

18. Sound and Communication

- Sound is the form of energy which gives the sensation of hearing. It travels in the form of waves.
- The wave which can travel without medium is called non mechanical or electromagnetic wave. The wave which requires medium for its propagation is called mechanical wave. Mechanical waves are of two types: (i) longitudinal waves and (ii) transverse waves.
- The wave in which vibrations are along the direction of wave propagation are longitudinal waves. They travel in the form of rarefactions and compressions. These types of waves are sound waves. Vibrations produce sound and the sound of frequency 20 Hz to 20000 Hz is audible to humans. The sound of frequency greater than 20000 Hz is called ultrasonic and less than 20 Hz is called infrasonic.
- The transverse wave travels in the form of crest and trough.
- The minimum distance between two successive crest or troughs is called wavelength.
- The minimum distance between two rarefactions or compressions is also the wavelength of the wave.
- The time of one oscillation or one vibration is called time period. The number of oscillations or vibrations in one second is called frequency.
- The velocity of the wave (v) is product of wavelength (λ) and frequency (ν).

$$v = \nu\lambda$$

Also, $v = \frac{\lambda}{T}$, T is time period

- Sound is a longitudinal mechanical wave which travels in air with the speed of 333 ms^{-1} at N.T.P. The velocity of sound in solids is more than in liquids. In steel it travels with the

speed of 5200 ms^{-1} while in water with 1520 ms^{-1} .

- Sound level is measured in unit of decibel (dB). Here deci means one-tenth and bel is the level of sound. It is a unit which compares the levels of power of two sources. Two power levels P_1 and P_2 are known to differ by n decibels if $n = 10 \log_{10} \left(\frac{P_2}{P_1} \right)$.
- For average human ears, the whisper is about 30 decibel. The normal conversation is about 65 decibels while jet plane taking off makes a noise of about 150 decibels. Beyond 85 decibels, sound is damaging and can lead to temporary loss of hearing.
- We can not have sound communication on moon, because moon has negligible atmosphere. In such cases the effective communication is done by electromagnetic waves. They do not require medium for their propagation. Radio, micro, IR and X-rays are examples of electromagnetic waves. They travel in free space with speed of light i.e., $3 \times 10^8 \text{ ms}^{-1}$.
- Now a days satellite communication is very common. The satellite has to be launched using a rocket, lifted into the correct orbit and given suitable energy and momentum in the right direction so that it keeps moving. A satellite having time period equal to the time period of earth's rotation is called geostationary. It appears stationary with respect to earth. The satellite which appears at the same place at same time every day is called sunsynchronous satellite.
- Computer and internet are inevitable in daily life. Even at home, majority of the gadgets, whether television, automatic washing machine

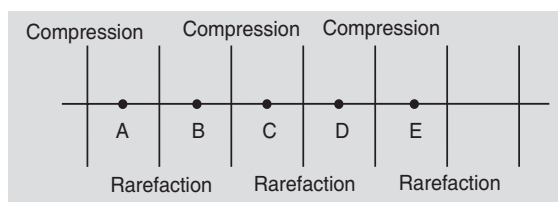
or microwave oven, one can find applications of computers.

- In the form of application to internet, computers have emerged as very strong

communication link. Using e-mail, one can send a message, chat live and even talk instantly which has revolutionized communication.

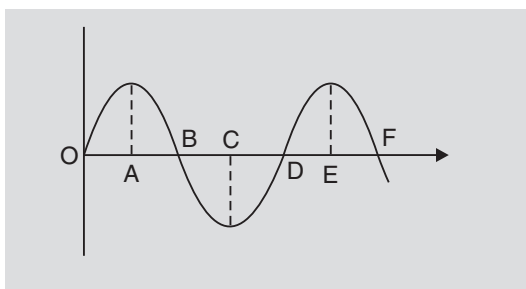
Built Your understanding

1. Express the separation AB, AC and CE in terms of wavelength (λ) for the given wave.



Sol: $AB = \frac{\lambda}{2}$, $AC = \lambda$, $CE = \lambda$

2. Express the separation AB, BD and AE in terms of wavelength (λ) for the wave shown in the figure.



Sol: $AB = \frac{\lambda}{4}$, $BD = \frac{\lambda}{2}$, $AE = \lambda$

3. A wave sends 100 wavelengths in 4s and travels a distance of 50 m. Find its speed,

frequency and wavelength.

Sol: speed, $v = \frac{\text{distance}}{\text{time}} = \frac{50}{4} = 12.5 \text{ ms}^{-1}$

Frequency, $v = \frac{100}{4} = 25 \text{ Hz}$

wavelength, $\lambda = \frac{v}{v} = \frac{12.5}{25} = 0.5 \text{ m}$.

4. A wave travels a distance of 20m in 5 oscillations. Find its wavelength.

Sol: $\lambda = \frac{20}{5} = 4 \text{ m}$

5. The frequency of an electromagnetic wave is 10^{14} Hz . Find its wavelength in free space.

Sol: $\lambda = \frac{v}{v} = \frac{3 \times 10^8}{10^{14}} = 3 \times 10^{-6} \text{ m}$

6. Write a function of microphone and speaker each.

Sol: Microphone converts sound signals into electrical signal.

Speaker converts electrical signals into sound signals.

✓ Maximise Your Marks

- Wave is a periodic disturbance which carries energy from one place to another.
- The maximum displacement of the oscillation is called amplitude.
- Sound is a mechanical longitudinal wave whose speed depend upon medium and temperature. It increases with increase in temperature and

decreases with the increase in the density of the medium. It also increases with increase in humidity in the air.

- For communication new techniques are evolved e.g. computer, internet and satellite.



Stretch Yourself

1. Considering the effect of sound on human health it become necessary to develop an instrument to measure loudness of sound. The loudness depends upon the maximum displacement from the mean position called amplitude. The Decibel meter makes use of a special crystal called piezo electric crystal. It generates electrical signal due to difference of pressure.
2. The shrill sound has high pitch i.e., higher frequency. The sound of same pitch and loudness can be distinguish by quality of sound. Quality of sound depends upon the number of harmonics.
3. In communication, telephone is very common. A basic telephone has three parts:
 - (i) Cradle with a hook switch.
 - (ii) A mouth piece which houses a microphone.
 - (iii) A hearing piece which houses a speaker (usually an 8W speaker).



Test Yourself

1. Distinguish between mechanical and electromagnetic waves.
2. How do the longitudinal and transverse waves travel in a medium?
3. Establish the relation between frequency, wavelength and speed of the wave.
4. Write the relation between frequency and time period.
5. How has the computer revolutionised the world of communication? Explain.