Chapter- 13 Sound

Sound and How Sound is produced ?

Sound Produced by Humans

Sound Needs a Medium for Propagation

Human Ears

Characteristics of Sound

Noise and Music

Sound and How Sound is produced?

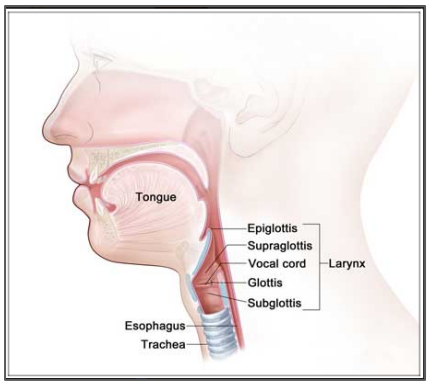
Sound is produced by a Vibrating Body

Sound is a form of energy which produces a sensation of hearing in our ears. Sound is vibration transmitted through a solid, liquid, or gas, composed of frequencies within the range of hearing and of a level sufficiently strong to be heard, or the sensation stimulated in organs of hearing by such vibrations. The vibrating body can be a string on a violin or piano, a column of air in an organ pipe or clarinet, an animal skin or piece of plastic stretched over a drum, or the vocal cords in a person's throat.

Vibrating strings produce sound

Sound Produced by Humans

In humans, the sound is produced by the **voice box** or the **larynx**. Put your fingers on the throat, you find a hard hump that seems to move when you swallow. This part of the body is known as the voice box. This is at the upper end of the **windpipe.** Two **vocal cords** are stretched across the voice box or larynx in such a way that it leaves a narrow slit between them for the passage of air. When the lungs force air through the suit the vocal cords vibrate, producing sound.



Larynx

The vocal cords in men are about 20mm long. In women these are about 5mm shorter. Children have very short vocal cords. This is the reason why the voices of men, women and children are different.

Sound Needs a Medium for Propagation

Human voice originates from the vibrations of the vocal chords and the sound from the musical instruments is due to the vibrations of the air columns. Sound travels in the form of longitudinal wave and it requires a material medium for its propagation. This can be explained by following example

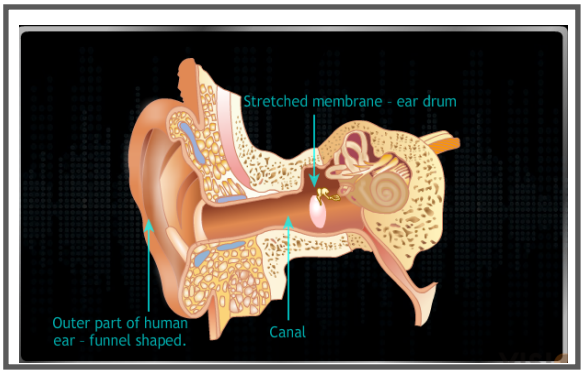
Electric bell suspended inside an airtight glass bell jar

An electric bell is suspended inside an airtight glass bell jar connected to a vacuum pump. As the electric bell circuit is completed, the sound is heard. Now if the air is slowly removed from the bell jar by using a vacuum pump, the intensity of sound goes on decreasing and finally no sound is heard when all the air i s drawn out. We would be seeing the hammer striking the gong repeatedly. This clearly proves that sound requires a material for its propagation.

Sound can propagate not only through gases but also through solids and liquids. Some materials like air, water, iron etc can easily transmit sound energy from one place to another. On the other hand materials like blanket and thick curtains absorb most of the sound energy.

Human Ears

Structure of the Ear



The outer ear:

The outer ear consists of the pinna which collects the sound vibrations from the air.
These sound vibrations reach to the ear drum through ear canal/auditory canal.

Middle ear:

It is air filled cavities which lies just beyond the ear drum and is surrounded by a bone.

There are three bones in the cavity. The **hammer** (malleus), **anvil** (incus) & **stirrup** (stapes).
These small bones help to amplify the vibrations.

Inner ear:

The inner ear is embedded in the bone of the skull and is filled with a liquid.
It consists of main organ of hearing called Cochlea that carries the vibrations in the form of electrical impulses from the Auditory nerve to the brain.

Persistence of Hearing:

The impression of sound heard by our ears persists in our mind for 1/10th of a second.
Sound takes only 1/10th of a second to reach our ear when the sound producing body is 33 meter away from the ear.
Sound is always reflected back when it falls on the objects around them, these reflected sound reach to our ear in the time less than $1/10^{th}$ of a second.
If the reflected sound and the direct sound reach to our ear in mingled form then it is slightly difficult to distinguish between them.
Reflected sound can only be heard when the reflecting surface is 17 meter away from the ear.

Working of the Ear

Sound waves enter the external ear and strike on the eardrum causing it to vibrate.These vibrations are amplified many times by three bones:

(i) Hammer
(ii) Anvil
(iii) Stirrup, in the middle ear and transmitted to the inner ear by the hollow bones of the middle ear.

The inner ear has coiled tube called cochlea. The tiny hairs present in it picks up the vibrations and sends the signals to the brain through auditory nerve to the brain, which interprets and make us hear sounds.

Characteristics of Sound

Amplitude, Time Period and Frequency Of A Vibration

Amplitude:- The maximum displacement from the central position of vibrating body is called amplitude.
SI unit of amplitude is meter.
Frequency:-The number of cycles completed by a vibrating body in one second is called frequency.
Frequency is measured in number of cycle per second. Therefore the SI unit of frequency is Hertz.
Frequency = Number of cycle completed/second.
Time period: The time taken to complete one vibration is called time period SI unit of time period is seconds

Loudness and Pitch

Loudness of sound: Loudness is the measure of the energy possess by the sound.
It depends upon the amplitude.
More the amplitude more is the loudness and farther the sound will travel
Unit of loudness is decibel.
Pitch: The shrillness of a sound is called pitch. It depends upon the Frequency.

Audible and Inaudible Sounds

The sound that can be heard by human ears is called as audible sound. The range of audible sound is 20 Hz to 20,000 Hz.

Ultrasonic sounds are produced by dolphins, bats and tortoises.
Infrasonic sounds are produced by whales and elephants and they can observe the earthquake before the main shock waves.
Bat is able to locate any obstacle in its path due to the reflection of the ultrasonic waves from the object

Noise and Music

We hear different types of sounds around us. Some sounds are pleasant to the ear, whereas some are not. Do we enjoy the sounds produced by horns of buses and trucks? Such unpleasant sounds are called noise. In a classroom, if all the students speak together, it is unpleasant and called noise.

On the other hand we enjoy sounds from musical instruments. Musical sound is one which is pleasing to the ear. Sound produced by a harmonium is a musical sound. The string of a sitar also gives out a musical sound.


Source of noise pollution

Noise Pollution

Noise pollution is unwanted human-created sound that disrupts the environment. The dominant form of noise pollution is from transportation sources, principally motor vehicles, referred to as environmental noise.

Sources of noise pollution

The overarching cause of most noise worldwide is generated by transportation systems, principally motor vehicle noise, but also including aircraft noise and rail noise.

Hybrid vehicles for road use are the first widely sold automobiles in 100 years to achieve significant noise source reduction.

Poor urban planning may also give rise to noise pollution, since juxtaposition of industrial to residential land uses, for example, often results in adverse consequences for the residential acoustic environment.

Besides transportation noise, other prominent sources are office equipment, factory machinery, appliances, power tools, lighting hum and audio entertainment systems.

With the popularity of digital audio player devices, individuals in a noisy area might increase the volume in order to drown out ambient sounds. Construction equipment also produces noise pollution.

Measures to Limit Noise Pollution

- To control noise, we must control the sources of noise.
- For this, silencing devices must be installed in air craft engines, transport vehicles, industrial machines and home appliances.
- The noisy operations must be conducted away from any residential area.
- Noise producing industries should be set up away from such areas.
- Use of automobile horns should be minimized.
- TV and music systems should be run at low volumes.
- Trees must be planted along the roads and around buildings to cut down on the sounds reaching the residents, thus reducing the harmful effects of noise pollution.