ALLEN®

SOUND

"A form of energy, produced by rapidly vibrating objects, that can be heard by the human ear is called sound."
Sound plays an important role in our life.
It helps us to communicate with one another.



Some musical instruments

Lightning and thunder

Light travels nearly 1 million times faster than sound in air. Thus, we see lighting first and then we hear its sound (thunder).

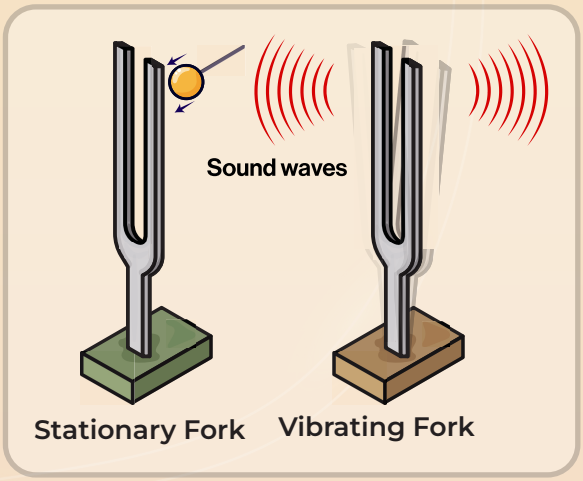
Sound is produced by a vibrating body

All types of sounds originate from vibrating objects. But, some vibrations are visible some are not.





Vibrations of a guitar strings can be visible



A tuning fork

- There are many vibrations that are not visible, however. When you speak, for instance, parts of your throat vibrate.
- A tuning fork is a two-pronged steel fork which produces sound when struck. A tuning fork makes a sound as the prongs of the fork vibrate in the air.

Jal tarang

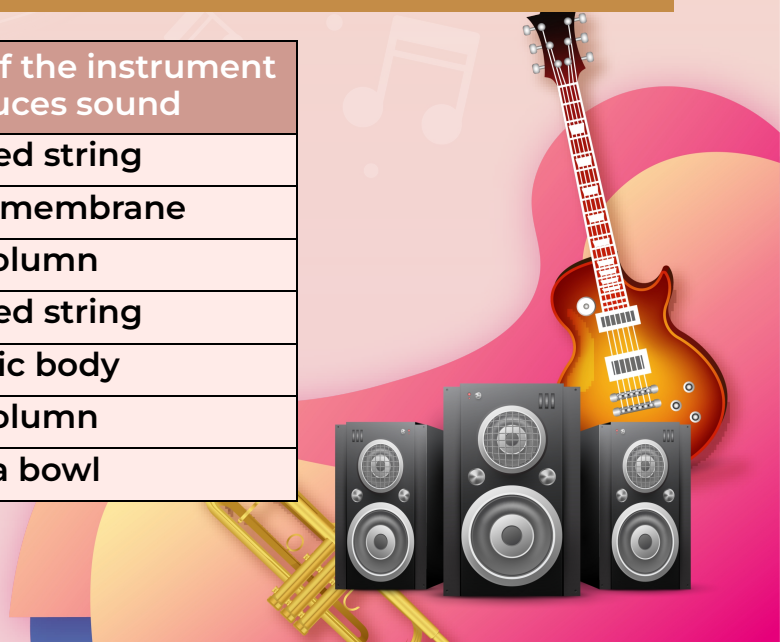
- The Jal tarang is one of the most rarely heard instruments today. It is one of the oldest instrument in the world. It consists of china bowls filled with water and struck by means of two cane sticks.



A kid playing on Jal tarang

Table to show some musical instruments and their vibrating parts

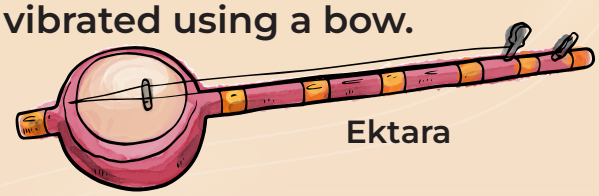
Sr. No.	Musical Instrument	Vibrating part of the instrument that produces sound
1.	Veena	Stretched string
2.	Tabla	Stretched membrane
3.	Flute	Air column
4.	Violin	Stretched string
5.	Manjira	Metallic body
6.	Trumpet	Air column
7.	Jal tarang	China bowl



- Vibration of a violin strings can be visible while playing it.

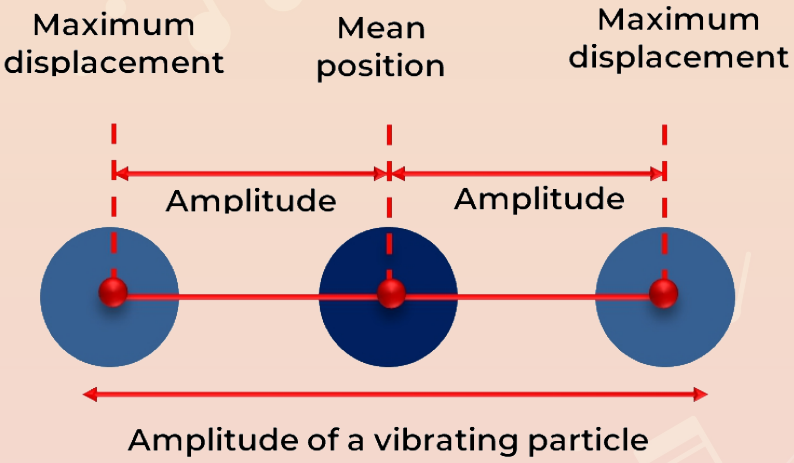


- An Ektara consists of a single stretched string which produces sound when it is vibrated using a bow.



Amplitude of a vibrating particle

- As a particle vibrates, it repeats the same motion in equal time intervals.
- The distance in either direction from the mean position (or rest position) to maximum displacement is called its amplitude.



Wave motion

- Waves that require a material medium are called mechanical waves.
- In sound waves, the vibrations of particles of the medium through which it travels are parallel to the direction of travel of the wave.
- Thus, we can say that sound waves are longitudinal waves.

Ripple waves created on the surface of water





Sound needs a medium for propagation

- Sound is a mechanical wave which require material medium to propagate.
- Sound waves cannot travel through outer space, because space is very nearly a vacuum.

Bell Jar experiment

- It is a demonstration, As the air is pumped out of the jar, the sound gradually disappears.
- When the air is returned to the jar, the sound returns. Thus, in order for sound to be transmitted, a medium must be present.



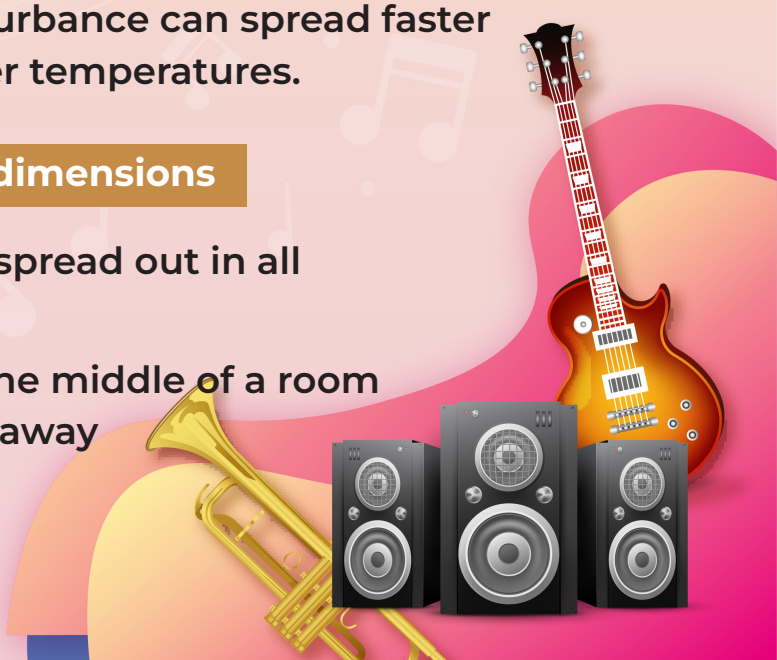
A bell jar experiment for sound

Speed of sound depends

- **Medium :** Sound waves generally travel faster through solids than through gases, the molecules of a solid are closer together than those of a gas.
- **The temperature Medium :** The disturbance can spread faster at higher temperatures than at lower temperatures.

Sound waves propagate in three dimensions

- Throughout the room sound waves spread out in all directions.
- A musical instruments is played in the middle of a room because Sound waves always travel away from a vibrating source in all three dimensions.

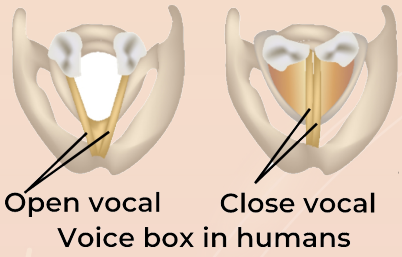


Echolocation

- A process for locating distant or invisible objects by means of sound waves reflected back to the sender from the objects.
- Dolphins and orca whales rely on the production and reflection of sound to navigate, communicate, and hunt in dark and murky waters.
- The bat can identify an object by the echo and can even tell the size, shape, and texture of a small insect.

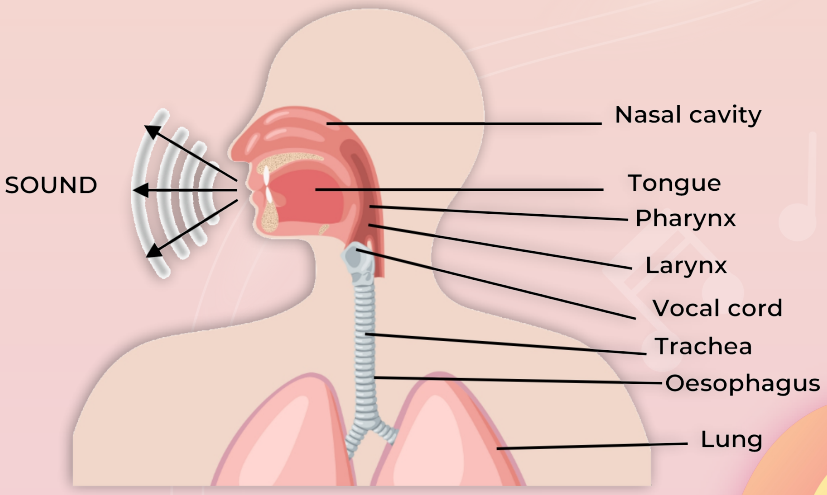
Sound produced by humans

- In humans, the sound is produced by the voice box or the larynx.
- This part of the body is known as the voice box.
- 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.



Voice box in humans

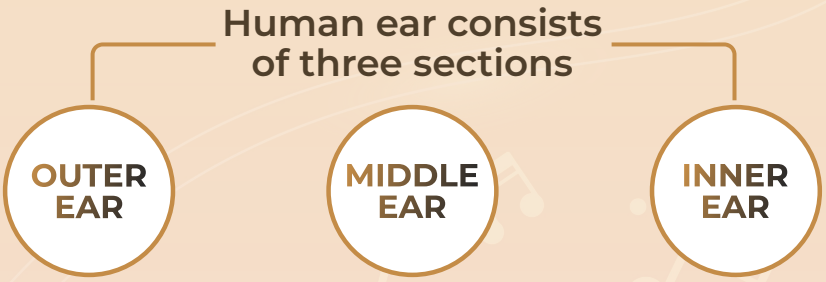
- When the lungs force air through the slit, the vocal cords vibrate, producing sound.
- The sound is amplified and modified by the group of parts collectively called the resonators.
- When the vocal cords are tight and thin, the type or quality of voice is different from that when they are loose and thick.



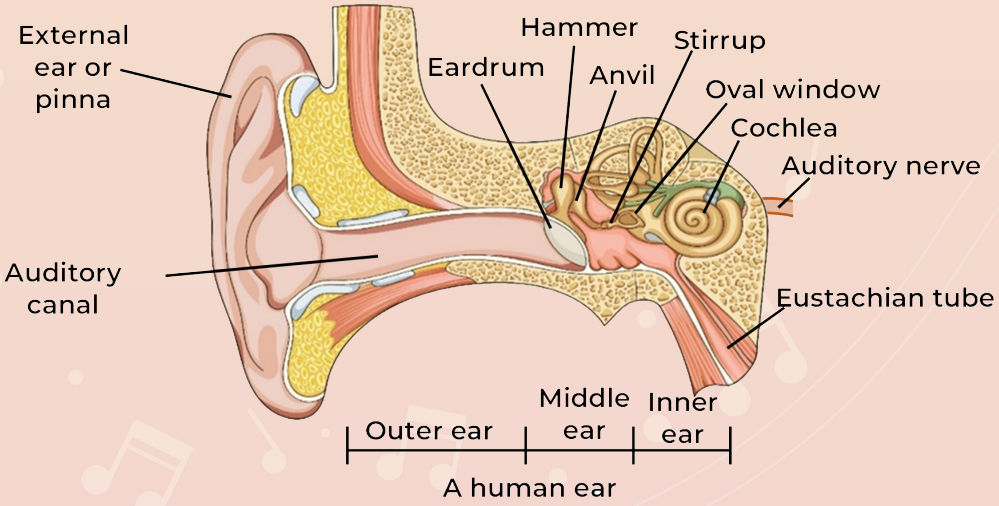


The human ear

- Your ears are organs that detect and analyse sound. Located on each side of your head, they help with hearing and balance.



- Working : Human ear is a sense organ responsible for hearing and body balance. The outer ear receives the sound waves and transmits them down the ear canal to the eardrum. This causes the eardrum to vibrate and sound is produced.

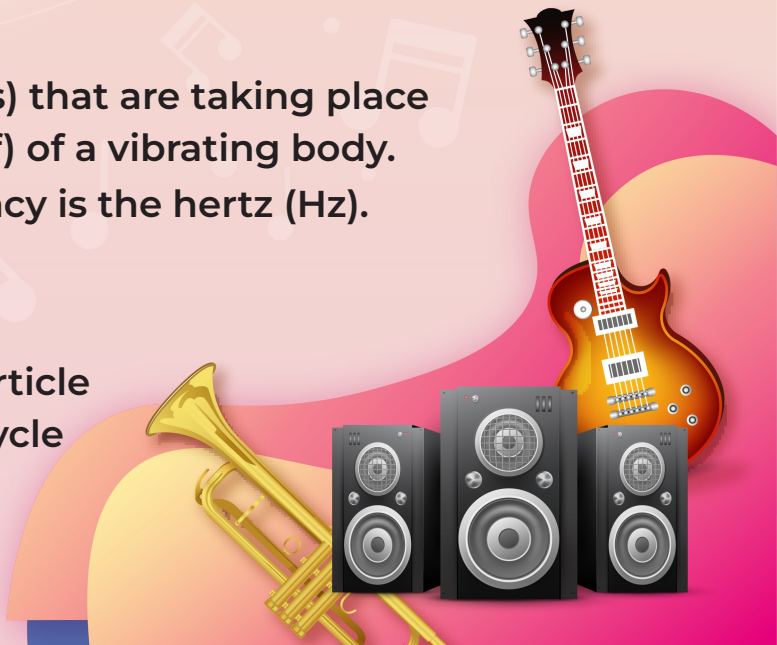


Frequency of a vibrating body

- The number of oscillations (or cycles) that are taking place per second is called the frequency (f) of a vibrating body.
- The SI unit used to measure frequency is the hertz (Hz).

Time period of a vibrating particle

- The time period (T) of a vibrating particle is the time taken to complete one cycle or oscillation.
- It is measured in seconds.



$$\text{Frequency, } f = \frac{1}{\text{Time period}} = \frac{1}{T} \text{ or } f = \frac{1}{T}$$

$$\text{or Time period, } T = \frac{1}{\text{frequency}} = \frac{1}{f} \text{ or } T = \frac{1}{f}$$

$$\text{Also, Frequency} = \frac{\text{No. of cycles}}{\text{time taken}}$$

Audible

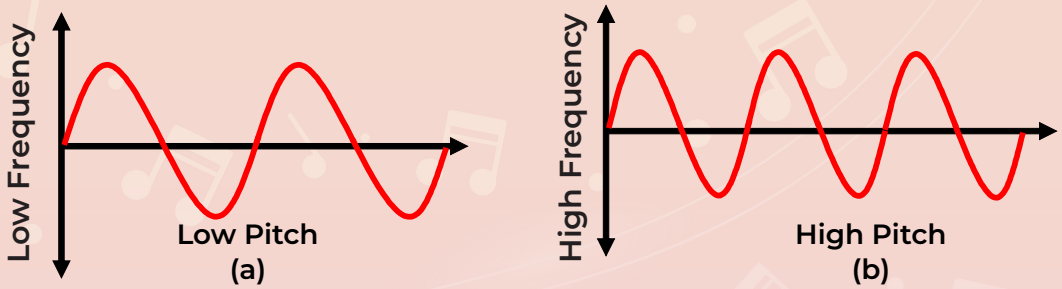
- The sounds of frequencies between 20 Hz and 20,000 Hz that can be detected by the human ear is called audible sounds.

Inaudible

- The sounds of frequencies less than about 20 Hz and those higher than 20,000 Hz cannot be detected by the human ear. Such sounds are called inaudible sounds.
- Frequencies of less than 20 Hz are called infrasonic sounds.
- Frequencies that are higher than 20,000 Hz are called ultrasonic sounds.

Characteristics of audible sounds

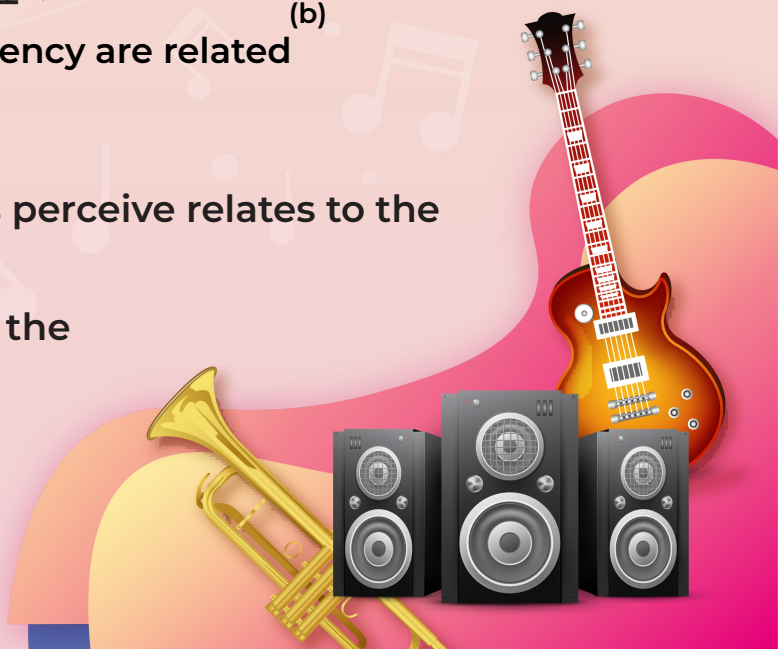
- Pitch : The frequency of an audible sound wave determines how high or low we perceive the sound to be, which is known as pitch.



Pitch and frequency are related

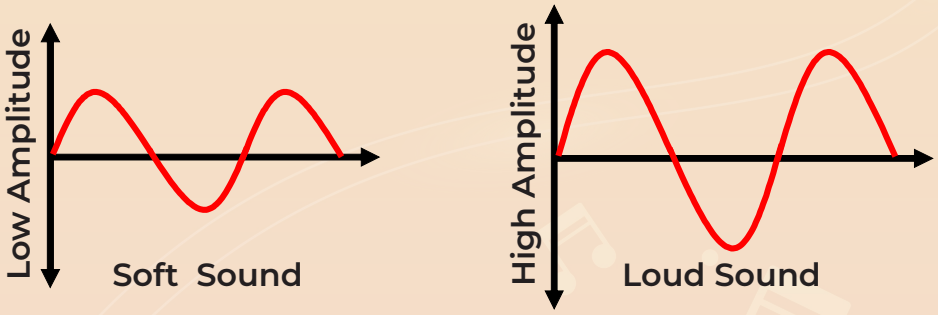
Loudness

- The loudness of the sounds humans perceive relates to the intensity of the sound.
- Sound intensity is energy carried by the sound per unit time per unit area.
- Sound intensity is usually measured in watt/(meter)^2 or (W/m^2).



Unit of loudness

- The loudness is expressed in a unit called decibel (dB). On the decibel scale, 0 dB is called the threshold of hearing.



- Human ear is sensitive to the sound intensity (loudness) ranging from 0 - 180 dB.

Quality (or timbre)

- Quality of a sound is the property by which two sounds of the same pitch (or frequency) emitted by two different sources can be distinguished from each other.

Noise

- Sounds produced by horns of buses and trucks. Such unpleasant sounds are called noise.

Noise pollution

- Presence of excessive or unwanted sounds in the environment is called noise pollution.

Sources of noise pollution

(1) Industrialisation





(2) Transportation

(3) Electrical devices at home





(4) Social functions



Effects of noise pollution

- Impairment of hearing (deafness) due to the prolonged exposure to loud noise.
- Severe damage to ear drum due to a sudden loud noise.
- Lack of sleep.
- Hypertension (high blood pressure).
- Anxiety.
- Noise pollution may also cause damage to heart, brain, liver and can result in emotional disturbances.

Measures to limit noise pollution

(1) Source of noise pollution :

(a) Setting industries away from crowded areas.

(b) Using better designed engines.

(c) Lubricating and maintaining machines.

(d) Use of automobile horns should be minimised.

(2) Path of noise :

(a) Planting of trees along the roads

(b) Interrupting the path of sound by materials which absorb the sound. Acoustic materials wool and mufflers (silencer) can be used.

(3) Receptive organs :

Using ear mufflers or cotton plugs.

Hearing impairment

- The total hearing impairment is rare, and it is usually from birth itself. Partial disability is generally the result of a disease, injury or age.

Hearing aid

- A hearing aid is an electronic device that amplifies sounds for people with hearing impairments.

