

Human Ear

All of us like listening to music. What is that enables us to listen to the pleasant music of the musical instruments, the soothing sound of the shores, phone calls with your friend who is at the long distance and more such sounds? This is all possible with our ear. Human Ear enables us to listen to all the sounds in our surroundings. Let us study the "Human Ear" in detail.

Human Ear



The ear is the human organ that enables us to hear sounds around us. The main function of the ear is to maintain our sense of balance and to detect the various sounds. It helps us to convert the pressure variations into electronic signals that travel through the brain with the auditory nerve.

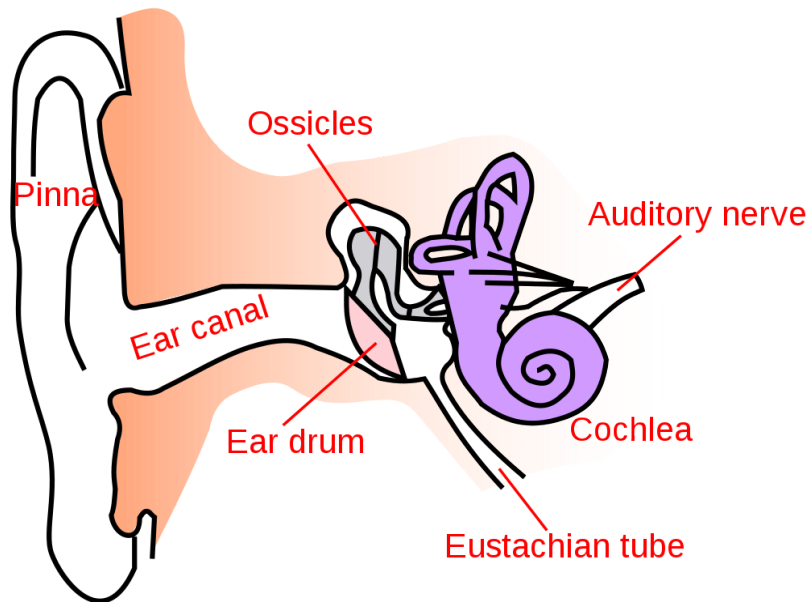
Important Parts of Ear

Human ear has three parts namely,

- Inner Ear
- Middle Ear
- Outer Ear

The Outer Ear

Whenever the sound waves enter our ear, they travel across the outer ear. Ear converts audible frequencies into electric signals that travel to the brain. The outer ear is known as pinna and earlobe which is the broad part and has shell-like structure. The compressions reaching the outer ear i.e. the pinna directs the compressions to the canal and makes them reach the eardrum or the membrane. The membrane being flexible separates the middle ear and the outer ear. These compressions are further amplified several times like about 20 times by the three bones inside the ear.



The Middle Ear

Bones are located in the middle part and are linked together to each other. Hammer, the Anvil, and the Stirrup are the three bones which transmit the sound. The center part of the eardrum is connected to the hammer. As the hammer vibrates, it transmits the sound to the other two bones, i.e. to the anvil and stirrup. These bones amplify the sound waves and all this takes place in the middle ear. So what is it that the outer ear does; it brings in the sound waves and further these waves are amplified by middle hear.

The Inner Ear

The inner ear known as Cochlea is a snail-like structure. As the number of vibrations is transmitted in the middle ear, cochlea sends the sound to the brain as some amount of fluid is present inside the cochlea. These electrical impulses then go to the auditory nerve. This is exactly what we perceive as sound.

Protection of The Human Ear

The audible range for human beings is about 20Hz to 20,000Hz. If any sounds exceed this range, the sound remains undetected, whatever the amplitude may be. Almost every other person uses headphones. These headphones are dangerous as they directly fit into our eardrums. Hence to protect our ears, the volume should not exceed 60%. When you attend concerts step outside the concerts at least for few minutes to bring your ears to rest. Keep your ears dry once you are done bathing and swimming.

Questions For You

1. The vibrations or the pressure variations inside the inner ear are converted into electrical signals by the:

A. Cochlea

B. Tympanic Membrane

C. Peena

D. Anvil

Answer: A. Cochlear converts vibrations into electric signals.

Hammer, Anvil, and Stirrup are the bones of the ear and they amplify the vibrations.

2. The threshold of audibility for the normal human ear is :

A. Maximum intensity of sound audible

B. Minimum intensity of sound below which it is inaudible

C. The pitch of the sound inaudible

D. Pitch of the sound audible

Answer: B. Minimum intensity of sound below which is inaudible is a threshold intensity of the human year.

Production and Propagation of Sound

Suppose you are playing hide and seek game and your friend who is blindfolded catches you and your friends. How does your friend catch the person who is closest to him/her? How did he/she hear the sound?

Lets us see how does sound propagate. Let's learn about the propagation of sound in detail.

Production of Sound

To study the production of sound we require a tuning fork. When the tuning fork is struck, the prongs of the fork begin to vibrate. Each time the prong vibrates, a new sound wave is produced. The movement of the speed of sound waves depends on the medium by which the sound waves travel. When the tuning fork strikes, you can hear the sound. Thus we have produced the sound by striking the tuning forks. The sound produced in humans is due to the vocal cords.



Propagation of Sound

Whenever you make a call, you can hear the voice of your friend even though he/she is at a great distance. The medium through which your sound is transmitted is called as the medium. The waves consist of particles of the medium through which it travels. A sound is an energy that is transmitted in the form of sound waves. When the objects vibrate, the air surrounding it vibrates and sound waves are carried. If there is no medium, then vibrations in an object will not travel through it. This is the mechanism for the propagation of sound.

Sound Produced by the Humans



The human voice is produced by the vocal chords. When air is blown from the lungs through the larynx, the vocal cords vibrate at a

frequency and produce sound. When these sound waves pass through our mouth and tongue, its pitch and quality are changed and the sound waves are converted into understandable speaking. The audible range of sound for human beings extends from about 20 Hz to 20000 Hz. Any sound outside this hearing range is undetected by human ears regardless of its amplitude.

Questions For You

Q1. For a wave propagating in a medium, identify the property that is independent of the others:

- A. Velocity
- B. Wavelength
- C. Frequency
- D. All these depend on each other

Answer: C. In a medium velocity and wavelength are dependent on the refractive index of the medium but frequency remains unchanged.

Q.2 Sound of the explosion taking on other planets are not heard by a person on the earth. Why?

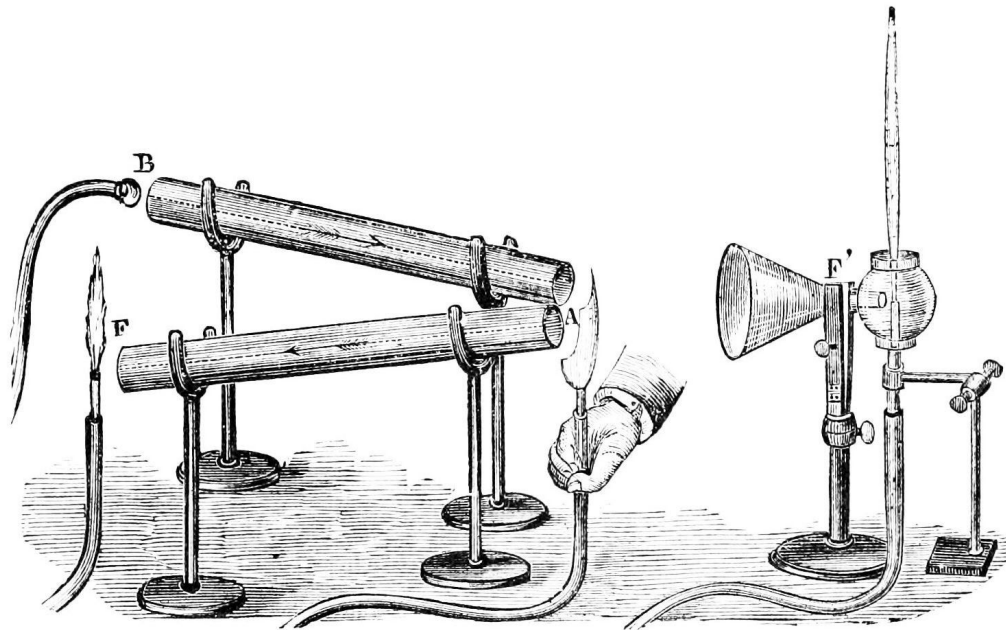
- A. The sound of explosion is not high so as to reach on earth
- B. Only air is present between planets and the earth
- C. There is a region of vacuum in between the planets and the earth
- D. The distance between the planets and the earth is too large for the sound to travel

Answer: C. Sound needs a material medium for its propagation from one place to another. Sound cannot travel through a vacuum. Since there is a region of vacuum in between the planets and the earth, where there is a vacuum, so the sound of explosions taking place on the other planets cannot pass through the vacuum.

Reflection, Transmission and Echo

Let us suppose you are standing at the height of a mountain and yell Hello!!! Within a second, you can hear your voice back echoing in the manner Hello!! Hello!! Hello!! This is what exactly echo is. It reflects back to you. Let us study this in detail.

Reflection of Sound



Why do we always need a large area to see reflections? When the sounds travel through a certain medium, it strikes the surface of other medium and bounces back to its original medium that is the initial medium. This is what reflection of sound is. The only requirement for the reflection of the sound wave is that the reflecting surface must be bigger than the wavelength of the wave. Reflection of the sound wave is seen in echoes, megaphone, ear trumpet etc.

Laws of Reflection of Sound

- I. An angle of incidence is equal to the angle of reflection.
- II. Incident wave reflected wave and normal at the point of incidence, all lie in the same plane.

Reflection of Sound can be applied in:

- Sound producing devices use a conical shape like megaphones to increase the intensity of sound waves in particular directions.
- In stethoscope, sound undergoes multiple reflections in the wires of the stethoscope.
- Curved ceilings of halls use soundboards to evenly distribute the sound across the hall.

Transmission of Sound

Every sound is produced by the vibration. Vibration is nothing but the back and forth movement of the object. How does the sound energy travel? Do you wonder how that works? Sound energy travels in the form of sound waves. Sound waves travel in all directions. In solids, the particles are very close to the other one. Sound energy moves as one particle hit another particle. Here sound travels at a very high speed. In liquids, the particles are at a distance, so it takes more time to travel. In gas, the particles are spread out. Here the speed of the sound energy is the slowest.

Echo



Every one must have heard of the word echo. Echo is basically a sound heard after the sound is reflected back when the actual sound has stopped. Thus the echo is the result of reflection. If we want to hear an echo, we cannot do it in a small room, we need a large area. When we shout in a large or vacant space, the sound is reflected back.

Suppose you are standing in front of a high wall and clap your hand, you can hear the same sound of the clap back again. This is an echo. An echo is heard when the distance between the person producing sound and the rigid obstacle is long enough to allow the reflected sound to reach the person least 0.1 seconds after the original sound is heard. Otherwise, the echo is not distinguished even on reaching the

ears. This value can be calculated and comes out to be 17.2 m for air and 70 m for water. Whenever echo is to be heard the time between two objects or body or points should be 0.1 sec.

Question For You

Q. Working of radars in oceans is based on the principle of

- A. Geo positional statement
- B. Reflection of sound
- C. Locus of sound waves
- D. None

Answer: B. Radars in oceans employ sound waves to detect the location of the surrounding object.

Characteristics of Sound

When you are in school, you come to know when the period gets over. When someone rings the doorbell at your door you can hear the sound. Suppose if someone approaching you, you can make it out by hearing the footsteps itself. Sound plays an important role in our daily lives.

You hear many types of sound in our surroundings. How is the sound audible to you? Let us discuss these characteristics of sound in detail.

Characteristics of Sound

The sound that we hear around us is the **type of energy** made by the vibration that travels through the air or any other medium and can be heard when it reaches a person's ear. So, basically sound helps us to communicate with the other person. For example, we can hear the musical instruments like tabla, flute, a guitar due to vibration. The characteristics of sound are as follows:

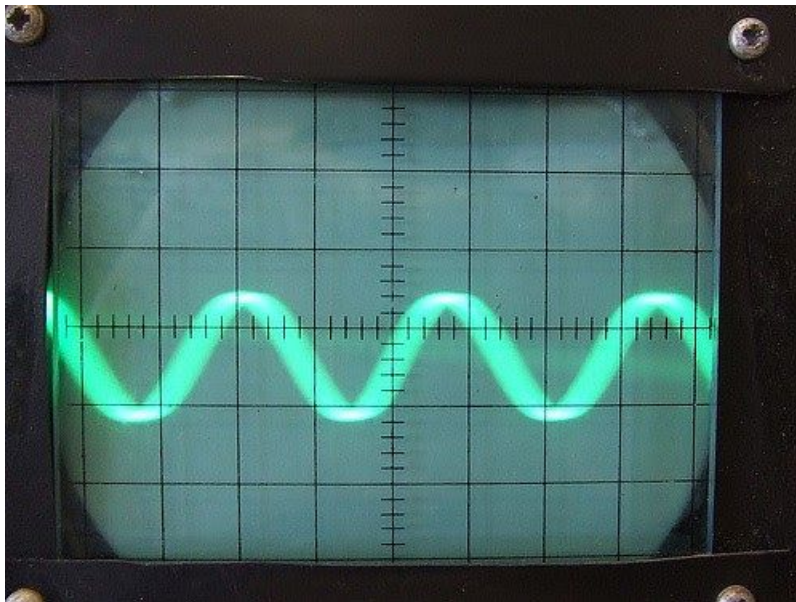
- Pitch
- Loudness
- Quality



Vibrating Parts of Musical Instruments

- Veena – Stretched string
- Tabla – Stretched membrane
- Drum – Stretched membrane
- Shehnai – Air Column
- Flute – Air Column

Pitch



Pitch is a characteristic of sound by which a correct note can be distinguished from a grave or a flat note. We can identify a female and male voice without seeing them. The term ‘pitch’ is often used in music. Pitch depends upon the frequencies of the sound wave. A note has a higher pitch when the frequency is high and a note of low

frequency has a low pitch. For example, when a small baby speaks something, his/her voice has a higher frequency so in case of a baby the pitch is higher than the pitch of a man. The sound with a high frequency is called as shrill.

Loudness

The loudness is a sensation of how strong a sound wave is at a place. It is always a relative term and is a dimensionless quantity. Loudness is measured in decibel (dB). It is given as:

$L = \log(I)$, here 'I' is the intensity.

The loudness depends on the amplitude of the vibration. It will be louder when the amplitude is high. Suppose when we pluck a string of the sitar it starts vibrating with low amplitude and if we apply more energy by plucking more strongly, the string will vibrate with the greater amplitude and produce a loud sound. As the amplitude of vibration increases, sound also increases.

Quality

The word timbre also describes the term quality. As different sources produce different sounds, the timbre helps us to distinguish between

them. A sound of good quality is pleasant to listen. The instruments are of different shapes and size and they produce different harmonics of loudness hence their sound can be easily distinguished.

Questions For You

Q. At what frequency we can't the sound of vibrations of a pendulum?

- A. Less than 20Hz
- B. More than 20Hz
- C. 20 Hz
- D. None of them

Answer: A. The frequency of the vibrating pendulum is small and less than 20Hz which is not in an audible range. Hence it is not heard.