

1. Sound:

A sound is a form of energy that produces a sensation of hearing in our ears.

2. Source of sound and its propagation:

A source of vibration motion of an object is normally a source of the sound.

3. Characteristics of the medium required for the propagation of sound:

(i) Medium must be elastic so that the medium particles have the tendency to return to their original positions after the displacement.

(ii) Medium must have inertia so that its particles can store the energy.

The frictional resistance of the medium should be negligible to minimize the loss of energy in propagation.

4. Types of waves

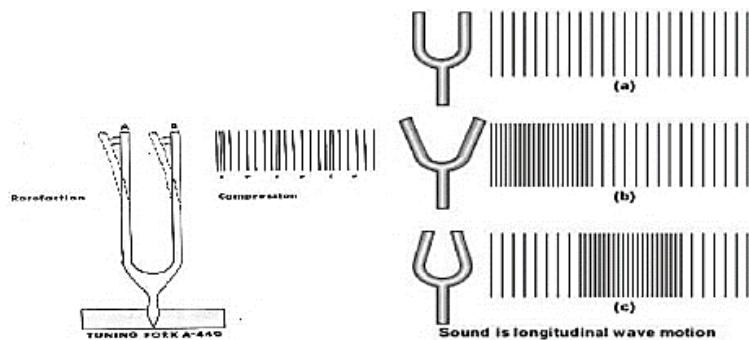
(i) Mechanical waves :

A mechanical wave is a periodic disturbance that requires a material medium for its propagation. Based on the motion of particles, the mechanical waves are classified into two parts.

(a) Transverse wave

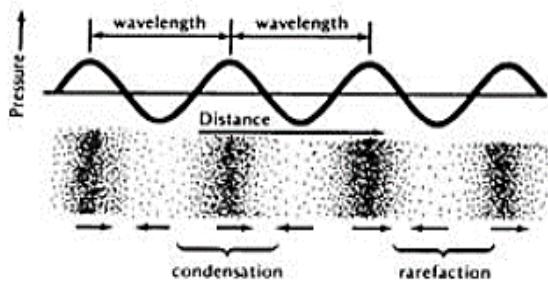
(b) Longitudinal wave

(C) Transverse wave :

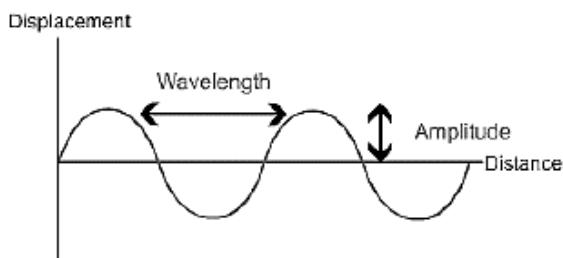


(a) Transverse wave: When the particles of the medium vibrate in a direction perpendicular to the direction of propagation of the wave, the wave is known as the transverse wave. For example, waves are produced in a stretched string.

(b) Longitudinal wave: When the particles of the medium vibrate along the direction of propagation of the wave, then the wave is known as the longitudinal wave, for example, sound wave in the air.



(ii) Electromagnetic waves: The waves which do not require a medium for propagation are called electromagnetic waves. These waves can travel through vacuum also. For example, light waves, X-rays.



5. Characteristics of a sound wave

(i) Frequency: The number of vibrations per second is called frequency. The unit of frequency is hertz.

(ii) Amplitude: The maximum displacement of each particle from its mean position is called amplitude. The S.I. unit of amplitude is metre (m).

(iii) Time period: The time taken to complete one vibration is called the time period.

$$\text{Frequency} = \frac{1}{\text{time period}} \text{ or } \nu = \frac{1}{T}$$

(iv) Wavelength: The distance between the two nearest (adjacent) crests or troughs of a wave is called its wavelength.

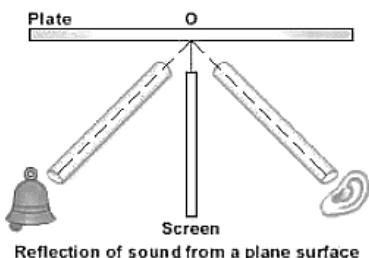
(v) Velocity of wave: The distance travelled by a wave in one second is called the velocity of the wave (or speed of the wave). The S.I. unit for the velocity of a wave is meters per second (m/s or ms^{-1})

(vi) Pitch : Pitch is the sensation (brain interpretation) of the frequency of an emitted sound and is the characteristic that distinguishes a shrill (or sharp) sound from a grave (or flat) sound.

(vii) Loudness : It is a measure of the sound energy reaching the ear per second.

6. Reflection of sound:

When sound waves strike a surface, they return to the same medium. This phenomenon is called reflection.



7. Laws of reflection :

The angle of incidence is equal to the angle of reflection.

The incident wave, the reflected wave, and the normal all lie in the same plane.

8. Echo :

The phenomenon of hearing back our sound is called an echo. It is due to successive reflection from the surfaces obstacles of large size.

9. Relation between the speed of sound, time of hearing echo and distance of reflection body:

If t is the time at which an echo is heard, d is the distance between the source of sound and the reflecting body, and v is the speed of sound. The total distance travelled by the sound is $2 d$.

$$\text{speed of sound, } v = \frac{2d}{t} \quad d = \frac{vt}{2}$$

10. Conditions for the formation of Echoes:

- (i) The minimum distance between the source of sound and the reflecting body should be 17.2 meters.
- (ii) The wavelength of sound should be less than the height of the reflecting body.
- (iii) The intensity of sound should be sufficient so that it can be heard after reflection.

11. Reverberation:

The persistence of sound after its production is stopped called reverberation. A short reverberation is desirable in a concert hall (where music is being played) because it gives 'life' to sound. Too much reverberation confuses the programmers and must be reduced to reduce reverberation.

12. Range of Hearing :

The audible range of sound for humans extends from about 20 Hz to $20,000\text{ Hz}$ (one Hz = one cycle/s). Sounds of frequencies below 20 Hz are called infrasonic sound or infrasound. Frequencies higher than 20 kHz are called ultrasonic sound or ultrasound. Dolphins produce ultrasound.

13. Applications of ultrasound:

The ultrasound is commonly used for medical diagnosis and therapy and also as a surgical tool. It is also used in a wide variety of industrial applications and processes. Some creatures use ultrasound for information exchange and the detection and location of objects. Also, some bats and porpoises use ultrasound for navigation and to locate food in darkness or at a place where there is inadequate light for vision (method of search is called echolocation).

14. Sonar:

SONAR means Sound Navigation Ranging. In this, sound waves (ultrasonic) are used [microwaves are absorbed by water)]. A source emits sound waves. These waves travel in water with velocity v . The waves reflected by targets (like the submarine bottom sea) are detected.

Uses:

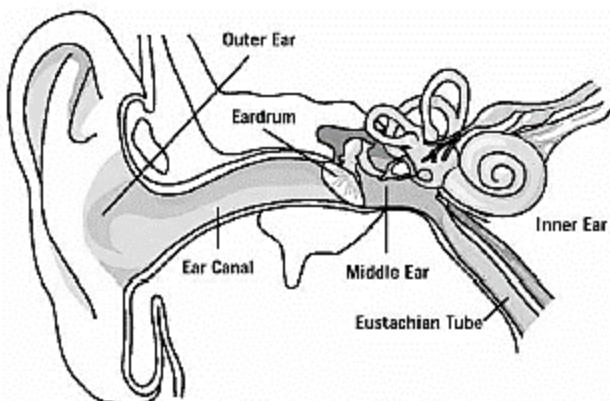
- (i) The SONAR system is used for detecting the presence of unseen underwater objects, such as a submerged submarine, a sunken ship, sea rock or a hidden iceberg, and locating them accurately.
- (ii) The principle of SONAR is also used in the industry of detection of flaws in metal blocks or sheets without damaging them.

15. Human ear:

It is a highly sensitive part of the human body that enables us to hear a sound. It converts the pressure variations in the air with audible frequencies into electric signals which travel to the brain via the auditory nerve.

The human ear has three main parts.

Their auditory functions are as follows:



(i) Outer ear :

The outer ear is called 'pinna'. It collects the sound from the surrounding. The collected sound passes through the auditory canal. At the end of the auditory canal, there is a thin membrane called the eardrum or tympanic membrane. When

compression of the medium produced due to vibration of the object reaches the eardrum, the pressure on the outside of the membrane increases and forces the eardrum inward. Similarly, the eardrum moves outward when a rarefaction reaches. In this way, the eardrum vibrates.

(ii) Middle ear:

The vibrations are amplified several times by three bones (the hammer, anvil and stirrup) in the middle ear, which are levers. The middle ear transmits the amplified pressure variations received from the sound wave to the inner ear

(iii) Inner ear:

In the inner ear, the pressure variations are turned into electrical signals by the cochlea. These electrical signals are sent to the brain via the auditory nerve, and the brain interprets them as sound.