Please read the chapter from your textbook and the attached notes. Then work out the exercise neatly in your notebook. Ensure neat and tidy work. Use black ink to solve the exercise.

Definition: The sound heard after reflection from a distant obstacles (such as a cliff, a hill side, wall of a building etc) after the original sound has eased is called an echo.

Conditions for hearing an echo.

Persistence of hearing is 0.1 second. Let d be the distance between the source and the obstacle. Total distance travelled by sound wave = 2d.

Let v be the velocity of sound in the medium. The time taken to hear the echo, \( t = \frac{2d}{V} \)

Or \( d = \frac{Vt}{2} \)
Substituting \( t = 0.1 \text{s} \), \( V = 340 \text{ m/s}^{-1} \)

\[
d = 340 \times 0.1/2 = 17 \text{ m}
\]

Thus, to hear an echo distinctly the reflecting surface in air should be at a minimum distance of 17 m from the listener.

To hear an echo distinctly, following three conditions must be satisfied;

- the minimum distance between the source of sound and the reflector in ear must be 17 m.
- the size of the reflector must be large enough as compared to the wavelength of the sound wave.
- the intensity of sound should be such that the reflected sound reaching the ear in sufficiently loud to be audible.

**Determination of speed of sound by the method of Echo.**

The echo method can be used to determine the speed of sound in air. The time interval ' \( t \) ' in which the echo reaches the place from where the sound was produced having the least count 0.01s.

Speed of sound is calculated by

\[
V = \frac{2d}{t} \text{ms}^{-1}
\]

**Use of Echoes:-**

- **Use of echoes by bats, dolphins and fishermen –**
  Bats and dolphins detect their enemy and obstacle by emitting ultrasonic waves and hearing their echo.
  A fisherman sends an ultrasonic pulse from a source into the sea and receives the pulse reflected from the shoal of fish in a detector.

- **Use of echoes by SONAR-**
SONAR means sound Navigation and Ranging. The principle of a sonar in which ultrasonic waves are sent in sea water in all directions from the ship. These waves are received after reflection from an obstacle such as an enemy submarine.

- Use of echoes in medical field—

  In medical field, echo method of ultrasonic waves is used for imagine human organs (liver gall bladder etc) This is called ultrasonography.

**Numerical (solved) :-**

A person standing between two vertical cliffs produces a sound.

Two successive echoes are hard at 4s and 6s. Calculate the distance between the cliffs. (Speed of sound in air = 320 ms$^{-1}$)

\[
\begin{align*}
\text{Solution:} \\
\text{1st cliff} & \quad \text{2nd cliff} \\
\text{\phantom{0}d_1} & \quad \text{\phantom{0}d_2} \\
\text{\phantom{0}d_1} & = \frac{Vt_1}{2} \\
& = \frac{320 \times 4}{2} = 640 \text{ m} \\
\text{d_2} & = \frac{Vt_2}{2} \\
& = \frac{320 \times 6}{2} = 960 \text{ m}
\end{align*}
\]
Distance between the cliffs

\[ d_1 + d_2 = 640 \text{ m} + 960 \text{ m} = 1600 \text{ m} \]

**Exercise**

**Answer the given question:-**

1. State two applications of echo
2. How do bats avoid obstacles in their way, when in flight?

**Numericals**

3. Calculate the minimum distance in air required between the source of sound and the obstacle to hear an echo. (Speed of sound in air = 350ms\(^{-1}\))
4. What should be the minimum distance between the source and reflector in water so that the echo is heard distinctly? (Speed of sound in water = 1400ms\(^{-1}\))
5. A ship on the surface of water sends a signal and receives it back from a submarine inside water after 4s. Calculate the distance of the submarine from the ship (Speed of sound in water =1400ms\(^{-1}\)).

Please tap on the hyperlink below to watch the video content of the topic Echo.

https://youtu.be/nkpvTcTcWDM

*******************************************************************************