

Explanation Content:

- Sound energy may be a sort of energy due to which our ears are ready to hear something.
- Energy can neither be created nor destroyed. So sound energy also can transform from one kind to another.

How is a sound produced?

A sound is produced when an object vibrates, that's they move during a 'to-and-fro' motion.

For instance,

- once we strike a tuning fork or a stretched elastic band, it vibrates and produces sound.
- The human voice is produced due to the vibration of the vocal cords.
- When in an instrument string vibrates, it produces sound
- A flute produces sound when we blow it because the air column of the flute vibrates as air passes through it.

How does sound travel?

- In order to propagate, sound requires a medium through which it can travel. This medium might be a gas, liquid or solid.
- Sound propagates during a medium because the particles of the medium vibrate from a start line. This means that sound always features a start line and an ending point.

- as an example , while you ask a lover , as you speak, the particles within the air get displaced thanks to the pressure caused by the sound you produce. They then displace the adjacent particles and so on. In this way, sound travels from your place to your friend's ears.
- Therefore, we will say that the particles of a medium don't travel from one point each other so as to propagate sound. Sound propagates thanks to the disturbance caused by a source of sound within the medium.

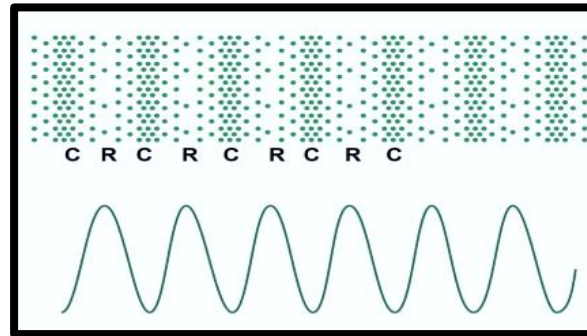
What is a wave?

- A wave may be a disturbance produced during a medium because the particles of the medium vibrate. The particles produce motion in one another without moving forward or backwards. This leads to the propagation of sound. Hence sound is often called a Wave.

How can sound travel through air?

- When an object vibrates within the air or produces a sound, some regions of high are created ahead of it. These are called the Regions of Compression. These regions of compression move forward within the medium as particles exert pressure on their adjacent particles.
- With alternate regions of compression, there also are regions of low pressure that are in its front. These are called Regions of Rarefaction.
- because the object would move forwards and backwards consecutively producing sound, the series of compressions and rarefactions are going to be created. This will allow sound to travel through air or the other medium also .
- If the medium is dense the pressure exerted on the particles will be more in order to propagate the sound and vice versa.

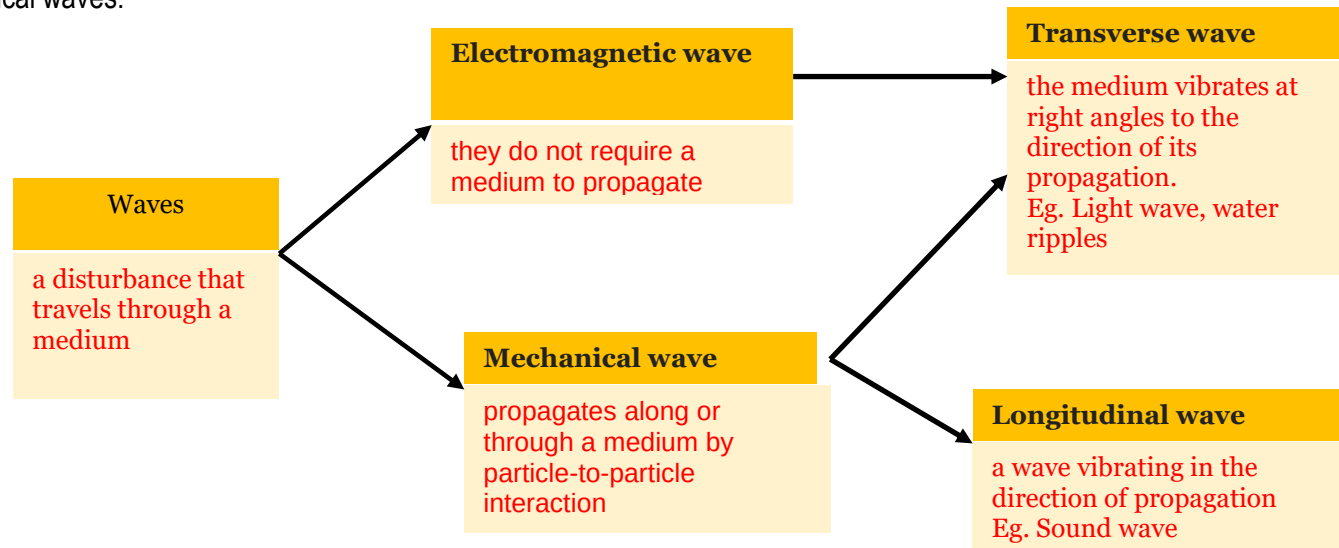
- Therefore, we will also say that propagation of sound is all about change within the pressure of the medium.



compression (C) and rarefaction (R)

What are mechanical waves?

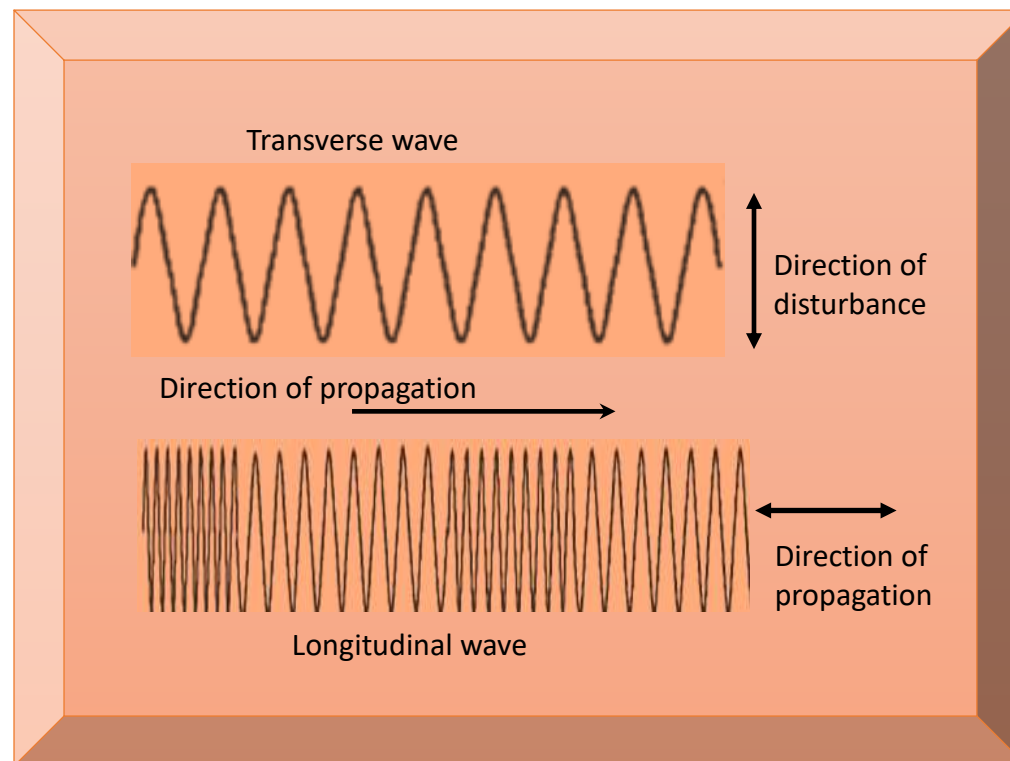
A wave that's produced when the particles of the medium oscillate is named Mechanical Wave. The sound waves are therefore, mechanical waves.



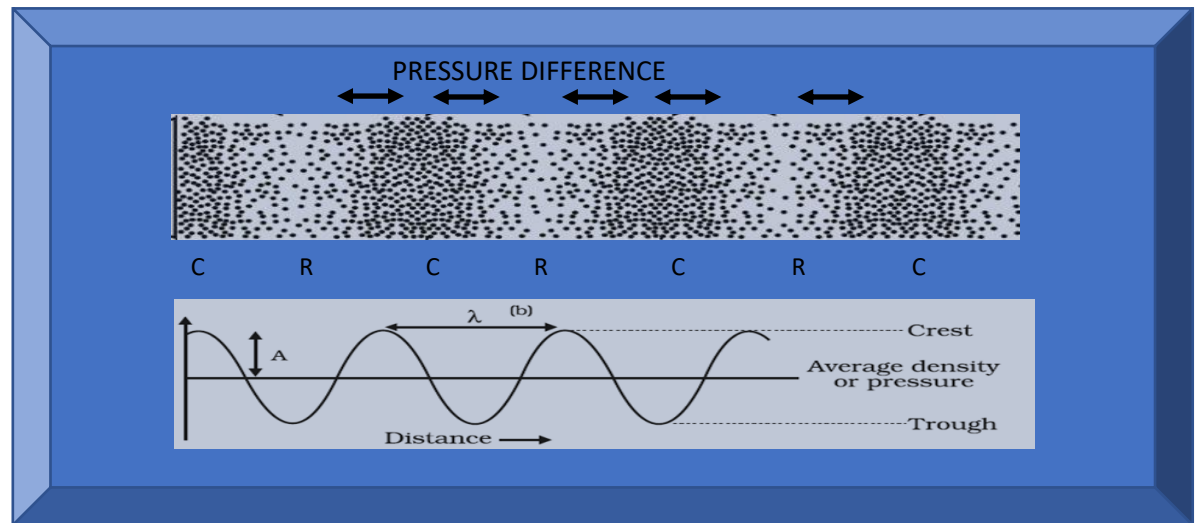
- Sound cannot travel through the vacuum because it always needs a medium to propagate. The vacuum contains no air hence no particles can propagate sound.

Longitudinal waves - Any wave that vibrates within the direction of the motion is named a Longitudinal Wave. Sound waves are longitudinal because the particles of the medium vibrate within the direction which is parallel to the direction of the propagation of the sound waves. The particles within the medium oscillate to and fro within the case of longitudinal waves.

Transverse Waves - A transverse wave is produced when the particles of the medium oscillate in a direction which is perpendicular to the direction of the propagation of the wave. The particles in a transverse wave oscillate in an up and down motion. For Example, light waves are transverse in nature.



- A sound wave is characterized by three factors:
 - Amplitude
 - Frequency
 - Speed



Characteristics of Sound

Wavelength (λ)	The distance between two consecutive compressions or rarefactions is called Wavelength. SI unit: metre (m)
Frequency (ν)	The number of oscillations per unit time is called the Frequency SI unit: Hertz (Hz)
Time Period (T)	The time taken between two consecutive compressions or rarefactions $T = \frac{1}{\nu}$ SI unit : Second (s).

Pitch	Pitch is the shrillness of the sound It depends upon frequency of the sound. More frequency – more pitch Less frequency – less pitch
Amplitude	The maximum or minimum disturbance caused in the medium is called the Amplitude of the Sound. Louder sound – more amplitude Softer sound – less amplitude
Timber	The timbre or quality of sound is a characteristic with which we can differentiate between different sounds even if they have same pitch and amplitude.
Tone	The sound which has single frequency throughout is called a Tone.
Note	A sound with more than one frequency is called a Note. It is pleasant to listen
Noise	It is an unpleasant sound.
Music	It is a sound which is pleasant and has rich quality
The Speed of sound (v)	The distance by which a compression or refraction of a wave travels per unit time is called as Sound's Speed. SI unit: m/s $v = \nu \lambda$ Speed of Sound in air = 333 m/s

Intensity	The amount of sound energy that passes through a unit area per second is called its intensity
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Sound cannot travel at an equivalent speed in several mediums. The speed of sound during a medium is suffering from three things:

- o The density of the medium. For instance, speed of sound is that the maximum through solids
- o The temperature of the medium. As the temperature increases, the sound propagates easily.
- o Humidity within the air also affects the travel of sound. As the humidity increases, so does the propagation of sound.

What is a sonic boom?

When an object travels within the air with a speed greater than that of the sound, it produces a sound with high energy. This energy is loud enough that it can break glasses or damage the buildings. The sound produced is analogous to the sound of an explosion or thunderclap.

These objects exert an outsized amount of pressure on the air which causes the assembly of shock waves within the air. These shock waves produce extremely large and loud sound waves which are called Sonic booms

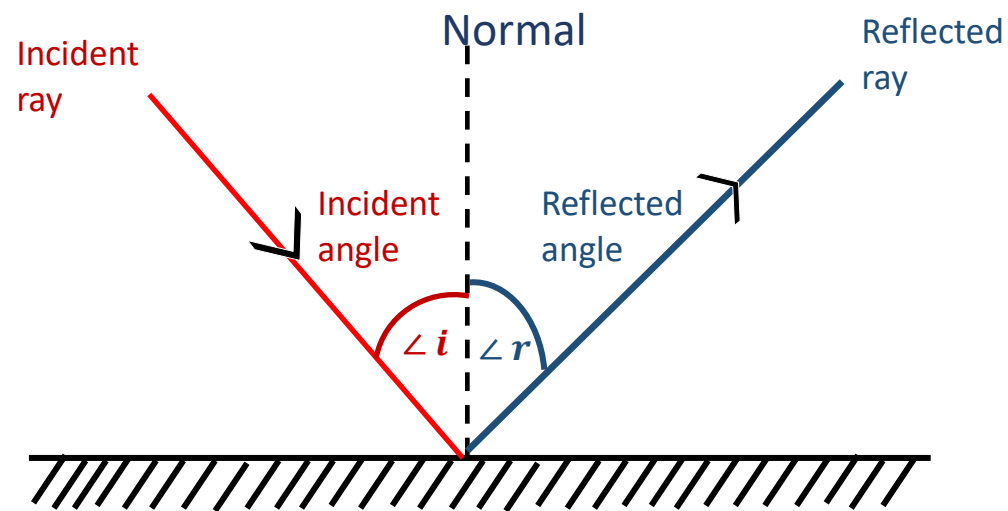
- Speed of light in air = 3×10^8 m/s
- Speed of sound in air = 333 m/s

This clearly states that sound travels a lower speed than that of sunshine in air. This is a reason why at the time of lightening, the sunshine is visible instantly while the sound of the thunder reaches our ears after a couple of seconds.

- Sound can bounce off a solid or a liquid. Some materials like metals and walls are called Good Reflectors of Sound as they are doing not absorb the sound while others like clothes and sponge are called Bad Reflectors of Sound as they absorb the sound easily.

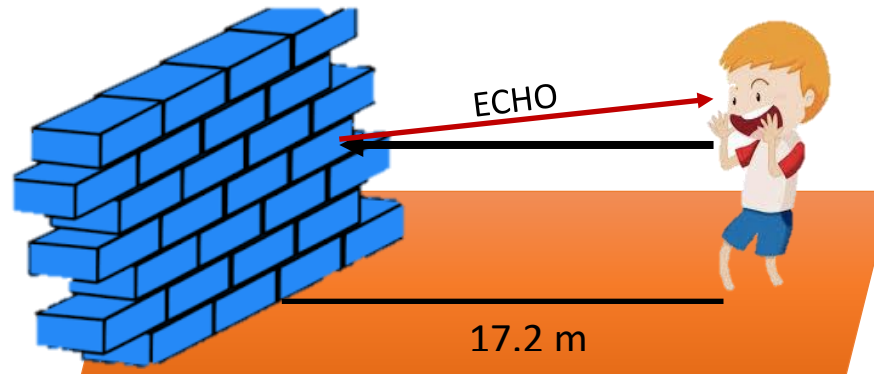
Laws of Reflection of Sound

- The incident sound wave, the reflected sound wave and the normal, all lie in the same plane.
- The angle of incident of incident sound wave is equal to the angle of reflection formed by the reflected sound wave, that is, $i = r$



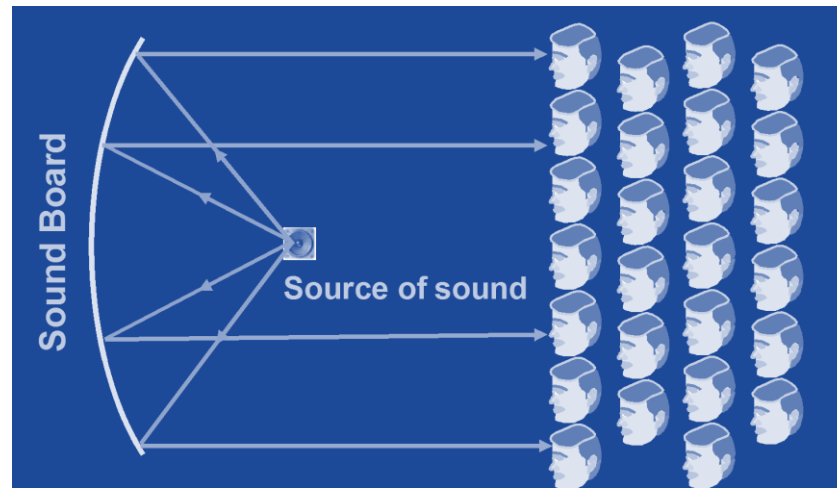
Echo

In a medium when we hear an equivalent sound again and again it's called Echo. The sound or echo persists in our brain for 0.1 seconds. This means that the difference between sound and its echo should be a minimum of 0.1 seconds. It is produced as a result of reflection of sound through a medium. If sound reflects quite once we may hear multiple echoes.



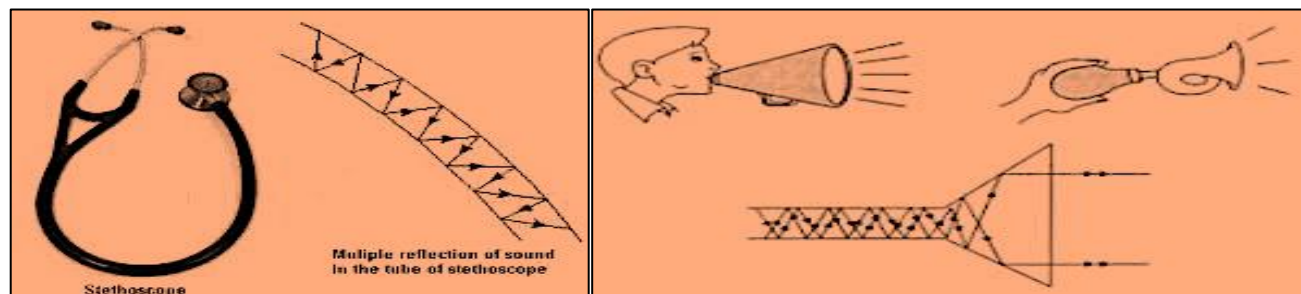
Reverberation

It is the persistence of a sound after a sound is produced. A reverberation is made when a sound signal is reflected multiple of times until it reaches a acoustic wave that can't be heard by human ears. Auditoriums and big halls often have to deal with reverberation. That is why the roofs are made from soundproof materials like Flipboard and therefore the chairs within the halls also are made from fabrics which will absorb sound.



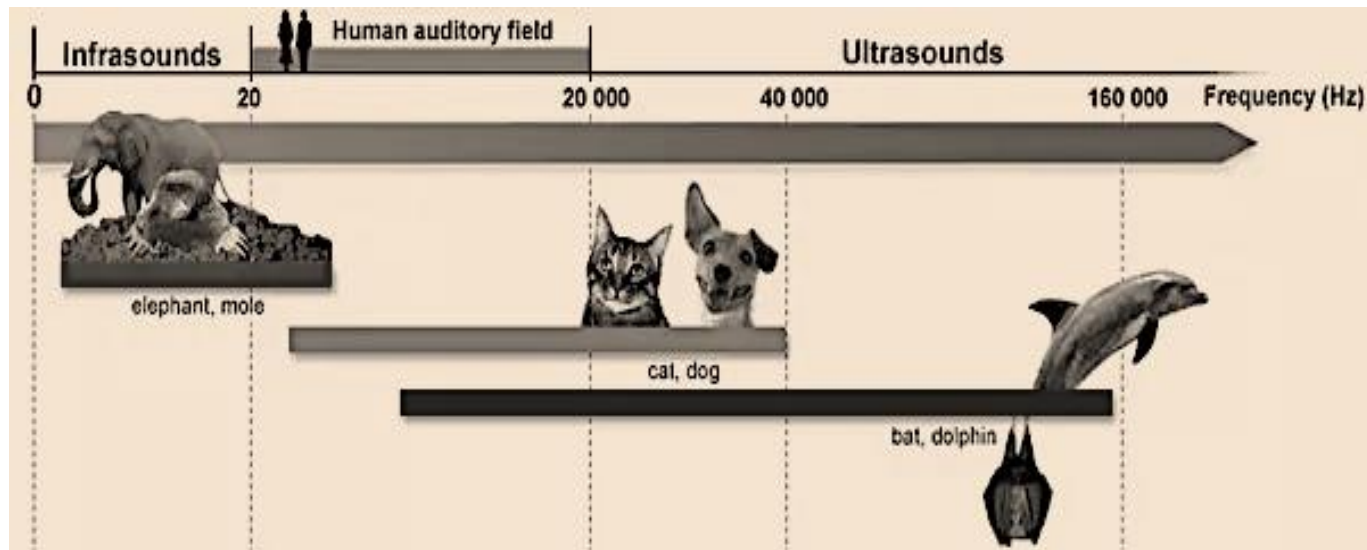
Advantages of Multiple Reflection of Sound

- Horns, trumpets, loudhailers or megaphones are designed in such how that sound can travel during a particular direction only without spreading out everywhere. This makes it easier for the audience to listen to the speaker. All these instruments work on the phenomena of multiple reflections of sound.



- The multiple reflections during a stethoscope tube make it possible for the doctors to concentrate to a patient's heartbeat.
- Concert halls are generally covered in order that sound can reflect through it and reach the broader audience. The range of sound – on the idea of the range of frequency of a sound, it's categorized into ultrasound and infrasound. Human auditory range is between 20 Hz and 20 kHz.

Range of Infrasound and Ultrasounds



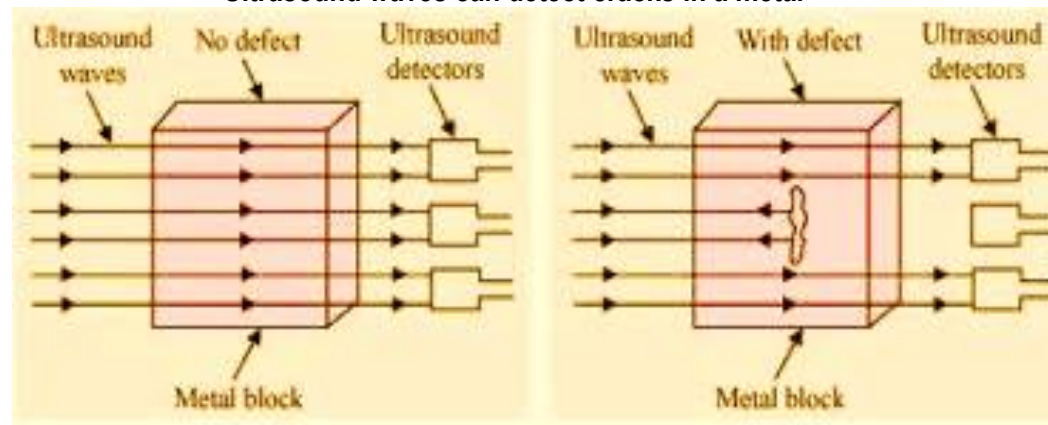
Hearing Aid- The Hearing Aid contains a microphone which receives the sound from the outer atmosphere and converts it into electric signals. This electric signal is amplified by an amplifier and then moves it to a speaker. The speaker then converts the electrical signal into sound waves and sends it to the ear and provides a transparent hearing.

Applications of Ultrasound

The ultrasound waves are the sound waves with high frequency. Due to this, they can travel long distances despite any obstacles between their paths.

- The ultrasound waves are utilized in clearing parts of objects that are hard to succeed in like a spiral tube or electronic components. In order to wash the objects, they're put during a solution, then the ultrasonic waves are skilled the answer . As a result, the dust particles on the object get detached and fall off them.
- Ultrasound waves can recognize tiny cracks in metallic objects that are utilized in the manufacture of huge structures, buildings and scientific equipment. The presence of such cracks can lower the strength of those structures and machines. Hence, the ultrasound waves are skilled the metallic objects and detectors are wont to detect the waves that undergo the cracks. If a crack is present the ultrasound waves would reflect back.

Ultrasound waves can detect cracks in a metal

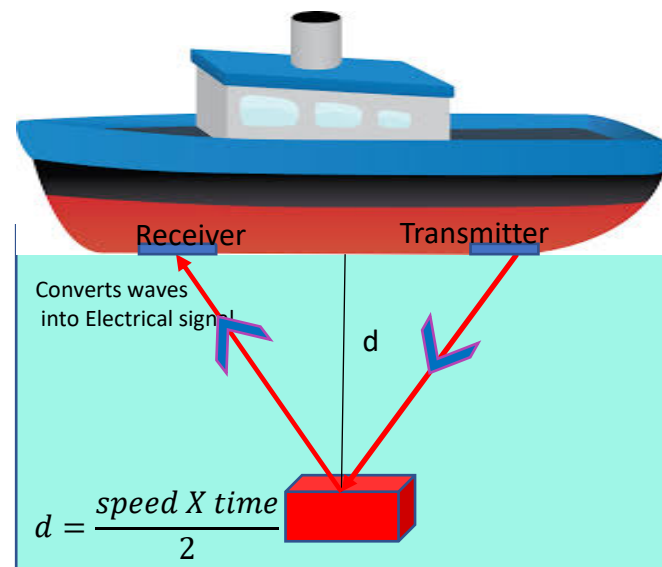


Medical application

Ultrasonic waves also are utilized in a medical process called Echocardiography. In this process, the ultrasound waves are skilled various parts of the guts so as to make the pictures of the organ.

- Ultrasonic waves also are utilized in a procedure called Ultrasonography. In this procedure, the ultrasonic waves are skilled the interior organs of the body so as to urge their image. In this way, the doctors can find out the cause of a disease or any abnormalities in the organs. The ultrasound waves travel through the tissues of the body and as soon because the density of the tissue changes they reflect back. The reflected waves are then converted into electrical signals which form the pictures of the interior organs.
- Ultrasound waves also are used to break the kidney stones

SONAR – Sound Navigation and Ranging

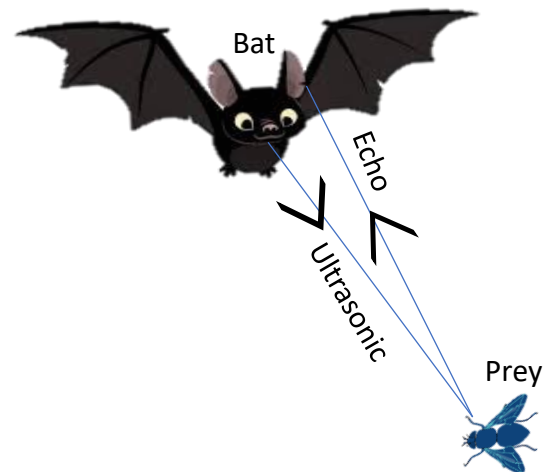


- This device is used to find the distance, direction and speed of objects that are present under the water. It uses Ultrasonic waves to do so.
- The Sonar consists of two main devices – The transmitter and the detector (or receiver). The main function of the transmitter is the production and transmission of the Ultrasonic waves in water.
- As these waves travel underwater, they, when hit by an object, reflect back to the detector. The detector then converts these sound waves into electrical signals which are then interpreted.
- The distance of the object is calculated with the help of the speed of sound in water and time taken by the way to reach the detector. This process is called Echo Ranging.
- Uses of Sonar
 - Finding the depth of a water body such as sea
 - Detecting the presence of underwater objects like submarines, hills, icebergs and ships.

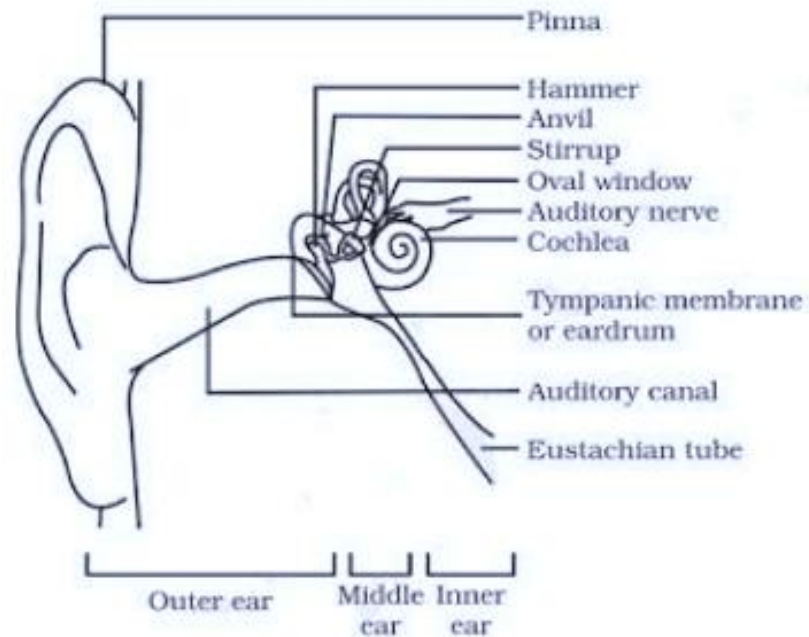
How do bats search their prey?

Bats generate Ultrasonic waves. As these waves hit an object, they get reflected back to the bat's ears. The bats can understand the nature of reflection of these waves and then can decide the position of the object over their prey.

Ultrasonic waves generated by bats



The Human Ear



Structure of Human Ear

Our ears allow us to receive audible frequencies in our surroundings. They then convert these sounds into electrical signals which are then passed through a special nerve called the auditory nerve to our brain. The brain that interprets these signals and responds accordingly.

- Pinna – The outer part of the ear that gathers sound from the environment.
- Auditory Canal – Sound collected from the surroundings passes through the Auditory Canal.

- Eardrum or Tympanic Membrane – It is located at the end of the auditory canal. The eardrum when receives a compression moves inwards because of increased pressure. Similarly, when it receives refraction it moves outwards due to a decrease in pressure. As a result, it starts to vibrate inwards and outwards on receiving a sound wave.
- The Middle Ear – It consists of three bones (hammer, anvil and stirrup). These bones amplify the vibrations produced by the eardrum. These vibrations are then passed onto the inner ear by the middle ear.
- Cochlea – It is located in the inner ear. It converts the vibrations into electrical signals which are then carried to the brain by the auditory nerve.

1. <https://www.youtube.com/watch?v=JWioG4fEhkl> - Sound needs a material medium to travel.
2. <https://www.youtube.com/watch?v=KFi519eXPMg> - sound is a longitudinal wave.
3. <https://www.youtube.com/watch?v=ZTsLLBo8lNQ> - characteristics of sound.
4. <https://www.youtube.com/watch?v=LR-AYApQbNE> - differentiate between echo and reverberation.
5. <https://www.youtube.com/watch?v=XW7hqpCbj2Y> - differentiate between ranges of hearing.
6. <https://www.youtube.com/watch?v=AxzVyMcmRcs> – working of a hearing aid.