases by 20% ?

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4. What should be the ratio of the lengths of a closed and an open pipe so that the frequency of the first overtone emitted from the closed pipe is in unison with that emitted from the open pipe ?

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5. The velocity of sound in air is $320 m \cdot s^{-1}$. The length of a closed pipe is 1 m . If the end error in nelected, which of the following frequencies produce resonance with the air column of the pipe : $80 Hz / 240 Hz / 320 Hz / 400 Hz$

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6. The ratio of frequency of the second harmonic emitted from an open organ pipe to the frequency of the third harmonic emitted from a similar pipe is 1 : 2 . What is the ratio of lengths of the two pipes ?

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7. The diameters of two 9 cm long closed pipes are 1 cm and 2 cm , respectively. What is the ratio of the f requencies of fundamental tones emitted from the two pipes ?

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8. The first harmonic emitted from a closed pipe p_1 and the third harmonic emitted from an open pipe p_2 produce resonance with a tuning fork. What is the ratio of lengths of $p_1 \text{ and } p_2$?

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9. When the length of air cloumn in a pipe, closed at one end, is 20 cm, it produces the first resonance with the vibration of a tuning fork . If the end error is 1 cm , what will be the length of the air column to produce the next resonance ?

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10. A 50 cm long pipe, open at both ends, produces resonant vibration with a tuning fork. If the velocity of sound in air is $350m\cdot s^{-1}$, what is the frequency of the tuning fork ?

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11. The lengths of a closed pipe and an open pipe of equal diameters are 55 cm and 36 cm, respectively. The 1st overtone of the closed pipe is in unison with the fundamental of the open pipe. Calculate the end errors of the two pipes .

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12. A tuning fork of frequency 256 Hz is held over the open upper end of a 200 cm long vertical pipe filled with water and the water is slowly darined out through the bottom end of the pipe. Determine the positions of the water level at the time of the first and the second resonances. Neglect the end error. Velocity of sound in air $= 320 m \cdot s^{-1}$.

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13. A vibrating tuning fork of frequency 340 Hz is held over a cylindrical pipe. The length of the pipe is 120 cm . Now water is slowly poured into it. What should be the water level at which resonance will occur ? Velociy of sound in air $= 340 m \cdot s^{-1}$.

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14. The frequency of the fundamental emitted from a pipe open at one end is 512 Hz. If the other end of the pipe is opened, then determine the frequency of the fundamental .

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15. Determine the frequencies of first three overtones produced in a 50 cm long pipe open at both ends .

[Velocity of sound in air $=330 m \cdot s^{-1}$]

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Problem Set I Based On Beats

1. When two tuning forks are vibrated together, 6 beats are produced per second. If one of the prongs of the tuning fork of frequency 400 Hz is made slightly heavier, the number of beats per second decreases. What is the frequency of the other tuning fork ?

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2. A vibrating tuning fork of frequency 260 Hz produces 4 beats per second with a tone emitted from a violin. If one of the prongs of the tuning fork is slightly rubbed, the number of beats produced per second increases . What is the frequency of the tone emitted from the violin ?

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3. 5 beats are heard per second, when two tuning forks are struck together. The frequency of one of the tuning forks, is 295 Hz . A small amount of wax is put on the second. When both are struck again simultaneously the number of beats per second decreases. What is the frequency of the second fork ?

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4. The lengths of two taut strings are 70 cm and 60 cm respectively . If each of the two strings is sounded with a tuning fork, 5 beats are produced per second. What is the frequency of the tuning fork ?

Watch Video Solution

5. A 75 cm long sonometer wire is in resonance with a tuning fork. If the length of the wire is decreased by 3 cm , it produces 6 beats per second with the tuning fork . What is the frequency of the tuning fork ?

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6. The ratio of the frequencies of two tones is 15 : 16 and the higher frequency is $64s^{-1}$. Find the number of beats .

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Problem Set I Miscellaneous

1. The first overtone emitted from a closed organ pipe produces resonance with the third overtone emitted from an open organ pipe. What is the ratio of lengths of the two organ pipes ?

Watch Video Solution

2. The frequencies of the fundamentals produced by a 200 cm long pipe open at both ends and a 25 cm long sonometer wire are the same. The mass of 1 cm length of the wire is 1 g . Calculate the tension produced in the wire . Velocity of sound in air is $330 m \cdot s^{-1}$.

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Problem Set Ii Based On Stading Wave

1. Stationary waves are formed due to superposition of two oppositely directed waves, each of frequency 550 Hz, velocity 330 $m \cdot s^{-1}$ and of equal amplitude . Find (i) the distance between two consecutive antinodes, (ii) the distance between three consecutive nodes, (iii) the distance between a pair of adjacent node and antinode in this stationary wave .

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

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

Where x and y are in m and t in s . The length of the string is 1 . 5 m and its mass is 3.0×10^{-2} kg .

Answer the following ,

Does the funcation represent a travelling wave or a stationary wave ?

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

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

Where x and y are in m and t in s . The length of the string is 1 . 5 m and its mass is 3.0×10^{-2} kg .

Answer the following ,

Interpret the wave as a superposition of two waves travelling in opposite directions . What is the wavelength, frequency and speed of each wave ?

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

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

Where x and y are in m and t in s . The length of the string is 1 . 5 m and its mass is 3.0×10^{-2} kg .

Answer the following ,

Determine the tension in the string .

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5. Given below are some functions of x and t to represent the displacement (transversal or longitudinal) of an elastic wave. Identify the waves .

y = 2 cos (3x) sin (10t)

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6. Given below are some functions of x and t to represent the displacement (transversal or longitudinal) of an elastic wave. Identify the waves .

$y = 2\sqrt{x - vt}$

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7. Given below are some functions of x and t to represent the displacement (transversal or longitudinal) of an elastic wave.

Identify the waves .

y = 3 sin (5x -0 . 5 t) + 4 cos (5 x - 0 . 5 t)

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8. Given below are some functions of x and t to represent the displacement (transversal or longitudinal) of an elastic wave. Identify the waves .

y = cos x sin t + cos 2 x sin 2 t

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9. A transverse harmonic wave on a string is described by

$$y(x, t) = 3.0 \sin\left(36t + 0.018x + \frac{\pi}{4}\right)$$

where x and y are cm and t in s. The positive direction of x is from left to right .

Is this a travelling wave or a stationary wave ?

. If it is travelling, what are the speed and direction of its propagation ?

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10. A transverse harmonic wave on a string is described by

$$y(x,t) = 3.0\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$$

where x and y are cm and t in s. The positive direction of x is from left to right .

What are its amplitude and frequency ?

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11. A transverse harmonic wave on a string is described by

$$y(x,t) = 3.0\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$$

where x and y are cm and t in s. The positive direction of x is from left to right .

What is the initial phase at the origin ?

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12. A transverse harmonic wave on a string is described by

$$y(x, t) = 3.0 \sin\left(36t + 0.018x + \frac{\pi}{4}\right)$$

where x and y are cm and t in s. The positive direction of x is from left to right .

What is the least distance between two successive crests in the wave ?

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Problem Set Ii Based On Transverse Vibration Of String And Sonometer

1. A tuning fork of frequency 550 Hz produces resonance with air column of a pipe, closed at one end , at one end, at 14 . 5 cm and 44 . 5 cm . Determine the velocity of sound in air and the end error .

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2. Three wires of equal length are mounted on a sonometer. The ratios of their specific masses and tensions are 2 : 8 : 18 and 12 : 12 : 27 , respectively. What is the ratio of their frequencies of transverse vibration ?

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Problem Set Ii Based On Vibration Of Air Column

1. The fundamental frequency of an air-filled open organ pipe is 500 Hz. The frequecny of the first harmonic in a carbon dioxide-filled organ pipe, closed at one end, is equal to the frequency of the first harmonic in the first pipe. Find the lengths of each of the organ pipes . The velocities of sound in air and carbon dioxide are $300m\cdot s^{-1}$ and $264m\cdot s^{-1}$, respectively .

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2. Neglecting end corrections, determine the lengths of the three shortest closed pipes and the shortest open pipes, which would resound to a note of frequency 512 Hz when air in the pipes is at a temperature of 298 K.

[Velocity of sound at $273K = 330m\cdot s^{-1}$] .

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Problem Set Ii Based On Beats

1. A tuning fork is vibrated together with a length of 100 cm and then with a length of 95 cm, of a stretched sonometer wire. 10 beats are produced per second in each case. Find the frequency of the tuning fork .

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2. 8 beats are produced per second, when two tuning forks (A and B) are vibrated togeter. The tuning fork A produces resonance in the air column of length 37 . 5 cm of and open pipe and the tuning fork B produces resonance in the air column of length 38 . 5 cm of same pipe. Determine the frequencies of the two tuning forks .

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3. 65 tuning forks are arranged in ascending order of their frequencies . Any two successive forks produce 8 beats per second when vibrated together. The first and the last tuning forks are in unison with the fundamental and the third harmonic emitted from a stretched string, respectively.What is the frequency of the first tuning fork ?

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Problem Set Ii Miscellaneous

1. The frequency of the fundamental tone in a 60 cm long string is n . At what position should a bridge be placed below the wire so that the frequency of one part will be n_1 and that of the other part will be n_2 in such a way that the ratio $n : n_1$ is equal to the ratio $n_1 : n_2$?

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2. The velocity of sound in hydrogen is 1270 $m \cdot s^{-1} \text{at} 0^\circ$ C and the frequency of a fork is 335 Hz . Find the distance travelled by sound in hydrogen at $0^\circ C$ and 30° C in the time in which the fork completes 71 vibrations .

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Hots Numercal Problems

1. The displacement of a particle for a wave at the point x = 0 is given by $y = \cos^2 \pi t \sin 4\pi t$. Find out the number of harmonic waves that are superposed . What are their frequencies ?

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2. The equation of a stationary wave is $y = 2A \sin kx \cos \omega t$. Find the amplitudes, velocities and wavelengths of the two progressive waves, which on superposition produce this stationary wave .

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3. The equation of vibration of a 60 cm long string string stretched at both ends is given by $y = 4 \sin \frac{\pi x}{15} \cos 96 \pi t$.

Here x and y are expressed in cm and t in s .

What will be the maximum displacement of a particle at the position x = 5 cm ?

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4. The equation of vibration of a 60 cm long string string stretched at both ends is given by $y = 4 \sin \frac{\pi x}{15} \cos 96 \pi t$.

Here x and y are expressed in cm and t in s .

what are the positions of the nodes along the wire ?

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5. The equation of vibration of a 60 cm long string string stretched at both ends is given by $y = 4\sin\frac{\pi x}{15}\cos 96\pi t$.

Here x and y are expressed in cm and t in s .

What is the velocity of the particle at the position x = 7 . 5 cm , at time t = 0 . 25 s ?

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6. The equation of vibration of a 60 cm long string string stretched at both ends is given by $y = 4\sin\frac{\pi x}{15}\cos 96\pi t$.

Here x and y are expressed in cm and t in s .

What are the equations of the two superposed waves ?

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Hots Numercal Problems Based On Transverse Vibration Of String And Sonometer

1. The length of a guitar string is 90 cm and the frequency of the fundamental tone is 124 Hz. At which point should the string be pressed by a finger so that the frequency of the fundamental tone will be 186 Hz ?

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2. A steel wire of length 1 m, mass 0.1 kg and uniform cross sectional area $10^{-6}m^2$ is rigidly fixed at two ends. The temperature of the wire is lowered by 20° C . If transverse waves are now set up by lucking the string at the middle, calculate the frequency of the fundamental tone. Givne, for steel, co-efficient of linear expansion $= 1.21 \times 10^{-5} {}^{\circ}C^{1}$ and Young's modulus $= 2 \times 10^{11} N \cdot m^{-2}$.

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3. When the length of a wire obeying Hooke's law increases by x as it is stretched, the speed of sound emitted from this wire is v . If the length of the wire is increased further of 1 . 5 x , what will be the speed of sound emitted from it ?

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4. A sonometer wire is made taut by hanging a body of mass so.7 kg volumn 0 .0075 m^3 from the free end. The frequency of the fundamental tone of the vibration in the wire is 260 Hz . If the body is completely immersed in water, what will be the frequency of the fundamental tone ?

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5. A wire kept on two bridges 25 cm apart is elongated by o . 0 4 cm by application of a tension. The density and the Young's modulus of the metrial of the wire are $10g \cdot cm^{-3}$ and $9 \times 10^{11} dyn \cdot cm^{-2}$, respectively . Find the frequency of the fundamental tone of such a stretched string .

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6. A copper string is fixed between two rigid supports. The tension in the string is nearly zero, when it is just taut at 30° C . Find the velocity of transverse wave in the string at 10° C . For copper Young's modulus $y = 1.3 \times 10^{11} N \cdot m^{-2}, \alpha = 1.7 \times 10^{-5} {}^{\circ} C^{-1}$, density = $9 \times 10^{3} kg \cdot m^{-3}$.

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7. The two ends of a wire are rigidly fixed . If the temperature is decreased by 10° C , find the tension in the string from the given quantities : cross sectional area of the wire $= 0.01 cm^2$, coefficient of linear expansion of the material of the wire $= 16 \times 10^{6} {}^{\circ}C^{-1}$ and Young's modulus $= 20 \times 10^{11} dyn \cdot cm^{-2}$. If the frequency of transverse wave produced in the wire is twiece the previous value, what was the initial tension in the wire ?

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8. One end of a sonometer wire is fixed and a tension is applied on the wire by suspending a solid body of mass M from the other end . A fundamental tone of particular frequency is emitted at length 70 cm of the wire. If the mass M is fundamental tone of the same frequency, the length of the wire should be changed by 5 cm . Determine the density of the material of mass M .

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9. A string 25 cm long and having a mass of 2.5 g is under tension. When the string is set vibrating in its first overtone and the air in the pipe in its fundamental frequency , 8 beats per second are heard. It is observed that decreasing in the string, decreases the beat frequency . If the velocity of sound in air be $320m \cdot s^{-1}$ find the tension in the string .

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Hots Numercal Problems Based On Vibration Of Air Column

1. When the temperature of air is 10° C , a fundamental tone of frequency 500 Hz is emitted from an open pipe . What will be the frequency if the temperature rises to 30° C ?

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2. To what value should the atmospheric temperature be increased from 10° C , so that the frequency of the tone emitted from an organ pipe increases by 4% ?

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Hots Numercal Problems Based Beats

1. The equations of two sound waves are given gelow :

$y_1 = 10\sin\frac{\pi}{150}(33000t - x)cm$

and $y_2 = 10\sin\frac{\pi}{165}(33000t - x)cm$

How many beats will be produced per second due to superposition of these two waves ?

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2. The equations of two sound waves are given below :

$y_1 = 0.\ 2\sin\frac{2\pi}{3}(330t - x)m$

and $y_2 = 0.02\sin\frac{2\pi}{3+k}(330t - x)m$

If 10 beats are produced per sound due to superposition of these two waves, determine the value of k .

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3. A metal wire of diameter 1 mm is held on two knife edges separated by a distance of 50 cm. The tension in the wire is 100 N . The wire, vibration with it fundamental frequency together with a vibrating tuning fork, produces 5 beats per second . The tension in the wire is then reduced to 81 N . Now , when the two are excited, beats are heard again at the same rate . Calculate (i) the frequency of the tuning fork, (ii) the density of the meterial of the wire .

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Hots Numercal Problems Miscellaneous

1. A 76 cm long sonometer wire is stretched by a 4×10^6 dyn force and an alternating current is passed through it . A horse-shoe magnet is placed at the mid-point of the wire in such a way that the wire passes between the poles of the magnet . Resonant vibration is observed due to the force acting on the wire in this arrangement. The density of the material of the wire is $8.8g \cdot cm^{-3}$ and radius of the wire is 0 . 5 mm . Determine the frequency of the alternating current .

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2. An aluminium wire of length 60 cm and cross sectional area $10^{-2} cm^2$ is joined with a steel wire of the same cross sectional area. A 10 kg mass is used to produce tension in the conjoined wires. The length of the steel wire is 86.8 cm . A transverse wave is produced in the wire with the help of an external source . Find the minimum frequency of vibration in the wire for which a stationary wave is produced with a node formed at the junction of the two wires. The densities of aluminium and steel are $2.6g \cdot cm^{-3}$ and $7.8g \cdot cm^{-3}$, respectively .

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3. 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 340 Hz) when the tube length is 25 . 5 cm or 79 . 3 cm . Estimate the speed of sound in air at the temperature of the experiment. The edge effects may be neglected .

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4. A string passing over a smooth pulley carries a stone at one end, while its other end is attached to a vibrating tuning fork and the string shows 8 loops. When the stone is immersed in water 10 loops are formed. Calculate the specific gravity of the stone .

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5. A string of mass per unit length μ is clamped at both ends such that one end of the string is at $x = 0$ and the other end is at x = l . When string vibrates in fundamental mode amplitude of the mid point O of the string is a and tension in the string is T . Find the total oscillation energy stored in the string .

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Entrance Corner Assertion Reason Type

1. Statement I : When two vibrating tuning forks have $f_1 = 300Hz$ and $f_2 = 350Hz$ and are held close to each other, beats cannot be heard .

Statement II : The priniciple of superposition is valid only when $f_1 - f_2 < 10Hz$.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I .

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I .

C. Statement I is true, statement II is false .

D. Statement I is false, statement II is true ,

Answer: C

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2. Statement I : When a wave goes from one medium to other, then average power transmitted by the wave may change .

Statement II : Due to change in medium, amplitude, speed, wavelenght and frequency of wave may change .

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I .

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I .

C. Statement I is true, statement II is false .

D. Statement I is false, statement II is true ,

Answer: C

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3. Statement I : For a closed pipe, the 1st resonance length is 60 cm . The 2nd resonance position will be obtained at 120 cm .

Statement II : In a closed pipe, $n_2 = 3n_1$, where $n_1 =$ frequency of the fundamental tone and $n_2 =$ frequency of the 1st overtone .

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I .

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I .

C. Statement I is true, statement II is false .

D. Statement I is false, statement II is true ,

Answer: D

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4. Statement I : If two waves of same amplitude , produce a resultant wave of same amplitude, then phase difference between them will be 120° .

Statement II : Velocity of sound is directly proportional to the square of its absolute temperature .

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I .

B.

C. Statement I is true, statement II is false .

D. Statement I is false, statement II is true ,

Answer: C

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Entrance Corner M C Q

1. Following are equations of four waves

(i) $y_1 a \sin \omega\left(t - \frac{x}{v}\right)$ (ii) $y_2 = a \cos \omega\left(t + \frac{x}{v}\right)$

(iii) $z_1 = a \sin \omega\left(t - \frac{x}{v}\right)$ (iv) $z_2 = a \cos \omega\left(t + \frac{x}{v}\right)$

Which of the following statements are correct ?

A. on superposition of waves (i) and (ii), a travelling wave having amplitude $a\sqrt{2}$ will be formed

B. superposition of waves (ii) and (iii) is not possible

C. on superposition of (i) and (ii) . A statopnary wave having amplitude $a\sqrt{2}$ will be formed

D. on superposition of (iii) and (iv), a transverse stationary wave will be formed

Answer: A::D

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2. one end of a taut string of length 3 m along the x -axis is fixed at x = 0 . The speed of the waves in the string is $100m \cdot s^{-1}$. The other end of the string is vibrating in the y-direction so that stationary waves are setup in string. Obtain the possible waveforms of these stationary wave

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

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

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

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

Answer: A::C::D

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Entrance Corner Comprehension Type

1. A closed air column 32 cm long is in resonance with a tuning fork. Another open air column of length 66 cm is in resonance with another tuning fork. The two forks produce 8 beats per second when sounded together .

The speed of sound in air

A. $33792cm \cdot s^{-1}$

B. $35790cm \cdot s^{-1}$

C. $31890cm \cdot s^{-1}$

D. $40980cm \cdot s^{-1}$

Answer: A

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2. A closed air column 32 cm long is in resonance with a tuning fork. Another open air column of length 66 cm is in resonance with another tuning fork. The two forks produce 8 beats per second when sounded together .

The frequencies of the forks

A. 230 Hz, 290 Hz

B. 250 Hz, 300 Hz

C. 264 Hz, 256 Hz

D. 150 Hz, 300 Hz

Answer: C

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3. Find the number of possible natural oscillations of air column in a pipe whose frequencies lie below 1250 Hz . The length of the pipe is 85 cm . The velocity of sound is $340 m \cdot s^{-1}$. Consider the following two cases:

The pipe is closed from one end

A. 2

B. 4

C. 8

D. 6

Answer: D

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4. Find the number of possible natural oscillations of air column in a pipe whose frequencies lie below 1250 Hz . The length of the pipe is 85 cm . The velocity of sound is $340 m \cdot s^{-1}$. Consider the following two cases:

The pipe is opened from both ends

A. 3

B. 7

C. 6

D. 9

Answer: C

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Entrance Corner Integer Answer Type

1. A closed organ pipe and an open organ pipe of same length produce 2 beats when they are set into vibration simultaneously in fundamental mode. The length of the open organ pipe is now halved and that of the closed ogran pipe is doubled . What will be the number of beats produced ?

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2. The displacement y of a particle executing pariodic motion is given by

$y = 4\cos^2\left(\frac{1}{2}t\right)$ sin (1000 t)

This expression may be considered as a result of the superposition of how many simple harmonic motions ?

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3. A string of length 1 . 5 m with its two ends calmped is vibrating in fundamental mode. Amplitude at the centre of the string is 4 mm . Find the distance between the two points (in m) having amplitude 2 mm .

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1. The resultant displacement due to superposition of two identical progressive waves is

$y = 5\cos(0.2\pi x)\sin(64\pi t)$, where x , y are in cm and t is in sec . Find the equations of the two superposing waves .

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2. The expression for a standing wave is $y(x, t) = 2\sin(0.1\pi x)\cos 100\pi t$, where x, y are in cm and t is in second. Find the distance between a node and the next antinode of the wave .

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3. Does the principle of conservation of energy always hold in case of superposition of two sound waves ?

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4. Two waves are expressed as,

$y_1 = a\sin\omega_1\left(\frac{x}{c} - t\right)$ and $y_2 = a\sin\omega_2\left(\frac{x}{c} - t\right)$

Find the resultant displacement due to superposi-tion of the two waves .

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5. Determine the amplitude of the resultant displace-ment at x = 0 .

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6. If the two frequencies are nearly equal, find the beat frequency .

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7. The ratio of the lengths of two uniform wires of the same material of equal diameter is 2 : 3 . If the fre-quency of the fundamental note emitted by the shorted wire is one octave above that of the note emitted by the longer wire, find the ratio of the ten-sions in the wires .

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8. When the waves $y_1 = A\sin\omega t$ and $y_2 = A\cos\omega t$ are superposed, then resultant amplitude will be

A. $\sqrt{2}$ A

B. $\frac{1}{\sqrt{2}}A$

C. A

D. 2A

Answer: A

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9. Sound emitted by an open organ pipe is more musical than that emitted by an organ by a an organ pipe closed at one end. Explanin the reason .

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10. A tuning fork produces 10 beats per second with sonometer wire of length 95 cm and 100 cm . Find the frequency of the fork .

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11. One mouth of an open pipe is suddenly closed. If is found that the frequency of the third harmonic of the closed pipe is greater by 100 Hz than the frequency of the fundamental of the open pipe. Calculate the funda-mental frequancy of the open pipe.

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12. If the tension and diameter of a sonometer wire of fun-damental frequency n are doubled and the density halved, then its fundamental frequency will become

A. $\frac{n}{4}$

B. $\sqrt{2}$ n

C. n

D. $\frac{n}{\sqrt{2}}$

Answer: C

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13. How much is the separation between two consecu-tive nodes in a stationary wave?

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14. Two travelling waves superpose to form a stationary wave whose equation is

$y(x, t) = 5\sin(0.1\pi x)\cos 50\pi t$ where x, y are in cm and t is in x . Find the equations of the two superposing travelling waves .

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15. Two tuning forks vibrating simultaneously produce 5 beats per second. Frequency of one fork is 275 Hz . A small wax is attached to the other fork and 2 beats per second are produced when the two vibrate simultaneously. Find the frequency of the other fork.

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1. Displacement of a particle, in periodic motion, is represented by $y = 4\cos^2\left(\frac{t}{2}\right)$ sin (1000t). If the equation is the superposition of n number of simple harmonic motion then n becomes

A. 1

B. 2

C. 3

D. 4

Answer: C

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2. A whistle whose air column is open at both ends has a fundamental of 5100 Hz . If the speed of sound in air is $340 m \cdot s^{-1}$, the length of the whistle in cm, is

A. $5/3$

B. $10/3$

C. 5

D. $20/3$

Answer: B

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3. Sound waves are passing through two routes-one in straight path and the other along a semicircular pat of radius r and are again combined into one pipe and superposed as shown in the fig . 4 . 23 , if the velocity of sound waves in the pipe is v , then frequencies of resultant waves of maximum amplitude will be integral multiples of

A. $\dfrac{v}{r(\pi - 2)}$

B. $\dfrac{v}{2(\pi - 1)}$

C. $\dfrac{2v}{r(\pi - 1)}$

D. $\dfrac{v}{r(\pi + 1)}$

Answer: A

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4. The length of an open organ pipe is twice the length of another closed organ pipe. The fundamental frequency of the open pipe is 100 Hz . The frequency of the thrid harmonic of the closed pipe is

A. 100 Hz

B. 200 Hz

C. 300 Hz

D. 150 Hz

Answer: C

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5. A uniform string of length L and mass M is fixed at both ends while it is subject to a tension T . It can vibrated of frequencies (v) given by the formula (where n = 1 , 2, 3.....)

A. $v=\frac{n}{2}\sqrt{\frac{T}{ML}}$

B. $v=\frac{n}{2L}\sqrt{\frac{T}{M}}$

C. $v=\frac{1}{2n}\sqrt{\frac{T}{ML}}$

D. $v=\frac{n}{2}\sqrt{\frac{TL}{M}}$

Answer: A

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Examination Archive With Solutions Aleee

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

A. 12

B. 8

C. 6

D. 4

Answer: C

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1. When a string is divided into three segments of length $l_1, l_2,$ and l_3 the fundamental frequencies of these three segments are v_1, v_2 and v_3 respectively .

The original fundamental frequency (v) of the string is

A. $\sqrt{v} = \sqrt{v_1} + \sqrt{v_2} + \sqrt{v_3}$

B. $v = v_1 + v_2 + v_3$

C. $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}$

D. $\frac{1}{\sqrt{v}} = \frac{1}{\sqrt{v_1}} + \frac{1}{\sqrt{v_2}} + \frac{1}{\sqrt{v_2}}$

Answer: C

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2. The number of possible natural oscillations of air col-umn in a pipe closed at one end of length 85 cm when frequencies lie below 1250 Hz are (velocity of sound $= 350 m \cdot s^{-1}$

A. 4

B. 5

C. 7

D. 6

Answer: D

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3. The fundamental frequency of a closed organ pipe of length 20 cm is equal to the second overtone of an organ pipe open at both the ends. The length of organ pipe open at both the ends is

A. 80 cm

B. 100 cm

C. 120 cm

D. 140 cm

Answer: C

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Examination Archive With Solutions Neet

1. An air column, closed at one end and open at the other, resonates with a tuning fork when the smallest length of the column is 50 cm . The next larger of the column resonating with the same tuning fork is

A. 100 cm

B. 150 cm

C. 200 cm

D. 66.7 cm

Answer: B

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2. Two open organ pipesof fundamental frequencies n_1 and n_2 are joined in series. The fundamental fre-quency of the new pipe so obtained will be :

A. $(n_1 + n_2)$

B. $\frac{n_1 + n_2}{2}$

C. $\sqrt{n_1^2 + n_2^2}$

D. $\frac{n_1 n_2}{n_1 + n_2}$

Answer: D

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3. The fundamental frequency in an open organ pipe is equal to the third harmonic of a closed organ pipe . If the length of the closed organ pipe is 20 cm , the length of the open organ pipe is

A. 12 . 5 cm

B. 8 cm

C. 13 . 2 cm

D. 16 cm

Answer: C

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4. A tuning fork is used to produce resonance in a glass tube . The length of the air column in this tube can be adjusled by a varlable pision. At room temperature of 27° C, two successlve resonances are produced at 20 cm and 73 cm of column length .If the frequency of the tuning fork is 320 Hz, the velocity of sound in air at 27° C is

A. 350 m/s

B. 339m/s

C. 330 m/s

D. 300 m/s

Answer: B

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1. A progressive wave is given by $y(x, l) = B\cos(300t - 0.15x)$ where x and y are in cm and t in second . What is the (i) direction of propagation, (ii) wavelength , (iii) frequency, (iv) wave speed and (v) phase difference between two points 0 . 2 m apart ?

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2. Give any three differences between progressive waves and stationary waves. A stationary wave is yn - 12 sin 300 t cos 2 x . What is the distance between two nearest nodes ?

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3. In an open organ pipe, third harmonic is 450 Hz . What is the frequency of fifth harmonic ?

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4. The frequencies of two tuning forks A and B are 250 Hz and 255 Hz respectively. Both are sounded together. How many beats will be heard in 5 seconds ?

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5. An incident wave and a reflected wave are represented by

$$\xi_1 = a\sin\frac{2\pi}{\lambda}(vt - x) \text{ and } \xi_2 = a\sin\frac{2\pi}{\lambda}(vt + x)$$

Derive the equation of the stationary wave and calcu-late the position of the nodes and antinodes.

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6. If an open organ pipe of length 20 cm resonates with 1 khz, in the third harmonic mode, find the wave length of the standing wave produced .

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7. Draw the stationary wave pattern in the fundamental mode for the following cases: (i) an open organ pipe (ii) resonance column apparatus (iii) a rigid metallic rod clamped in the middle, the rod is hit with a stick at one of its free ends .

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8. Two waves of nearly same frequencies travelling in the same direction superimpose on each other. Name the resulting phenomenon.

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9. Calculate the speed of sound in a gas in which two waves of wavelengths 1 . 00 m and 1 . 0 1 m produce 4 beats per second .

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10. A transverse harmonic wave on a string is describe by $Y(x, t) = 3\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$. Where X and Y are in cm and t in sec . The positive direction of x is form left to right

What is speed of this wave?

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11. A transverse harmonic wave on a string is describe by $Y(x, t) = 3\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$. Where X and Y are in cm and t in sec . The positive direction of x is form left to right

What is its amplitude ?

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12. A transverse harmonic wave on a string is describe by $Y(x, t) = 3\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$. Where X and Y are in cm and t in sec . The positive direction of x is form left to right what is its frequency ?

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13. A transverse harmonic wave on a string is describe by $Y(x, t) = 3\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$. Where X and Y are in cm and t in sec . The positive direction of x is form left to right What is the initial phase at the origin ?

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14. A transverse harmonic wave on a string is describe by $Y(x, t) = 3\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$. Where X and Y are in cm and t in sec . The positive direction of x is form left to right

What is its wavelength ?

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