PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

DOPPLER EFFECT

Examples

1. A person standing on one side of a road blows a whistle which has a frequency of

$600Hz$. A cyclist passes at 16 kilometre per hour. What does the frequency of the whistle appear to be to the cyclist before and after passing ?

(Velocity of sound in air $= 350ms^{-1}$)

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2. Two express trains moving at 100 kilometre per hour are travelling towards each other while one of them is whistling continuously. If the frequency of the note is 1000 Hz, find the

apparent pitch to an observer in the other train (a) before the trains pass by each other and (b) after they have passed each other. (Velocity of sound in air $= 340 m / s$)

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3. A source of sonic oscillations of frequency $n_0 = 2000 Hz$ and a receiver are located on the same normal to a wall. Both the source and the receiver are stationary and the wall recedes from the source with a velocity

$u = 10cm/s$. Find the beat frequency registered by the receiver. The velocity of sound is $v = 340m/s$

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4. A source of sonic oscillations of frequency $n_0 = 2000Hz$ and a receiver are located at the same point. At the instant $t = 0$ the source starts receding form the receiver with constant acceleration $a = 10ms^{-2}$. Find the frequency registered by the reciver at the

instant $t = 10s$. Velocity of sound, $v = 340m/s$

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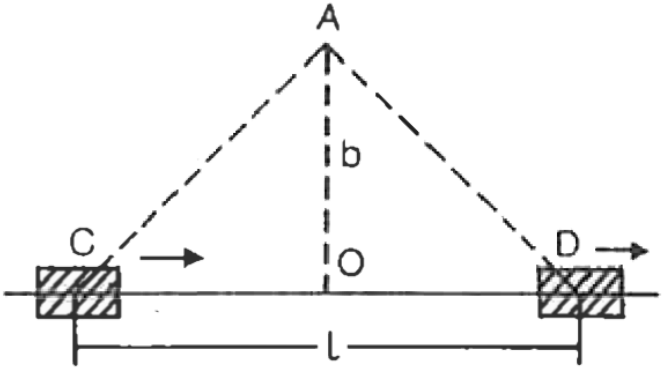
5. Two trains run at the same speed $v = 90km/h$ along a strainght track one after the other with a separation $l = 2km$. At the instant when they are located symmetrically relative to the point A at a distance $b = 1km$ form the track, both emit a brief signal of frequency $n = 500Hz$. What will be the

nature of the sound at A? The speed of sound is $V = 350m/s$



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Exercises

1. A train approaches a stationary observe at a speed of 75 kilometres per hour sounding a whistle of frequency 1000 Hz. What will be the apparent frequency of the whistle to the observes? Velocity of sound $= 332ms^{-1}$

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2. A train is whistling while approaching a tunnel at a speed of 36 kmph. The driver hears the echo of the whistle reflected from the

tunnel and estimates its frequency to be 850 Hz. Find the actual frequency of the whistle. The velocity of sound in air $= 330m/s$

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3. An observer on a railway station platform observed that as the train passed the station at 96 kmph, the frequency of the whistle appeared to drop by 400 Hz. Find the frequency of the whistle. (Velocity of sound $= 1200km/h$)

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4. Two aeroplanes are approaching each other and their velocities are 160 and 240 kilometres per hour. The frequency of the note emitted by the first as heard by the passengers in the other is $1000Hz$. Calculate the true frequency of the note as heard by its own passengers. (Velocity of sound $= 1200kmph$)

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5. A man is standing beside a railway line listening to the whistle of a passing train. The whistle which has frequency of 1000 Hz suffers an apparent change of 100 Hz. What is the speed of the train ? Velocity of sound $= 333.3ms^{-1}$

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6. Show that Dopple effect is greater when the source approaches the observe than when the

observer approaches the source with the same speed.

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7. The wavelength of the spectral line coming from a star is changed by the motion of the star from 6000Å to 6001Å. Find the velocity of the star with respect to the earth. (Velocity of light $= 3 \times 10^8 m/s$)

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8. A upersonic jet plane of Mach 1.5 is sighted overhead. How far will it be after 10 s ? (Velocity of sound $= 340ms^{-1}$)

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9. Show that the frequency of sound vibrations emitted by a source will appear to be doubled to a listener fixed in space when the source approaches the listener with a speed equalling half the speed of sound.

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10. The ratio of the apparent frequencies of the hom of a car when approching and receding a stationary observer is $11:9$. What is the speed of the car, if the velocity of sound in air is $300 m/s$?

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11. Can you go fast enough to have red light appear green ? $\lambda(\text{red}) = 6200\text{Å}$ and

$\lambda(\text{green}) = 5400\text{Å}.$

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12. A bullet is fired with a speed of $670ms^{-1}$. Find the angle made by the shock wave with the line of motion of the bullet. What is the Match number of the wave? (Velocity of sound in air $= 335ms^{-1}$)

[Hint : $\sin\theta = V/V_s$]

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

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14. A receiver and a source of sonic oscillations of frequency $v_0 = 2000Hz$ are located along the x-axis. The source swings simple harmonically along the axis with a constant frequency and amplitude $a = 50cm$. If the frequency band -width registered by the stationary receiver is $\Delta v = 200Hz$, find the value of oscillation frequency of the source. Speed of sound in air $= 340ms^{-1}$

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15. A train approaching a hill at a speed of 36 kmph sounds a whistle of frequency 500 Hz when it is at a distance of 1 km. A wind blows at 36 kmph in the direction of the motion of the train. Find (i) the frequency of the whistle as heard by an observer on the hill, (ii) the distance from the hill at which the echo from the hill is heard by the driver and its frequency. Velocity of sound $= 1200 kmph$

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16. A source of sound of frequency $1000 H_Z$ moves unifornly along a straight line with velocity 0.8 times velocity of sound . An observer is located at a distance $l = 250m$ from this line. Find

(a) the frequency of the sound at instant when the source is closest to the observer.

(b) the distance of the source when he observer no change in the frequency.

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17. A source of sound of frequency $2000Hz$ moves towards a wall velocity $u = 6cm/s$ and the wall moves towards the source at $v = 3cm/s$. What is the beat frequency registered by a receiver moving towards the wall at $w = 2cm/s$, it being in between the source and the wall ? Velocity of sound $= 340m/s$

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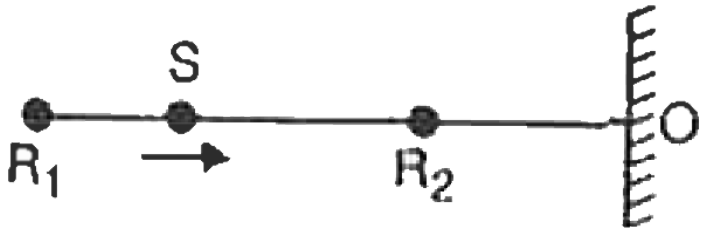
18. A stationary source sends forth monochromatic $(n = 500Hz)$ sound. A wall approaches it with velocity $u = 5cm/s$. The velocity of sound in the medium is $v = 340m/s$. What is the wavelength and frequency of the sound wave reflected from the wall ?



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19. A source of sonic oscillations of frequency $n_0 = 1500Hz$ moves at right angles to the wall with velocity $u = 2.0m/s$. Two stationary receivers R_1 and R_2 are located on a straight line coinciding with the line of motion of the source in the sequence: R_1 -source-R_2-wall. Which reciver registers the beat and what is the beat frequency? The velocity of sound, $v = 340m/s$.

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20. When a spectral line of wavelength $\lambda = 0.60\mu m$ is observed in the directions of the opposite edge of the solar disc $\left(R = 7.0 \times 10^8 m\right)$ along its equator, there is a difference in wavelength equal to $\Delta\lambda = 8.0pm$. Find the period of the sun's revolution about its own axis.

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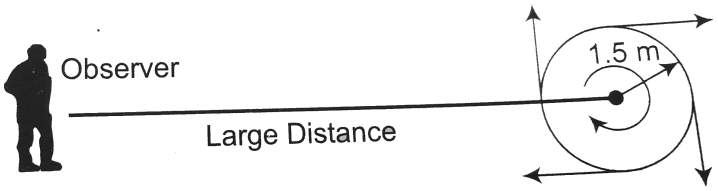
21.



A whistle emitting a sound of frequency $440Hz$ is tied to string of $1.5m$ length and rotated with an angular velocity of $20rad/\sec$ in the horizontal plane. Then the range of frequencies heard by an observer stationed at a large distance from the whistle will $(v = 330m/s)$

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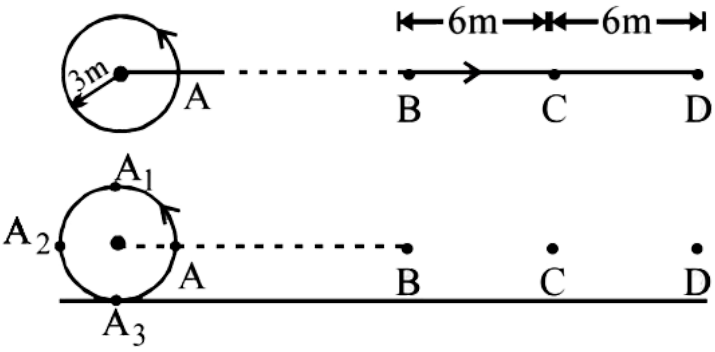
22. A source of sound is moving along a circular orbit of radius $3meter$ with an angular velocity of $10rad/s$. A sound detector located far away from the source is executing linear simple harmonic motion along the line BD with an amplitude $BC = CD = 6meters$. The frequency of oscillation of the detector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

detector.



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23. A bus is moving towards a huge wall with a velocity of $5m/s^{-1}$. The driver sounds a horn of frequency $200Hz$. The frequency of the beats heard by a passenger of the bus will be

..... Hz (Speed of sound in air $= 342m/s^{-1}$)

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24. A train approaching a crossing at a speed of 100 km/h sounds a whistle $400Hz$ when it is 1.5 km from the crossing. There is no wind and the speed of sound in air is 340 m/s. What frequency is heard by an observer 1.0 km on the strainght road from the crossing at right angles.

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