PHYSICS

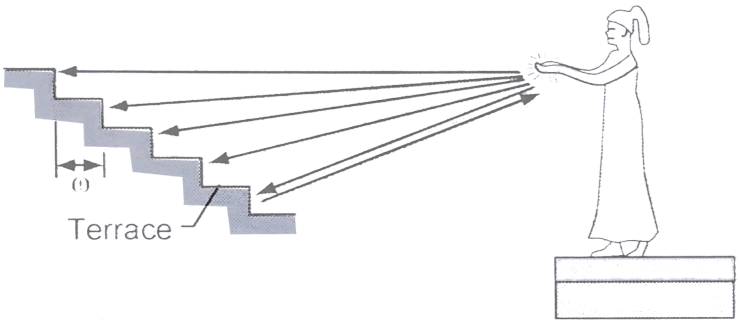
BOOKS - RESNICK AND HALLIDAY PHYSICS (HINGLISH)

WAVE - II

Sample Problem

1. A handclap on stage in an amphitheater sends out sound waves that scatter from

terraces of width $w = 0.75m$ (see figure). The sound returns to the stage as a periodic series of pulses, one from each terrace, the parade of pulses sound like a played note. Assuming that all the rays in Figure are horizontal, find the frequency at which the pulses return (that is, the frequency of the perceived note). Take the speed of sound to be $330m / s$



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2. The maximum pressure amplitude Δp_m that the human ear can tolerate in loud sounds is about 28 Pa (which is very much less than the normal air pressure of about 10^5 Pa). What is the displacement amplitude $s_m$for such a sound in air of density $\rho = 1.21 kg/m^3$, at a frequency of 1000 Hz and a speed of 343 m/s?

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3. An electric spark jumps along a straight line of length L = 10 m, emitting a pulse of sound that travels radially outward from the spark. (The spark is said to be a line source of sound.) The power of this acoustic emission is $P = 1.6 \times 10^4$ W. (a) What is the intensity I of the sound when it reaches a distance r = 12 m from the spark? (b) At what time rate P_A is sound energy intercepted by an acoustic detector of area $A_d = 2.0cm^2$?, aimed at the spark and located a distance r = 12 m from the spark?

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4. Many veteran rockers suffer from acute hearing damage because of the high sound levels they endured for years. Many rockers now wear special earplugs to protect their hearing during performances . If an earplug decreases the sound level of the sound waves by 20 dB, what is the ratio of the final intensity I_f of the waves to their initial intensity I_i ?

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5. Weak background noises from a room set up the fundamental standing wave in a cardboard tube of length L = 67.0 cm with two open ends. Assume that the speed of sound in the air within the tube is 343 m/s. (a) What frequency do you hear from the tube? (b) If you jam your ear against one end of the tube, what fundamental frequency do you hear from the tube?

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6. A cylindrical pipe of length 28 cm closed at one end is found to be at resonance when a tuning fork of frequency 850Hz is sounded near the open end. Find the mode of vibration of the air in the pipe value of the end - correction. (take the speed of sound in air as 340 m/s)

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7. Pipe A is open at both ends and has length L_A = 0.343 m. We want to place it near three

other pipes in which standing waves have been set up, so that the sound can set up a standing wave in pipe A. Those other three pipes are each closed at one end and have lengths $L_B = 0.500L_A, L_C = 0.250L_A$ and L_D = 2.00L. For each of these three pipes, which of their harmonics can excite a harmonic in pipe A?

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8. An open pipe 30 cm long and a closed pipe 23 cm long both of the same diameter, are each sounding their first overtone, and these are in unison. What is the end correction of these pipes?

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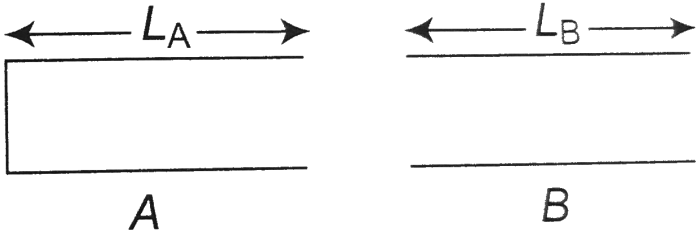
9.



The two pipes are submerged in sea water,

arranged as shown in figure. Pipe A with length $L_A = 1.5m$ and one open end, contains a small sound source that sets up the standing wave with the second lowest resonant frequency of that pipe. Sound from pipe A sets up resonance in pipe B, which has both ends open. The resonance is at the second lowest resonant frequency of pipe B. The length of the pipe B is

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10. In Fig. , two point sources S_1 and S_2 which are in phase and separated by distance $D = 1.5\lambda$, emit identical sound waves of wavelength λ.

(a) What is the path length difference of the waves from S_1 and S_2 at point P_1, which lies on the perpendicular bisector of distance D, at a distance greater than D from the sources ? (That is, what is the difference in the distance from source S_1 to point P_1 and the distance from source S_2 to P_1?) What type of interference occurs at P_1 ?

(b) What are the path length difference and type of interference at point P_2 in fig.

(c) Figure shows a circle with a radius much greater than D, centered on the midpoint between sources S_1 and S_2. What is the number of points N around this circle at which the interference is fully constructive? (That is, at how many points do the waves arrive exactly in phase?)

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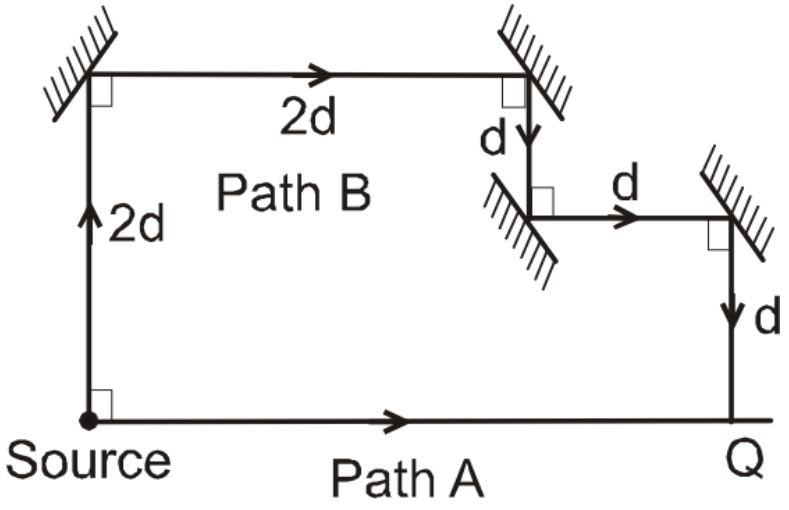
11. A sound source emits two sinusoidal sound waves, both of wavelength λ, along paths A and B as shown in figure.The sound travelling along path B is reflected from five surfaces as shown and then merges at point Q, producing minimum intensity at that point.The minimum value of d in terms of λ is :



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12. When an emperor penguin returns from a search for food, how can it find its mate among the thousands of penguins huddled together for warmth in the harsh Antarctic weather? It is not by sight, because penguins all look alike, even to a penguin. The answer lies in the way penguins vocalize. Most birds vocalize by using only one side of their two-sided vocal organ, called the syrinx. Emperor penguins, however, vocalize by using both

sides simultaneously. Each side sets up acoustic standing waves in the bird's throat and mouth, much like in a pipe with two open ends. Suppose that the frequency of the first harmonic produced by side A is f_{A1} = 432 Hz and the frequency of the first harmonic produced by side B is f_{B1} = 371 Hz. What is the beat frequency between those two first-harmonic frequencies and between the two second-harmonic frequencies?

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13. Bats navigate and search out prey by emitting, and then detecting reflections of, ultrasonic waves, which are sound waves with frequencies greater than can be heard by a human. Suppose a bat emits ultrasound at frequency f_{be} = 82.52 kHz while flying with velocity $\vec{v}_b = (9.00m/s)\hat{i}$ as it chases a moth that flies with velocity $\vec{v}_m = (8.00m/s)\hat{i}$. What frequency does the moth detect? What frequency f_{md} does the bat detect in the returning echo from the moth?

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14. An engine is continuously emitting sound of frequency 1.2 kHz moving uniformly along a straight track. A stationary listener is situated off the track at a perpendicular distance of l = 350 m. The velocity of engine is equal to 50 m/s and the velocity of sound is 350 m/s. Find the frequency of sound received by the listener at the moment when the engine gets closest to him.

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Checkpoints

1. When the oscillating air element is moving rightward through the point of zero displacement , is the pressure in the element at its equilibrium value. Just beginning to increase or just beginning to decrease ?

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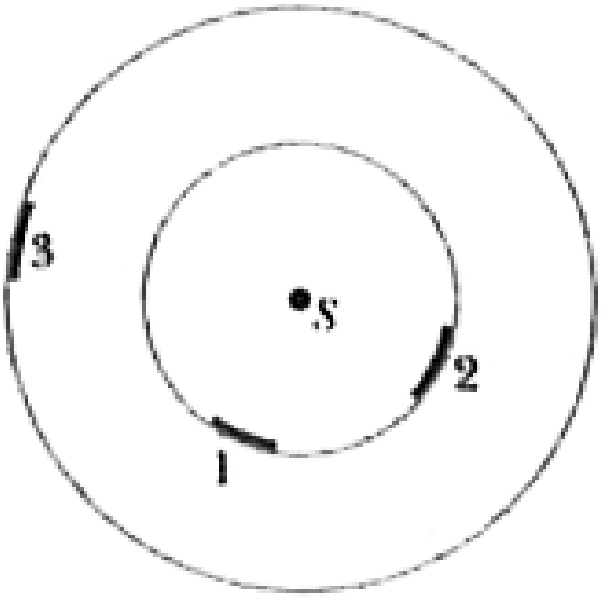
2. The figure indicates three small patches 1, 2, and 3 that lie on the surfaces of two imaginary spheres, the spheres are centered on an isotropic point source S of sound. The rates at which energy is transmitted through the three patches by the sound waves are equal. Rank the patches according to (a) the intensity of the sound on them and (b) their area, greatest

first.



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3. Pipe A , with length L , and pipe B , with length 2l , both have two open ends. Which

harmonic of pipe B has the same frequency as the fundamental of pipe A ?

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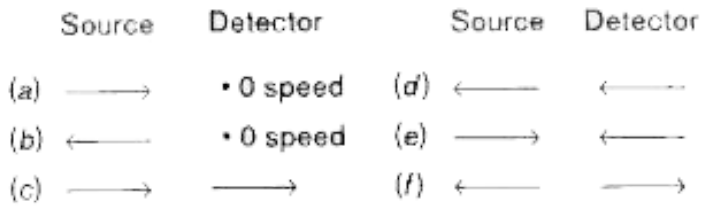
4. The figure indicates the directions of motion of a sound source and a detector for six situations in stationary air. For each situation, is the detected frequency greater than or less than the emitted frequency, or can not we tell without more information

about the actual speeds?



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Problems

1. Diagnostic ultrasound of frequency 3.80 MHz is used to examine tumors in soft tissue. (a) What is the wavelength in air of such a sound wave? (b) If the speed of sound in tissue is

1500 m/s, what is the wavelength of this wave in tissue?

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2. What is the intensity at radial distances (a) 2.50 m and (b) 6.00 m from an isotropic point source of sound that emits energy at the rate 12.0 W, assuming no energy absorption by the surrounding air?

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3. When you "crack" a knuckle, you suddenly widen the knuckle cavity, allowing more volume for the synovial fluid inside it and causing a gas bubble suddenly to appear in the fluid. The sudden production of the bubble, called "cavitation, "produces a sound pulse - the cracking sound. Assume that the sound is transmitted uniformly in all directions and that it fully passes from the knuckle interior to the outside. If the pulse has a sound level of 50 dB at your ear, estimate

the rate at which energy is produced by the cavitation.

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4. A tuning fork of unknown frequency makes 4.00 beats per second with a standard fork of frequency 384 Hz. The beat frequency decreases when a small piece of wax is put on a prong of the first fork. What is the frequency of this fork?

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5. A sound wave of frequency 280 Hz has an intensity of $1.00W/m2$? What is the amplitude of the air oscillations caused by this wave?

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6. Two identical piano wires have a fundamental frequency of 600 Hz when kept under the same tension. What fractional increase in the tension of one wire will lead to

the occurrence of 8.0 beats/s when both wires oscillate simultaneously?

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7. A sound source A and a reflecting surface B move directly toward each other. Relative to the air, the speed of source A is 20.0 m/s, the speed of surface B is 80.0 m/s, and the speed of sound is 329 m/s. The source emits waves at frequency 2000 Hz as measured in the source frame. In the reflector frame, what are the (a)

frequency and (b) wavelength of the arriving sound waves? In the source frame, what are the (c) frequency and (d) wavelength of the sound waves reflected back to the source?

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8. A whistle of frequency 540 Hz moves in a circle of radius 60.0 cm at an angular speed of 20.0 rad/s. What are the (a) lowest and (b) highest frequencies heard by a listener a long

distance away, at rest with respect to the center of the circle?

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9. The shock wave off the cockpit of the FA 18 has an angle of about 60°. The airplane was traveling at about 1350 km/h when the photograph was taken. Approximately what was the speed of sound at the air plane's altitude?

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10. A bat is flitting about in a cave, navigating via ultrasonic bleeps. Assume that the sound emission frequency of the bat is 39 .000 Hz. During one fast swoop directly toward a flat wall surface, the bat is moving at 0.020 times the speed of sound in air. What frequency does the bat hear reflected off the wall?

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11. The source of a sound wave has a power of $3.00\mu W$. If it is a point source, (a) what is the intensity 4.20 m away and (b) what is the sound level in decibels at that distance?

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12. A sound source sends a sinusoidal sound wave of angular frequency 3000 rad/s and amplitude 10.0 nm through a tube of air. The internal radius of the tube is 2.00 cm. (a) What

is the average rate at which energy (the sum of the kinetic and potential energies) is transported to the opposite end of the tube? (b) If, simultaneously, an identical wave travels along an adjacent, identical tube, what is the total average rate at which energy is transported to the opposite ends of the two tubes by the waves? If, instead, those two waves are sent along the same tube simultaneously, what is the total average rate at which they transport energy when their phase difference is (c) 0, (d) 0.40π rad, and (e) π rad?

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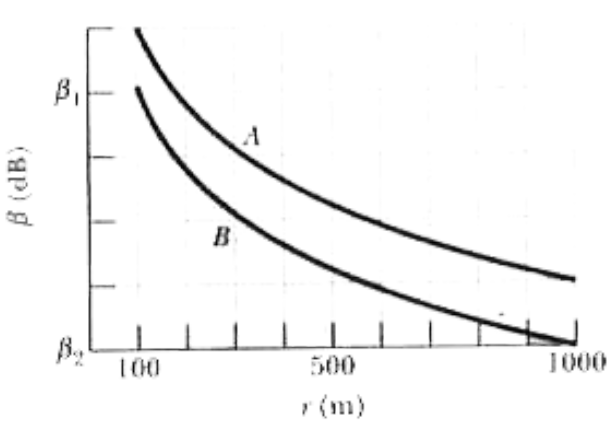
13. Two atmospheric sound sources A and B emit isotropically at constant power. The sound levels β of their emissions are plotted in Fig. versus the radial distance r from the sources. The vertical axis scale is set by $\beta_1 = 85.0dB$ and $\beta_2 = 65.0dB$. What are (a) the ratio of the larger power to the smaller power and (b) the sound level difference at r =

23 m?



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14. A jet plane passes over you at a height of 4800 m and a speed of Mach 1.5. (a) Find the Mach cone angle (the sound speed is 331 m/s).

(b) How long after the jet passes directly overhead does the shock wave reach you?

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15. Organ pipe A, with both ends open, has a fundamental frequency of 425 Hz. The fifth harmonic of organ pipe B, with one end open, has the same frequency as the second harmonic of pipe A. How long are (a) pipe A and (b) pipe B?

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16. A certain sound source is increased in sound level by 40.0 dB. By what multiple is (a) its intensity increased and (b) its pressure amplitude increased?

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17. Figure shows four tubes with lengths 1.0 m or 2.0 m, with one or two open ends as drawn. The fifth harmonic is set up in each tube, and some of the sound that escapes from them is

detected by detector D, which moves directly away from the tubes. In terms of the speed of sound v, what speed must the detector have such that the detected frequency of the sound from (a) tube 1, (b) tube 2, (c) tube 3, and (d) tube 4 is equal to the tube's fundamental frequency?

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18. A point source emits 30.0 W of sound isotropically. A small microphone intercepts the sound in an area of 0.750 cm?, 180 m from the source. Calculate (a) the sound intensity there and (b) the power intercepted by the microphone

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19. A plane flies at 2.00 times the speed of sound. Its sonic boom reaches a man on the ground 35.4 s after the plane passes directly

overhead. What is the altitude of the plane? Assume the speed of sound to be 330 m/s.

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20. A point source emits sound waves isotropically. The intensity of the waves 6.00 m from the source is $4.50 \times 10^{-4} W/m^2$. Assuming that the energy of the waves is conserved, find the power of the source.

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

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

(b) the tension in the wire.

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

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22. Earthquakes generate sound waves inside Earth. Unlike a gas, Earth can experience both transverse (S) and longitudinal (P) sound waves. Typically, the speed of S waves is about 4.5 km/s, and that of P waves 8.0 km/s. A seismograph records P and S waves from an earthquake. The first P waves arrive 3.5 min before the first S waves. If the waves travel in a straight line, how far away did the earthquake occur?

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23. Pipe A, which is 1.80 m long and open at both ends, oscillates at its third lowest harmonic frequency. It is filled with air for which the speed of sound is 343 m/s. Pipe B, which is closed at one end, oscillates at its second lowest harmonic frequency. This frequency of B happens to match the frequency of A. An x axis extends along the interior of B, with x = 0 at the closed end. (a) How many nodes are along that axis? What are the (b) smallest and (c) second smallest

value of x locating those nodes? (d) What is the fundamental frequency of B?

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24. (a) Find the speed of waves on a violin string of mass 860 mg and length 22.0 cm if the fundamental frequency is 920 Hz. (b) What is the tension in the string? For the fundamental, what is the wavelength of (c) the waves on the string and (d) the sound waves emitted by the string?

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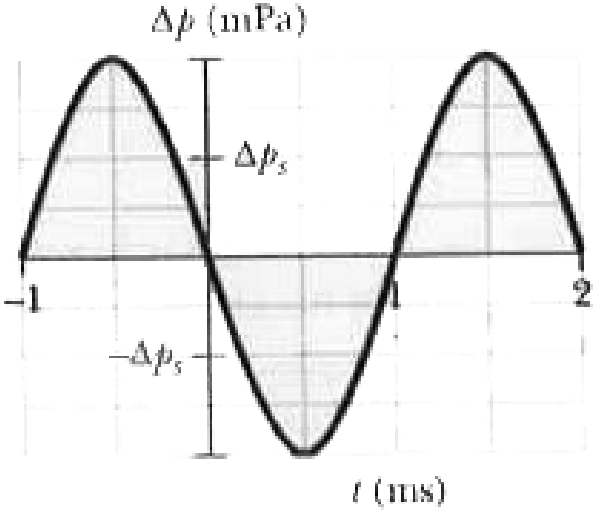
25. Figure shows the output from a pressure monitor mounted at a point along the path taken by a sound wave of a single frequency traveling at 343 m/s through air with a uniform density of $1.21 kg/m^3$. The vertical axis scale is set by $\Delta p = 5.0 mPa$. If the displacement function of the wave is s(.x, t) = $s_m \cos(kx - \omega t)$, what are (a) s_m(b) k, and (c) ω? The air is then cooled so that its density is 1.35 kg/m and the speed of a sound wave

through it is 320 m/s. The sound source again emits the sound wave at the same frequency and same pressure amplitude. What now are (d)s_m, $(c)k$, and $(f)\omega$?



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26. A violin string 15.0 cm long and fixed at both ends oscillates in its N = 1 mode. The speed of waves on the string is 280 m/s, and the speed of sound in air is 318 m/s. What are the (a) frequency and (b) wavelength of the emitted sound wave?

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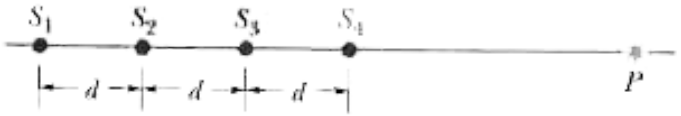
27. Figure shows four isotropic point sources of sound that are uniformly spaced on an x

axis. The sources emit sound at the same wavelength λ and same amplitudes s_m and they emit in phase. A point P is shown on the x axis. Assume that as the sound waves travel to P, the decrease in their amplitude is negligible. What multiple of s_m is the amplitude of the net wave at P if distance d in the figure is $(a)\lambda/4 (b)\lambda/2$ and $(c)\lambda$?



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28. The water level in a vertical glass tube 1.00 m long can be adjusted to any position in the tube. A tuning fork vibrating at 900 Hz is held just over the open top end of the tube, to set up a standing wave of sound in the air-filled top portion of the tube. (That airfilled top portion acts as a tube with one end closed and the other end open.) (a) For how many different positions of the water level will sound from the fork set up resonance in the tube's air-filled portion? What are the (b) least

and (c) second least water heights in the tube for resonance to occur?

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29. In Fig. , a French submarine and a U.S. submarine move toward each other during maneuvers in motionless water in the North Atlantic. The French sub moves at the speed v_v = 48.00 km/h, and the U.S. sub at v_{US} = 72.00 km/h. The French sub sends out a sonar signal (sound wave in water) at 1.560×10^3 Hz.

Sonar waves travel at 5470 km/h. (a) What is the signal's frequency as detected by the U.S. sub? (b) What frequency is detected by the French sub in the signal reflected back to it by the U.S. sub?

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30. Two sounds differ in sound level by 3.00 dB. What is the ratio of the greater intensity to the smaller intensity?

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31. The A string of a violin is a little too tightly stretched. Beats at 4.50 per second are heard when the string is sounded together with a tuning fork that is oscillating accurately at concert A (440 Hz). What is the period of the violin string oscillation?

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32. A man strikes one end of a thin rod with a hammer. The speed of sound in the rod is 15 times the speed of sound in air. A woman, at the other end with her ear close to the rod, hears the sound of the blow twice with a 60 ms interval between, one sound comes through the rod and the other comes through the air alongside the rod. If the speed of sound in air is 343 m/s, what is the length of the rod?

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33. A 2000 Hz siren and a civil defense official are both at rest with respect to the ground. What frequency does the official hear if the wind is blowing at 15 m/s (a) from source to official and (b) from official to source?

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34. One of the harmonic frequencies of tube A with two open ends is 400 Hz. The next-highest harmonic frequency is 480 Hz. (a)

What harmonic frequency is next highest after the harmonic frequency 160 Hz? (b) What is the number of this next-highest harmonic? One of the harmonic frequencies of tube B with only one open end is 1080 Hz. The next-highest harmonic frequency is 1320 Hz. (c) What harmonic frequency is next highest after the harmonic frequency 600 Hz? (d) What is the number of this next-highest harmonic?

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35. A violin string 30.0 cm long with linear density 0.650 g/m is placed near a loudspeaker that is fed by an audio oscillator of variable frequency. It is found that the string is set into oscillation only at the frequencies 1040 and 1560 Hz as the frequency of the oscillator is varied over the range 600-1600 Hz. What is the tension in the string?

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36. A stationary motion detector sends sound waves of frequency 3.00 MHz toward a truck approaching at a speed of 61.0 m/s. What is the frequency of the waves reflected back to the detector?

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37. A stone is dropped into a well. The splash is heard 3.35 s later. What is the depth of the well?

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38. Two trains are traveling toward each other at 35.7 m/s relative to the ground. One train is blowing a whistle at 850 Hz. (a) What frequency is heard on the other train in still air? (b) What frequency is heard on the other train if the wind is blowing at 35.7 m/s toward the whistle and away from the listener? (c) What frequency is heard if the wind direction is reversed?

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39. You have five tuning forks that oscillate at close but different resonant frequencies. What are the (a) maximum and (b) minimum number of different beat frequencies you can produce by sounding the forks two at a time, depending on how the resonant frequencies differ?

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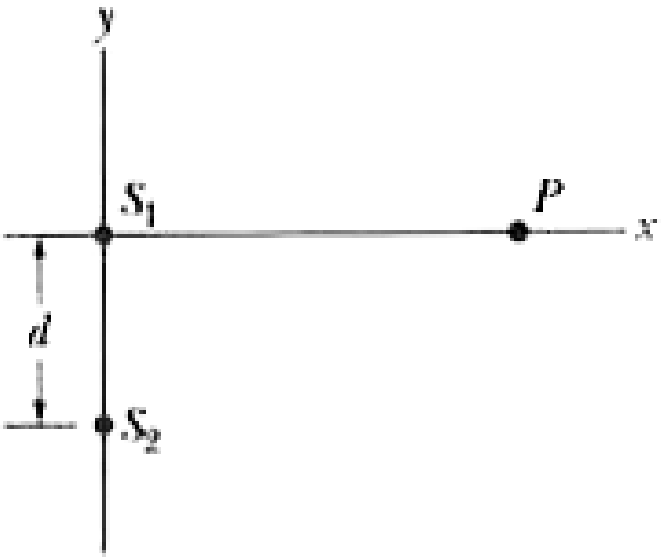
40. Figure shows two point sources S_1 and S_2 that emit sound of wavelength λ = 3.00 m. The emissions are isotropic and in phase, and the separation between the sources is d = 16.0 m. At any point P on the x axis, the wave from S_1 and the wave from S_2 interfere. When P is very far away $(x \approx 0)$, what are (a) the phase difference between the arriving waves from S_1 and S_2 and (b) the type of interference they produce? Now move point P along the x axis toward S_1. (c) Does the phase difference between the waves increase or decrease? At

what distance x do the waves have a phase difference of (d) 0.50λ, $(e)1.00\lambda$, and (f) 1.50λ ?



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41. An ambulance with a siren emitting a whine at 1620 Hz overtakes and passes a cyclist pedaling a bike at 2.44 m/s. After being passed, the cyclist hears a frequency of 1590 Hz. How fast is the ambulance moving?

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42. When the door of the Chapel of the Mausoleum in Hamilton, Scotland, is slammed shut, the last echo heard by someone

standing just inside the door reportedly comes 15 s later. (a) If that echo were due to a single reflection off a wall opposite the door, how far from the door is the wall? (b) If, instead, the wall is 32.0 m away, how many reflections (back and forth) occur?

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43. A stationary detector measures the frequency of a sound source that first moves at constant velocity directly toward the

detector and then (after passing the detector) directly away from it. The emitted frequency is f. During the approach the detected frequency is f'_{app} and during the recession it is f'_{rec} If $(f_{app} - f'_{rec})/f = 0.200,$ what is the ratio v/v of the speed of the source to the speed of sound?

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44. Figure shows two isotropic point sources of sound, S_1 and S_2 The sources emit waves in

phase at wavelength 0.50 m, they are separated by D = 2.20 m. If we move a sound detector along a large circle centered at the midpoint between the sources, at how many points do waves arrive at the detector (a) exactly in phase and (b) exactly out of phase?

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45. Approximately a third of people with normal hearing have ears that continuously emit a low-intensity sound outward through the ear canal. A person with such spontaneous otoacoustic emission is rarely aware of the sound, except perhaps in a noise-free environment, but occasionally the emission is loud enough to be heard by someone else nearby. In one observation, the sound wave had a frequency of 1200 Hz and a pressure amplitude of 2.50×10^{-3} Pa. What were (a)

the displacement amplitude and (b) the intensity of the wave emitted by the ear?

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46. Two loud speakers are located 3.35 m apart on an outdoor stage. A listener is 175 m from one and 19.5 m from the other. During the sound check, a signal generator drives the two speakers in phase with the same amplitude and frequency. The transmitted frequency is swept through the audible range (20 Hz to 20

kHz). (a) What is the lowest frequency $f_{\mathrm{min}.1}$ that gives minimum signal (destructive interference) at the listener's location? By what number must $f_{\mathrm{min}.1}$ be multiplied to get (b) the second lowest frequency $f_{\mathrm{min}.2}$ that gives minimum signal and (c) the third lowest frequency $f_{\mathrm{min}.3}$ that gives minimum signal? (d) What is the lowest frequency $f_{\mathrm{max}.1}$ that gives maximum signal (constructive interference) at the listener's location? By what number must $f_{\mathrm{max}.1}$ be multiplied to get (e) the second lowest frequency $f_{\mathrm{max}.2}$ that

gives maximum signal and (f) the third lowest frequency $f_{\max .3}$ that gives maximum signal?

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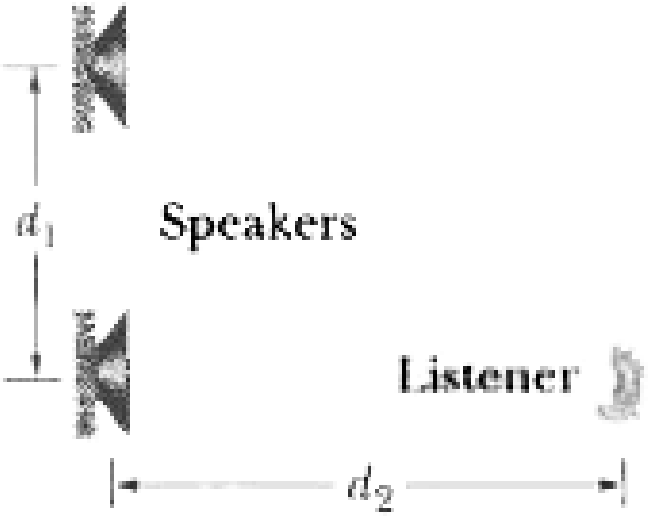
47. In Fig. , two speakers separated by distance d_1 = 2.00 m are in phase. Assume the amplitudes of the sound waves from the speakers are approximately the same at the listener's ear at distance d_2 = 4.00 m directly in front of one speaker. Consider the full audible range for normal hearing, 20 Hz to 20 kHz. (a)

What is the lowest frequency $f_{\mathrm{min}.1}$ that gives minimum signal (destructive interference) at the listener's ear? By what number must $f_{\mathrm{min}.1}$ be multiplied to get (b) the second lowest frequency $f_{\mathrm{min}.2}$ that gives signal and (c) the third lowest frequency $f_{\mathrm{min}.3}$ that givesr minimum signal? (d) What is the lowest frequency $f_{\mathrm{max}.1}$ that gives maximum signal (constructive interference) at the listener's ear? By what number must $f_{\mathrm{max}.1}$be multiplied to get (e) the second lowest frequency $f_{\mathrm{max}.2}$ that gives maximum signal and (f) the third lowest frequency $f_{\mathrm{max}.3}$ that

gives maximum signal?



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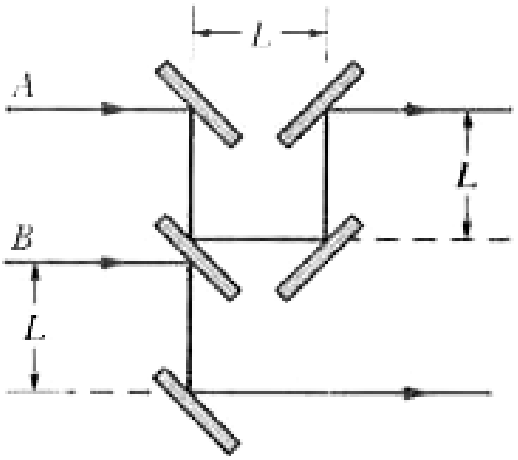
48. In Fig., sound waves A and B, both of wavelength λ , are initially in phase and traveling rightward, as indicated by the two

rays. Wave A is reflected from four surfaces but ends up traveling in its original direction. Wave B ends in that direction after reflecting from two surfaces. Let distance L in the figure be expressed as a multiple q of λ: $L = q\lambda$. What are the (a) smallest and (b) third smallest values of q that put A and B exactly out of phase with each other after the

reflections?



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49. A girl is sitting near the open window of a train that is moving at a velocity of 10.00 m/s to the east. The girl's uncle stands near the tracks and watches the train move away. The

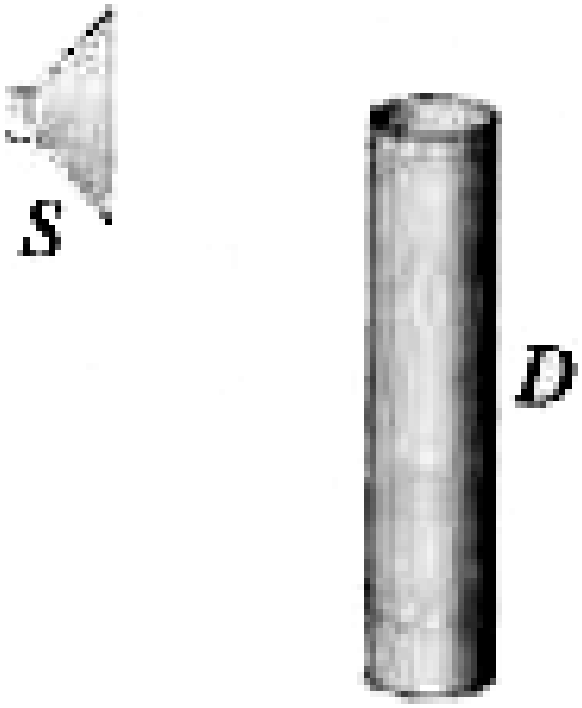
locomotive whistle emits sound at frequency 520.0 Hz. The air is still. (a) What frequency does the uncle hear? (b) What frequency does the girl hear? A wind begins to blow from the east at 10.00 m/s. (c) What frequency does the uncle now hear? (d) What frequency does the girl now hear?

View Text Solution

50. In Fig., S is a small loud speaker driven by an audio oscillator with a frequency that is

varied from 1000 Hz to 2000 Hz, and D is a cylindrical pipe with two open ends and a length of 48.9 cm. The speed of sound in the air-filled pipe is 344 m/s. (a) At how many frequencies does the sound from the loudspeaker set up resonance in the pipe? What are the (b) lowest and (c) second lowest

frequencies at which resonance occurs?



View Text Solution

51. The pressure in a traveling sound wave is given by the equation

$\Delta p = (2.00Pa)\sin\pi\left(0.900m^{-1}\right)x - \left(450s^{-1}\right)t]$

Find the (a) pressure amplitude, (b) frequency, (c) wave length, and (d) speed of the wave.

Watch Video Solution

52. 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 $1.10kgm^{-3}$ and bulk modulus of water is $1.33 \times 10^5 N/m^2$. How deep is the well ?

Watch Video Solution

53. A column of soldiers, marching at 100 paces per minute, keep in step with the beat of a drummer at the head of the column. The soldiers in the rear end of the column are striding forward with the left foot when the drummer is advancing with the right foot. What is the approximate length of the column?

View Text Solution

54. From two sources, sound waves of frequency 270 Hz are emitted in phase in the positive direction of an x axis. At a detector that is on the axis and 5.00 m from one source and 4.00 m from the other source, what is the phase difference between the waves (a) in radians and (b) as a multiple of the wavelength?

View Text Solution

55. Suppose that the sound level of a conversation is initially at an angry 75 dB and then drops to a soothing 55 dB. Assuming that the frequency of the sound is 500 Hz, determine the (a) initial and (b) final sound intensities and the (c) initial and (d) final sound wave amplitudes.

View Text Solution

56. A sound wave in a fluid medium is reflected at a barrier so that a standing wave is formed. The distance between nodes is 4.9 cm, and the speed of propagation is 1250 m/s. Find the frequency of the sound wave.

Watch Video Solution

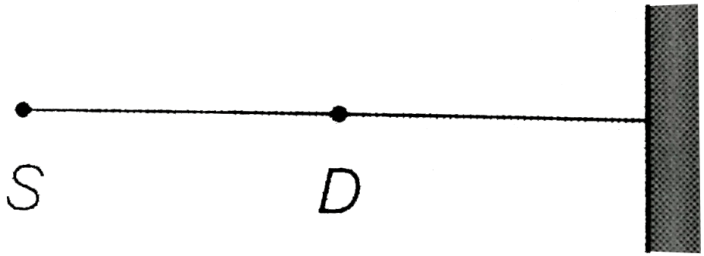
57. A train approachign a railway crossing at a speed of $120kmh^{-1}$ sounds a short whistle at frequency 640 Hz when it is 300 m away from

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 ?

Watch Video Solution

58. (a) A source of sound S and a detector D are placed at some distance from one another. A big cardboard is placed near the detector and perpendicular to the line SD as shown in

figure. It is gradually moved away and it is found that the intensity changes from a maximum to a minimum as the board is moved through a distance of $20cm$. Find the frequency of the sound emitted. Velocity of sound in are is $336m/s$.



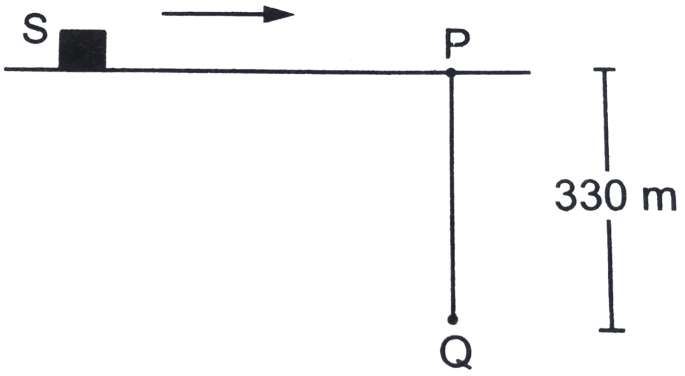
(b) A source emitting sound of frequency $180Hz$ is placed in front of a wall at a distance of $2m$ from it. A detector is also placed in front of the wall at the same distance from it.

find the minimum distance between the source and the detector for which the detector detects a maximum of sound . Speed of sound in air $= 360m/s$.

Watch Video Solution

59. Figure shows a source of sound moving along the X-axis at a speed of $22ms^{-1}$ continuously emitting a sound of frequency 2.0 kHz which travels in air at a speed of $330 \in s^{-1}$. A listener Q stands on the Y-axis at

a distance of 330 m from the origin. At t = 0, the source crosses the origin P. (a) When does the sound emitted from the source at P reach the listener Q 9 (b) What will be the frequency heard by the listener at. this instant 9 (c) Where will the source be at this instant ?



Watch Video Solution

Practice Questions Single Correct Choice Type

1. A bell is ringing inside of a sealed glass jar that is connected to a vacuum pump. Initially, the jar is filled with air, What does one hear as the air is slowly removed from the jar by the pump?

A. The sound intensity from the bell gradually decreases

B. The frequency of the sound from the bell gradually increases.

C. The frequency of the sound from the bell gradually decreases. (

D. The speed of the sound from the bell gradually increases.

Answer: A

Watch Video Solution

2. Take the speed of sound to be 340 m/s. A thunder clap is heard about 3 s after the

lightning is seen. The source of both light and sound is

A. moving overhead faster than the speed of sound.

B. emitting a much higher frequency than is heard.

C. emitting a much lower frequency than is heard

D. about 1000 m away

Answer: D

Watch Video Solution

3. Two closed organ pipe A and B have the same length. A is wider than B. They resonate in the fundamental mode at frequencies V_A and V_B respectively , then

A. $n_A = n_B$

B. $n_A > n_B$

C. $n_A < n_B$

D. Either (b) or (c) depending on the ratio of their diameters.

Answer: C

Watch Video Solution

4. A car moving at 35 m/s approaches a stationary whistle that emits a 220 Hz sound. The speed of sound is 343 m/s. What is the speed of the sound relative to the driver of the car?

A. 300 m/s

B. 340 m/s

C. 378 m/s

D. 305 m/s

Answer: C

Watch Video Solution

5. The speed of sound in fresh water at $20^{\circ}C$ is 1482 m/s. At what temperature is the speed of sound in helium gas the same as that of

fresh water at 20° C? Helium is considered a monatomic ideal gas (λ = 1.67 and atomic mass = 4.003 u).

A. 313 K

B. 442 K

C. 633 K

D. 377 K

Answer: C

Watch Video Solution

6. Ethanol has a density of $659kg/m^3$. If the speed of sound in ethanol is 1162 m/s, what is its adiabatic bulk modulus?

A. $1.7 \times 10^8 N/m^2$

B. $7.7 \times 10^8 N/m^2$

C. $2.2 \times 10^8 N/m^2$

D. $8.9 \times 10^8 N/m^2$

Answer: D

Watch Video Solution

7. A fire whistle emits a tone of 170 Hz. Take the speed of sound in air to be 340 m/s. The wavelength of this sound is about

A. 0.5m

B. 1.0m

C. 2.0m

D. 3.0m

Answer: C

Watch Video Solution

8. An aircraft carrier has a speed of 13.0 m/s relative to the water. A jet is catapulted from the deck and has a speed of 67.0 m/s relative to the water. The engines produce a 1550-Hz whine, and the speed of sound is 343 m/s. What is the frequency of the sound heard by the crew on the ship?

A. 1200 Hz

B. 1450 Hz

C. 1180 Hz

D. 1350 Hz

Answer: D

Watch Video Solution

9. Two golf carts have horns that emit sound with a frequency of 390 Hz. The golf carts are traveling toward one another. each traveling with a speed of 9.0 m/s with respect to the ground. What frequency do the drivers of the

carts hear? The speed of sound at the golf course is 343 m/s.

A. 390 HZ

B. 400 Hz

C. 410 Hz

D. 420 Hz

Answer: C

 Watch Video Solution

10. At a distance of 5.0 m from a point sound source, the sound intensity level is 110 dB. At what distance is the intensity level 95 dB?

A. 5.0 m

B. 14 m

C. 7.1 m

D. 28 m

Answer: D

Watch Video Solution

11. When we clap our hands, the sound produced is best described by Here p denotes the change in pressure from the equilibrium value

A. $p = p_0 \sin(kx - \omega t)$

B. $p = p_0 \sin kx \cos \omega t$

C. $p = p_0 \cos kx \sin \omega t$

D. $p = \sigma p_0 \sin(k_n x - \omega_n t)$

Answer: D

Watch Video Solution

12. The sound level at a point P is 14 dB below the sound level at a point 1.0 m from a point source. The distance from the source to point P is

A. 4.0 m

B. 20.2 m

C. 2.0 m

D. 5.0 m

Answer: D

View Text Solution

13. Two pianos each sound the same note simultaneously, but they are both out of tune. On a day when the speed of sound is 343 m/s, piano A produces a wavelength of 0.769 m, while piano B produces a wavelength of 0.776 m. How much time separates successive beats?

A. 1.4 s

B. 0.76 s

C. 0.25 s

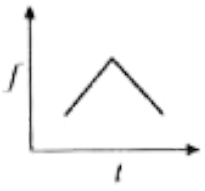
D. 0.07 s

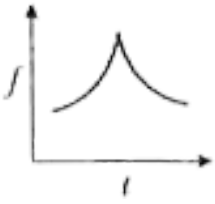
Answer: C

Watch Video Solution

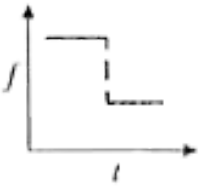
14. A railway engine whistling at a constant frequency moves with a constant speed. It goes past a stationary observer standing beside the railway track. The frequency (n) of

the sound heard by the observer is plotted agains time (t). Which of the following best represents the resulting curve?

A. 

B. 

C. 

D. 

Answer: D

 Watch Video Solution

15. How far must one stand from a 5 mW point sound source if the intensity is at the hearing threshold? Assume the sound waves travel to the listener without being disturbed.

A. 500m

B. 20km

C. 2km

D. 1km

Answer: B

View Text Solution

16. A vibrating tuning fork is held over a water column with one end closed and the other open. As the water level is allowed to fall, a loud sound is heard for water levels separated by 17 cm. If the speed of sound in air is 340 m/s, the frequency of the tuning fork is:

A. 500 Hz

B. 1000 Hz

C. 2000 Hz

D. 5780 Hz

Answer: B

17. Two identical tuning forks vibrate at 256 Hz.

One of them is then loaded with a drop of wax,

after which 6 beats per second are heard. The period of the loaded tuning fork is

A. 0.006 s

B. 0.005 s

C. 0.004 s

D. 0.00 3 s

Answer: C

 Watch Video Solution

18. A pebble is dropped in a lake, and it produces ripples with a frequency of 0.25 Hz. When should a second pebble be dropped at the same place to produce destructive interference?

A. 0.50 s after the first

B. 1.0 s after the first

C. 2.0 s after the first

D. 0.75 s after the first

Answer: C

Watch Video Solution

19. A tube, open at only one end, is cut into two shorter (non equal) lengths. The piece that is open at both ends has a fundamental frequency of 425 Hz, while the piece open only at one end has a fundamental frequency of 675 Hz. What is the fundamental frequency of the original tube?

A. 127 Hz

B. 162 Hz

C. 209 Hz

D. 148 Hz

Answer: B

Watch Video Solution

20. A stationary source generates 5.0 Hz water waves whose speed is 2.0 m/s. A boat is approaching the source at 10 m/s. The frequency of these waves, as observed by a person in the boat, is

A. 25 Hz

B. 15 Hz

C. 20 Hz

D. 30 Hz

Answer: D

 Watch Video Solution

21. When two waves with same frequency and constant phase differenc interfere,

A. there is a gain of energy.

B. there is a loss of energy.

C. the energy is redistributed and the distribution changes with time.

D. the energy is redistributed and the distribution remains constant in time.

Answer: D

Watch Video Solution

22. A rocket in a fireworks display explodes high in the air. The sound spreads out uniformly in all directions. The intensity of the sound is $2.0 \times 10 W/m^2$ at a distance of 120 m from the explosion. Find the distance from the source at which the intensity is $0.80 \times 10^{-6} W/m^2$.

A. 690 m

B. 220 m

C. 110 m

D. 190m

Answer: D

View Text Solution

23. A source emits sound with a frequency of 1000 Hz. It is moving at 20 m/s toward a stationary reflecting wall. If the speed of sound is 340 m/s an observer at rest directly behind the source hears a beat frequency of

A. 11 Hz

B. 86 Hz

C. 97 Hz

D. 118 Hz

Answer: D

Watch Video Solution

24. Pipe A is 0.50 m long and open at both ends. Pipe B is open at one end and closed at the other end. Determine the length of pipe B

so that it has the same fundamental frequency as A.

A. 0.25 m

B. 0.75 m

C. 0.50 m

D. 1.0m

Answer: A

Watch Video Solution

25. A piano wire has a length of 81 cm and a mass of 2.0 g. If its fundamental frequency is to be 394 Hz, it tension must be

A. 0.32 N

B. 63 N

C. 130 N

D. 250 N

Answer: B

Watch Video Solution

26. An organ pipe is open at both ends. It is producing sound at its third harmonic, the frequency of which is 262 Hz. The speed of sound is 343 m/s. What is the length of the pipe?

A. 1.96 m

B. 1.31 m

C. 1.85 m

D. 0.926 m

Answer: A

Watch Video Solution

27. The security alarm on a parked car goes off and produces a frequency of 960 Hz. The speed of sound is 343 m/s. As you drive toward this parked car, pass it, and drive away, you observe the frequency to change by 95 Hz. At what speed are you driving?

A. 9.2 m/s

B. 17 m/s

C. 12 m/s

D. 25 m/s

Answer: B

Watch Video Solution

28. A bird is flying directly toward a stationary bird-watcher and emits a frequency of 1250 Hz. The bird-watcher, however, hears a frequency of 1290 Hz. What is the speed of the bird, expressed as a percentage of the speed of sound?

A. 0.02

B. 0.0097

C. 0.031

D. 0.014

Answer: C

Watch Video Solution

29. Two timpani (tunable drums) are played at the same time. One is correctly tuned so that when it is struck, sound is produced that has a

wavelength of 2.20 m. The second produces sound with a wavelength of 2.08 m. If the speed of sound is 343 m/s, what beat frequency is heard?

A. 7 beats/s

B. 9 beats/s

C. 11 beats/s

D. 13 beats/s

Answer: B

Watch Video Solution

30. Two identical tuning forks vibrate at 587 Hz. After a small piece of clay is placed on one of them, eight beats per second are heard. What is the period of the tuning fork that holds the clay?

A. $1.67 \times 10^{-3} s$

B. $1.70 \times 10^{-3} s$

C. $1.73 \times 10^{-3} s$

D. $1.76 \times 10^{-3} s$

Answer: C

Watch Video Solution

31. Four standing wave segments, or loops, are observed on a string fixed at both ends as it vibrates at a frequency of 140 Hz. What is the fundamental frequency of the string?

A. 23 Hz

B. 28 Hz

C. 35 Hz

D. 47 Hz

Answer: C

Watch Video Solution

32. A 4.00-m long string, clamped at both ends, vibrates at 2.00×10^2 Hz. If the string resonates in six segments, what is the speed of transverse waves on the string?

A. 100 m/s

B. 133 m/s

C. 267 m/s

D. 328 m/s

Answer: C

 Watch Video Solution

33. A string of length 1m and mass 5g is fixed at both ends. The tension in the string is 12.5 N. The string is set into vibration using an external vibrator of frequency 100 Hz. The

separation between successive nodes on the string (in m) is _____ .

A. 270 N

B. 410 N

C. 550 N

D. 680 N

Answer: A

Watch Video Solution

34. A bat emits a sound whose frequency is 91 kHz. The speed of sound in air at 20.0° C is 343 m/s. However, the air temperature is $35^\circ C$, so the speed of sound is not 343 m/s. Find the wavelength of the sound.

A. $5.0 \times 10^{-2} s$

B. $3.9 \times 10^{-3} s$

C. $1.1 \times 10^{-2} s$

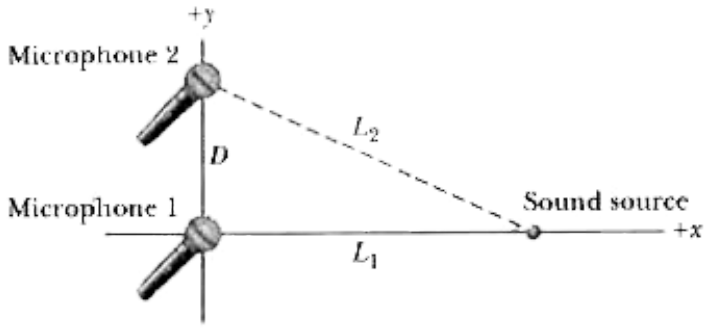
D. $5.5 \times 10^{-3} s$

Answer: B

View Text Solution

35. As the drawing shows, one microphone is located at the origin, and a second microphone is located on the $+y$ axis. The microphones are separated by a distance of D = 1.50 m. A source of sound is located on the +x axis, its distances from microphones 1 and 2 being L_1 and L_2 respectively. The speed of sound is 343 m/s. The sound reaches microphone 1 first, and then, 1.46 ms later, it reaches microphone 2. Find the distances L_1

and L_2 .



	L_1	L_2
(a)	1.00 m	1.80 m
(b)	1.25 m	1.95 m
(c)	1.50 m	2.12 m
(d)	2.00 m	2.50 m

View Text Solution

Practice Questions More Than One Correct Choice Type

1. Coherent sources are characterized by the same

A. phase and phase velocity.

B. wavelength, amplitude, and phase velocity

C. wavelength, amplitude, and frequency.

D. wavelength and phase

Answer: B::C

 Watch Video Solution

2. When the open organ pipe resonates in its fundamental mode then at the centre of the pipe

A. the gas molecules undergo vibrations of maximum amplitude.

B. the gas molecules are at rest

C. the pressure of the gas is constant.

D. the pressure of the gas undergo maximum variation

Answer: B::D

Watch Video Solution

3. A listener is at rest with respect to the source of sound. A wind starts blowing along the line joining the source and the observer. Which of the following quantities do not change?

(i) Frequency

(ii) Velocity of sound

(iii) Wavelength

(iv) Time period

A. Frequency

B. Velocity of sound

C. Wavelength

D. Time period

Answer: A::D

Watch Video Solution

4. To raise the pitch of a stringed musical instrument the player can

A. loosen the string

B. tighten the string.

C. shorten the string

D. lengthen the string.

Answer: B::C

Watch Video Solution

5. A sound wave passes from a medium A to a medium B. The velocity of sound B is greater than that in A. Assume that there is no absorption or reflection at the boundary. As the wave moves across the boundary

A. the frequency of sound will not change

B. the wavelength will increase

C. the wavelength will decrease

D. the intensity of sound will not change

Answer: A::B::

Watch Video Solution

6. Two idential straight wires are stretched so as to produce 6 beats per second when vibrating simultaneously. On changing the tension slightly in one of them, the beat frequency remains unchanged. Denoting by T_1 , T_2 the higher and the lower initial tension in the strings, then it could be said that while making the above changes in tension,

A. T_2 was decreased

B. T_2 was increased .

C. T_1 was increased .

D. T_1 was decreased .

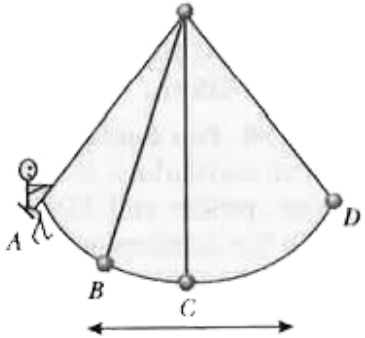
Answer: B::D

Watch Video Solution

Practice Questions Linked Comprehension

1. The diagram shows the various positions of a child in motion on a swing. Somewhere in

front of the child a stationary whistle is blowing.



At which position(s) will the child hear the highest frequency for the sound from the whistle?

A. At both A and D.

B. At C when moving toward B

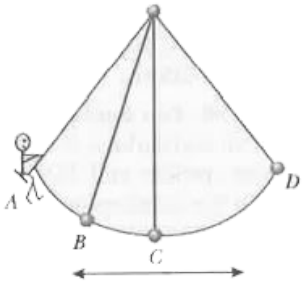
C. At B when moving toward A.

D. At C when moving toward D

Answer: D

Watch Video Solution

2. The diagram shows the various positions of a child in motion on a swing. Somewhere in front of the child a stationary whistle is blowing.



At which position(s) will the child hear the lowest frequency for the sound from the whistle?

A. At both A and D.

B. At C when moving toward B

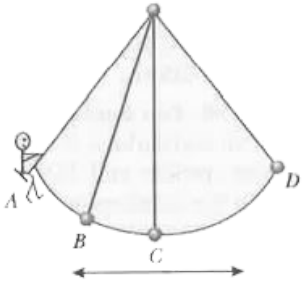
C. At B when moving toward A

D. At C when moving toward D.

Answer: B

Watch Video Solution

3. The diagram shows the various positions of a child in motion on a swing. Somewhere in front of the child a stationary whistle is blowing.



At which position(s) will the child hear the

same frequency as that heard by a stationary observer standing next to the whistle?

A. At both A and D.

B. At C when moving toward B

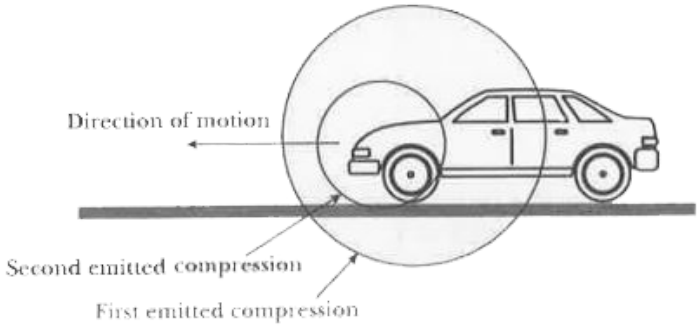
C. At B when moving toward A

D. At C when moving toward D

Answer: A

Watch Video Solution

4. The car in the figure is moving to the left at 35 m/s. The car's horn continuously emits a 2.20×10^2 Hz sound. The figure also shows the first two regions of compression of the emitted sound waves. The speed of sound is 343 m/s.



How far does the car move in one period of the sound emitted from the horn?

A. 0.08m

B. 0.16m

C. 8m

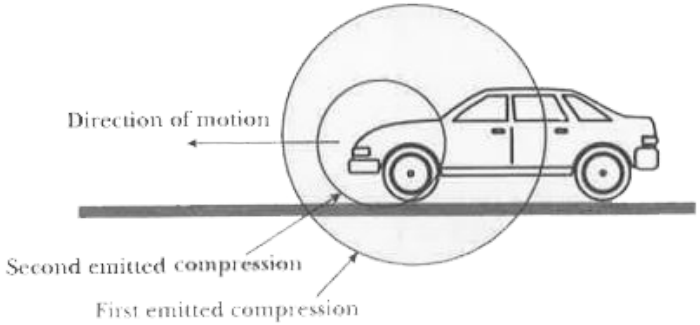
D. 16m

Answer: B

Watch Video Solution

5. The car in the figure is moving to the left at 35 m/s. The car's horn continuously emits a 2.20×10^2 Hz sound. The figure also shows

the first two regions of compression of the emitted sound waves. The speed of sound is 343 m/s.



How far has the initial compression traveled when the second compression is emitted?

A. 0.77 m

B. 7.7 m

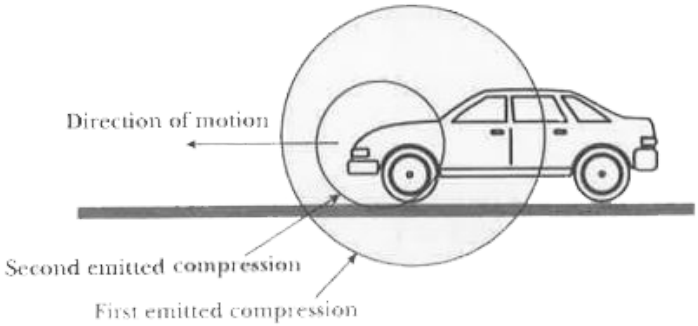
C. 1.56 m

D. 15.5 m

Answer: C

Watch Video Solution

6. The car in the figure is moving to the left at 35 m/s. The car's horn continuously emits a 2.20×10^2 Hz sound. The figure also shows the first two regions of compression of the emitted sound waves. The speed of sound is 343 m/s.



What is the wavelength of the sound in the direction of motion of the car?

A. 1.40 m

B. 1.70 m

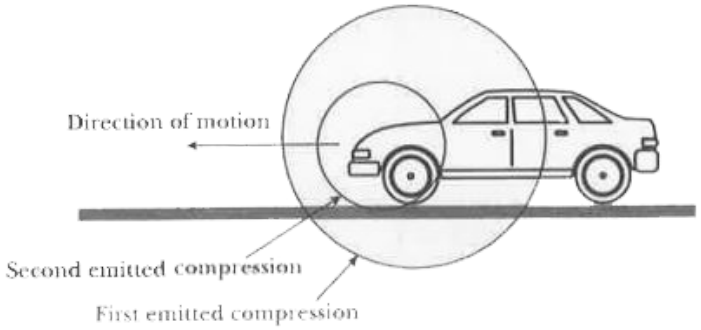
C. 1.56 m

D. 1.93 m

Answer: A

Watch Video Solution

7. The car in the figure is moving to the left at 35 m/s. The car's horn continuously emits a 2.20×10^2 Hz sound. The figure also shows the first two regions of compression of the emitted sound waves. The speed of sound is 343 m/s.



What is the frequency heard by a stationary observer standing in front of the car?

A. 9.7 Hz

B. 245 Hz

C. 176 Hz

D. 219 Hz

Answer: B

Watch Video Solution

8. Two loudspeakers are located 3 m apart on the stage of an auditorium. A listener at point P is seated 29.0 m from one speaker and 25.0 m from the other. A signal generator drives the speakers in phase with the same amplitude and frequency. The wave amplitude at P due to each speaker alone is A. The frequency is then varied between 20 Hz and 300 Hz. The speed of sound is 343 m/s.

At what frequency or frequencies will the listener at P hear a maximum intensity?

A. 170 Hz only

B. 57 Hz, 113 Hz, 170 Hz, 227 Hz, and 284 Hz

C. 113 Hz and 226 Hz

D. 86 Hz, 170 Hz, 257 Hz

Answer: D

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9. Two loudspeakers are located 3 m apart on the stage of an auditorium. A listener at point P is seated 29.0 m from one speaker and 25.0

m from the other. A signal generator drives the speakers in phase with the same amplitude and frequency. The wave amplitude at P due to each speaker alone is A. The frequency is then varied between 20 Hz and 300 Hz. The speed of sound is 343 m/s.

Determine the value of the maximum amplitude in terms of A.

A. 2.0A

B. 3.0 A

C. 2.5 A

D. 4.0A

Answer: A

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10. Vibrations with frequency 6.00×10^2 Hz are established on a 1.33 m length of string that is clamed at both ends. The speed of waves on the string is $4.0 \times 10^2 m / s$

How many antinodes are contained in the resulting standing wave pattern?

A. 2

B. 4

C. 3

D. 5

Answer: B

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11. Vibrations with frequency 6.00×10^2 Hz are established on a 1.33 m length of string that is clamed at both ends. The speed of waves on

the string is $4.0 \times 10^2 m / s$

How far from either end of the string does the first node occur?

A. 0.17m

B. 0.49 m

C. 0.33m

D. 0.66 m

Answer: C

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Practice Questions Matrix Match

1. A source of sound of frequency 1000 Hz moves to the right with a speed of 32 m/s relative to the ground. To its right is a reflecting surface moving to the left with a speed of 64 m/s relative to the ground. Take speed of sound in air to be 332 m/s.

Column I	Column II
(a) Wavelength of sound emitted in air by source in the right side of source (in mm)	**(p)** 1320
(b) Number of waves arriving per second at the reflecting surface	**(q)** 364
(c) Speed of reflected wave (in m/s)	**(r)** 332
(d) Wavelength of reflected wave (in mm)	**(s)** 200

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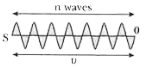
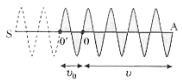
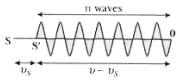
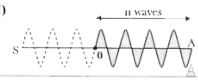
2. there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

Doppler's effect

Column I	Column II	Column III
(I) Sound waves propagate in the form of spherical wavefronts	**(i)** the distance between two successive circles is equal to wavelength λ	**(J)** 
(II) No change in wavelength received by either observer X or Y	**(ii)** sound waves propagate in the form of spherical wavefronts	**(K)** 
(III) Source at three different positions	**(iii)** waves are represented by concentric circles	**(L)** 
(IV) Change in wavelength received by either observer X or Y	**(iv)** waves are represented by non-concentric circles	**(M)** 

What happens when the observer and source are stationary?

A. (1) (i) (J)

B. (III) (ii) (K)

C. (II) (ii) (L)

D. (I) (iii) (J)

Answer: A

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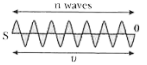
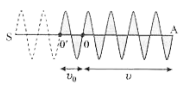
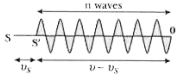
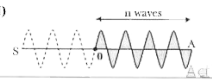
3. there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b), (c) and (d), ONLY ONE of these four options is correct.

Doppler's effect

Column I	Column II	Column III
(I) Sound waves propagate in the form of spherical wavefronts	**(i)** the distance between two successive circles is equal to wavelength λ	**(J)** 
(II) No change in wavelength received by either observer X or Y	**(ii)** sound waves propagate in the form of spherical wavefronts	**(K)** 
(III) Source at three different positions	**(iii)** waves are represented by concentric circles	**(L)** 
(IV) Change in wavelength received by either observer X or Y	**(iv)** waves are represented by non-concentric circles	**(M)** 

What happens when the source is moving but observer is at rest?

A. (I) (ii) (M)

B. (III) (iv) (L)

C. (II) (ii) (K)

D. (II) (iv) (M)

Answer: B

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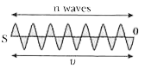
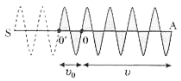
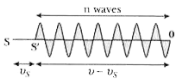
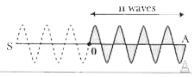
4. there is a table having 3 columns and 4 rows. Based on the table, there are 3 questions. Each question has 4 options (a), (b),

(c) and (d), ONLY ONE of these four options is correct.

Doppler's effect

Column I	Column II	Column III
(I) Sound waves propagate in the form of spherical wavefronts	(i) the distance between two successive circles is equal to wavelength λ	(J) 
(II) No change in wavelength received by either observer X or Y	(ii) sound waves propagate in the form of spherical wavefronts	(K) 
(III) Source at three different positions	(iii) waves are represented by concentric circles	(L) 
(IV) Change in wavelength received by either observer X or Y	(iv) waves are represented by non-concentric circles	(M) 

What happens when the source is at rest, but observer is moving?

A. (III) (i) (L)

B. (IV) (i) (J)

C. (III) (iv) (J)

D. (II) (iii) (M)

Answer: D

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Practice Questions Integer Type

1. Two tuning forks when sounded together give 8 beats per second. When tuning fork A is sounded with air column of length 37.5 cm closed at one end, resonance occurs in its

fundamental mode. Tuning fork B gives resonance with air column of length 38.5 cm and is closed at one end in its fundamental mode. Find the frequencies of tuning forks.

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2. The speed of a sound in a container of hydrogen at 201 K is 1220 m/s. What would be the speed of sound if the temperature were raised to 405 K? Assume that hydrogen behaves like an ideal gas.

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3. A hunter is standing on fiat ground between two vertical cliffs that are directly opposite one another. He is closer to one cliff than to the other. He fires a gun and, after a while, hears three echoes. The second echo arrives 1.6 S after the first, and the third echo arrives 1.1 s after the second. Assuming that the speed of sound is 343 m/s and that there are no reflections of sound from the ground, find the distance between the cliffs.

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4. Two submarines are underwater and approaching each other head-on. Sub A has a speed of 12 m/s and sub B has a speed of 8 m/s. Sub A sends out a 1550-Hz sonar wave that travels at a speed of 1522 m/s. What is the frequency detected by sub B?

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5. A tube is open only at one end. A certain harmonic produced by the tube has a frequency of 450 Hz. The next higher harmonic has a frequency of 750 Hz. The speed of sound in air is 343 m/s. What is the integer n that describes the harmonic whose frequency is 450 Hz?

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