# CLASS 09 CHAPTER SOUND

## Numericals

1. A man standing in front of a cliff, fires a rifle. He heard the echo after 3 seconds. Calculate the distance of man from the cliff. (Velocity of sound in air = 340 m/s).
2. An observer stands at a distance of 850 m from a cliff and fires a gun. After what time gap will he hear the echo, if sound travels at a speed of 340 $ms^{-1}$ in air?
3. An observer standing between two cliffs fires a gun. He hears the first echo after 1 second and the next after 3 seconds. Find
   (*i*) his distance from the nearer cliff.
   (*ii*) his distance between the two cliffs.
   (Velocity of sound = 330 $ms^{-1}$).
4. A man standing between two parallel cliffs fires a rifle. He hears one echo after 1.5 s and another after 2.5 s. If the velocity of sound is 340 m/s, what is the distance between the cliffs?
5. A ship on the surface of water sends ultrasonic waves and receives them back from a submarine inside the water after 5 seconds. If the speed of sound in water is 1400 m/s, what is the distance of submarine from the ship?
6. If 5 seconds elapse between a lightning flash and the clap of thunder, how far away is the storm? Speed of sound = 332 m/s.
7. A child watching Dusshera celebrations from a distance sees the effigy of Ravana burst into flames and hears the explosion associated with it 2 s after that. How far was he from the effigy if the speed of sound in air that night was 335 m/s?
8. A person makes a loud sound and hears the echo of this sound 1.2 s later. Calculate how far the person is from the object causing the echo. Assume that the speed of sound is 332 m/s.

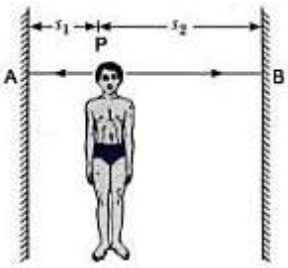
## Answers

| | | | |
|---|---|---|---|
| **1.** 510 m | **2.** 5 s | **3.** (*i*) 165 m, (*ii*) 660 m, | **4.** 680 m, |
| **5.** 3.5 km | **6.** 1660m | **7.** 670 m | **8.** 199.2 m |

**Q. A person standing between two vertical cliffs and 640 m away from the nearest cliff shouted. He heard the first echo after 4 seconds and the second echo 3 seconds later. Calculate**

**(*i*) the velocity of sound in air, and**

**(*ii*) the distance between the cliffs.**




**Ans.** (*i*) Let $P$ be the person standing between the cliffs $A$ and $B$. Let $s_1$ be distance of nearest cliff $A$ from $P$ and $s_2$ the distance of second cliff $B$ from $P$. The first echo is heard when sound reaches the person after being reflected from cliff $A$.

Given $s_1 = AP = 640$ m

Time interval of first echo, $t_1 = 4$ seconds

From relation $2s_1 = vt_1$, we have

$$\text{Speed of sound, } v = \frac{2s_1}{t_1} = \frac{2 \times 640}{4} = \mathbf{320\ m/s}$$

$\therefore$ Speed of sound in air, $v = 320$ m/s

(*ii*) The second echo is heard when sound reaches the person after being reflected from the cliff $B$.

Time interval of second echo, $t_2 = 4 + 3 = 7$ seconds

$\therefore$ From relation, $2s_2 = vt_2$,

We have, $$s_2 = \frac{vt_2}{2} = \frac{320 \times 7}{2} = 1120 \text{ m}$$

$\therefore$ Distance between cliffs $A$ and $B$,

$$s = s_1 + s_2 = 640 + 1120 = 1760 \text{ m}$$

**Q. A sound wave has a frequency 2 kHz and wavelength 40 cm. How long will it take to travel 1.6 km?**

**Ans.** Given frequency, $\nu = 2$ kHz $= 2 \times 10^3$ Hz,

Wavelength, $\lambda = 40$ cm $= 0.40$ m

Speed of sound = frequency × wavelength

That is $v = \nu\lambda = (2 \times 10^3 \text{ Hz}) \times (0.40 \text{ m})$

$= 0.80 \times 10^3$ Hz $= \mathbf{800\ ms^{-1}}$

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

That is $t = \frac{s}{v}$

Given distance, $s = 1.6$ km $= 1.6 \times 10^3$ m

$\therefore$ $$\text{Time, } t = \frac{1.6 \times 10^3 \text{ m}}{800 \text{ ms}^{-1}} = \frac{1{,}600}{800} \text{ s} = \mathbf{2\ s}$$

**Q. A boy shouts while standing in front of a hill at a distance of 800 m. The boy hears the echo of his shout after 4.8 seconds. Find the speed of the sound.**

**Ans.** Here, distance, s = 800 m

Time after which echo is heard = 4.8 s.

$\therefore$ Distance 's' of body from the hill is given by the formula

$$2s = vt$$

or $$v = \frac{2s}{t} = \frac{2 \times 800 \text{ m}}{4.8 \text{ s}} \text{ or } v = \frac{s}{t} = \frac{800 \text{ m}}{2.4 \text{ s}} = \mathbf{333.3\ m/s}$$

**Q.** **The wavelength of waves produced on the surface of water is 20cm. If the wave velocity is 24 $ms^{-1}$, calculate (*a*) the number of waves produced in one second (*b*) the time required to produce one wave.**

**Ans.** Given wavelength, $\lambda = 20$ cm $= 0{\cdot}20$ m, wave velocity, $v = 24\ ms^{-1}$

(*a*) From relation, $v = \nu\lambda$,

Frequency, $\nu = \dfrac{v}{\lambda}$

Number of waves produced in one second is simply the frequency *i.e.*

$$\nu = \frac{v}{\lambda} = \frac{24}{0{\cdot}20} = 120 \text{ waves per second}$$

(*b*) Time period, $T = \dfrac{1}{\nu} = \dfrac{1}{120}$ second $= 8.33 \times 10^{-3}$ seconds

**Q.** **A longitudinal wave of wavelength 1 cm travels in air with a speed of 330 m/s. Calculate the frequency of the wave. Can this wave be heard by a normal human body?**

**Ans.** The relation between wave velocity ($v$), frequency ($\nu$) and wavelength ($\lambda$) is

$$v = \nu\lambda \Rightarrow \nu = \frac{v}{\lambda}$$

Given, $\lambda = 1$ cm $= 1 \times 10^{-2}$ m, $v = 330$ m / s

$\therefore$ Frequency, $\nu = \dfrac{v}{\lambda} = \dfrac{330}{1 \times 10^{-2}} = 33{,}000$ Hz

This frequency is more than 20,000 Hz (maximum frequency audible to man); hence, it cannot be heard by a normal human being.

**Q.** **A sound wave of wavelength $0{\cdot}332$ m has a time period of $10^{-3}$ s. If the time period is decreased to $10^{-4}$ s, calculate the wavelength and frequency of new wave.**

**Ans.** Given wavelength, $\lambda = 0{\cdot}332$ m

Time period of wave, $T = 10^{-3}$ s

$\therefore$ Frequency of wave, $\nu = \dfrac{1}{T} = \dfrac{1}{10^{-3}} = 1000$ Hz

$\therefore$ Velocity of wave, $v = \nu\lambda = 1000 \times 0.332 = 332$ m/s

In a given medium, the velocity of sound waves remains same.

New time period of new wave, $T' = 10^{-4}$ s

Frequency of new wave $\nu' = \dfrac{1}{T'} = \dfrac{1}{10^{-4}} = 10{,}000$ Hz

$\therefore$ Wavelength of new wave, $\lambda' = \dfrac{v}{\nu'} = \dfrac{332}{10{,}000} = 0.0332$ m

**Q.** **A boy hears the echo of his own voice from a distant hill after $0{\cdot}8$ second. If the speed of sound in air is 340 m/s, calculate the distance of hill from the boy.**

**Ans.** Let $s$ be the distance of the hill from the boy and $t$ the time of to and fro journey of sound waves, then from relation

distance = velocity × time,

We have $2s = vt$

$\Rightarrow$ $s = \dfrac{vt}{2}$

Here, $v = 340$ m/s, $t = 0.8$ s

$\therefore$ $s = \dfrac{340 \times 0.8}{2} = 340 \times 0.4$ m $= 136$ m