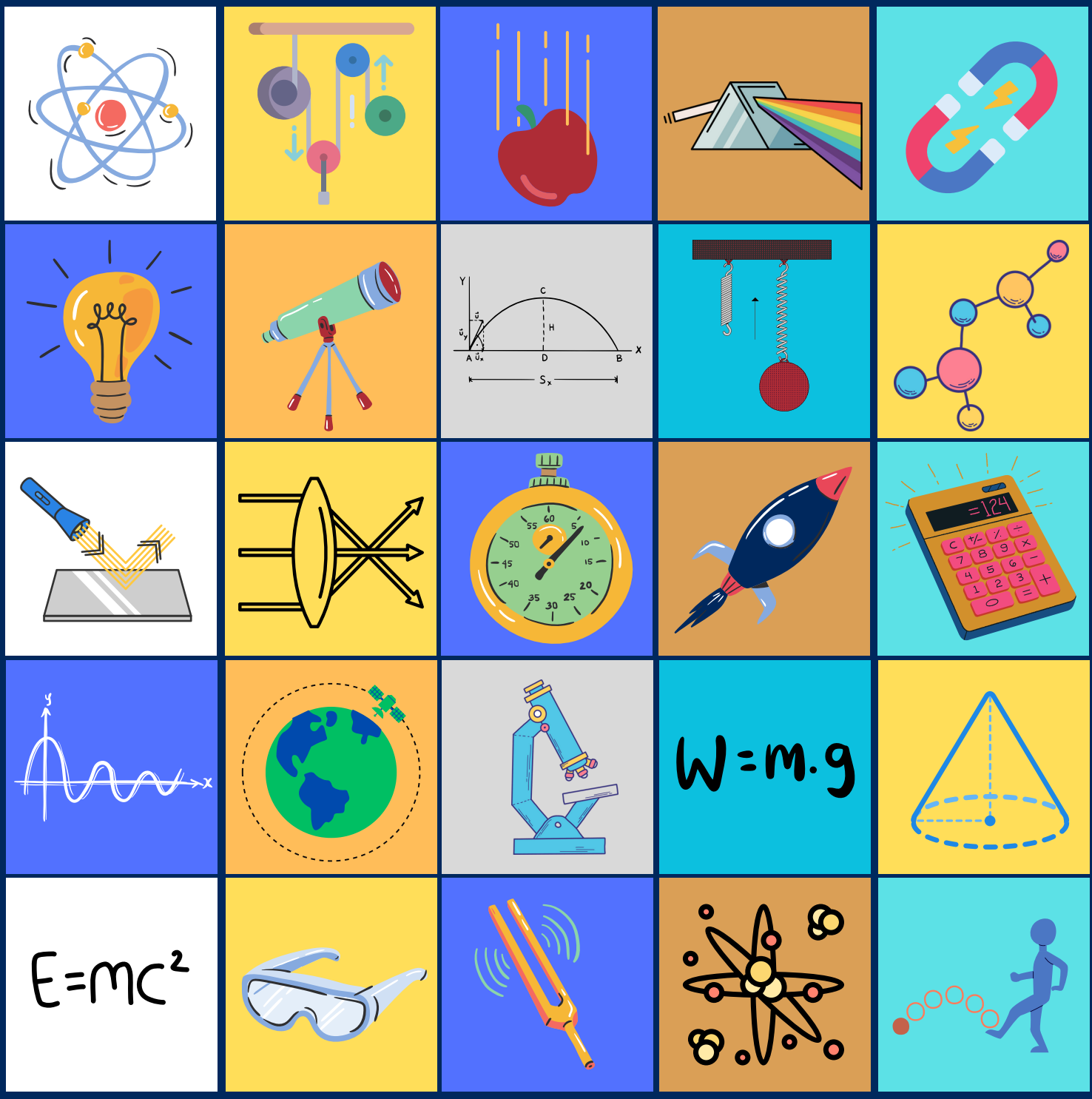


CLASS 9th NOTES

PHYSICS

SOUND

PRASHANT KIRAD

SOUND

Sound:

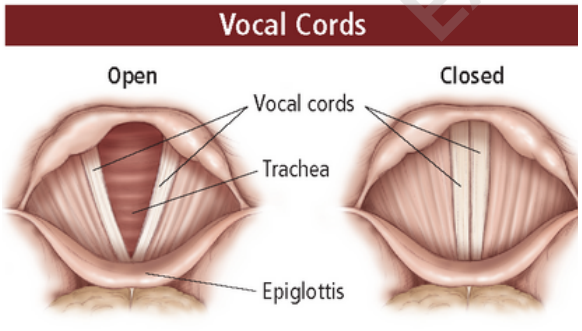
- A sound is a form of energy which produces a sensation of hearing in our ears.
- It is produced due to vibrations of different objects.
- It travels in the form of waves.

Production of Sound:

- Sound is produced by the vibrations of objects.
- Vibrations create compressions and rarefactions in the surrounding air, leading to the formation of a sound wave.
- The energy required to make an object vibrate and produce sound is provided by some outside source (like our hand, wind etc.).

Examples:-

- Sound of our voice is produced by the vibration of two vocal cords in our throat.
- Sound of a drum or tabla is produced by vibration of its membrane when struck.



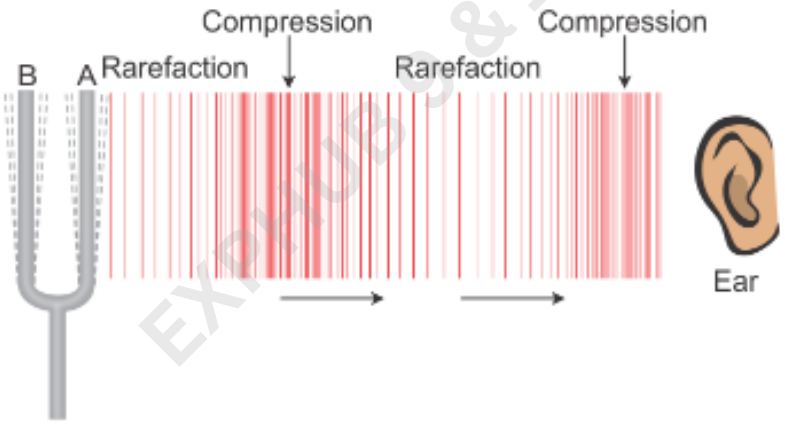
Sound can be produced by following methods:

- ***By vibrating string (sitar)***
- ***By vibrating air (flute)***
- ***By vibrating membrane (tabla, drum)***
- ***By vibrating plates (bicycle bell)***
- ***By friction***
- ***By scratching or scrubbing the objects etc.***

Propagation of Sound

- The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Air is the most common medium for sound propagation.
- A wave is a disturbance that moves through a medium when the particles of the medium set neighbouring particles into motion.
- Sound waves are characterised by the motion of particles in the medium and are called mechanical waves.

- When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure. This region is called a ***compression (C)***.This compression starts to move away from the vibrating object.
- When the vibrating object moves backwards, it creates a region of low pressure called ***rarefaction (R)***.

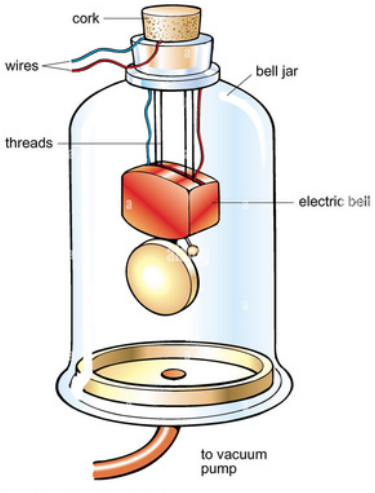


Sound needs medium for propagation:

- It needs material medium for propagation like air, water, steel, etc.
- It cannot travel in vacuum.

Experiment to show that sound needs a medium:

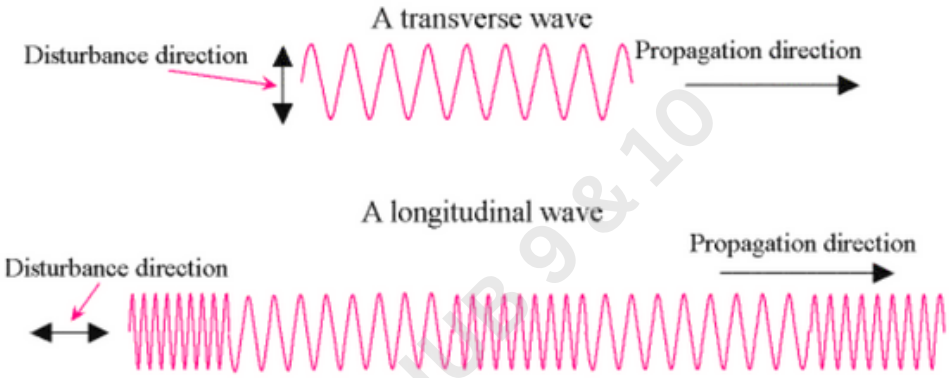
- An electric bell is suspended in airtight bell jar connected with vacuum pump.
- This shows that presence of medium is necessary for propagation of sound waves.



Sound waves as longitudinal Waves:

- The matter or substance through which sound is transmitted is called a medium. It can be solid, liquid or gas. Air is the most common medium for sound propagation.
- When longitudinal waves travel through any given medium, they also include ***compressions*** and ***rarefactions***.

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.***



Characteristics of Sound Waves:

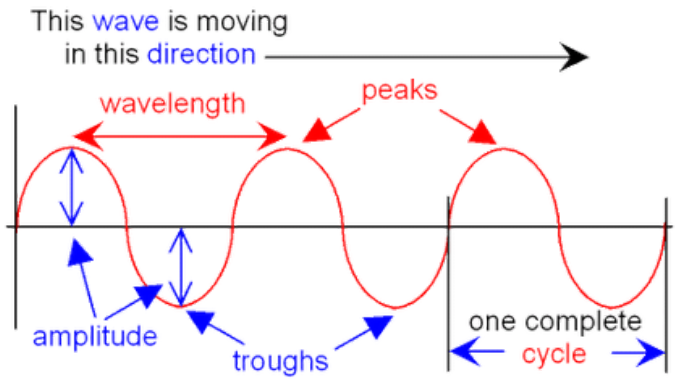
Wavelength (λ): The distance between two consecutive compressions or refractions is called Wavelength.
SI unit: ***metre (m)***

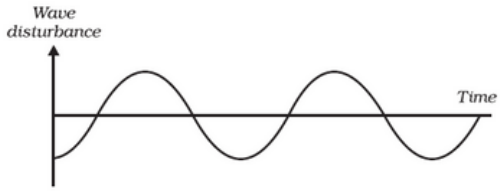
Frequency (f): The number of oscillations per unit time is called the Frequency of a Wave (Number of compressions + the number of refractions per unit time)
SI unit: ***Hertz (Hz)***

Amplitude (A): The maximum displacement of the particle of the medium from their original undisturbed position is called amplitude of the wave.
SI unit: ***metre (m).***

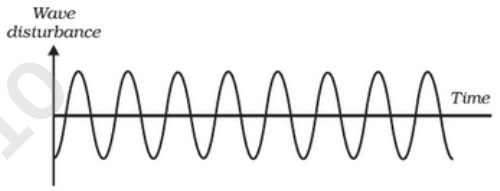
Time period (T): The time taken between two consecutive compressions or refractions to cross a fixed point is called Time Period of the Wave. In other words, the time taken for one complete oscillation through a medium is called a Time Period.
SI unit: ***second (s)***

Relationship between Frequency and Time period: $f = 1/T$





Wave shape for a low pitched sound

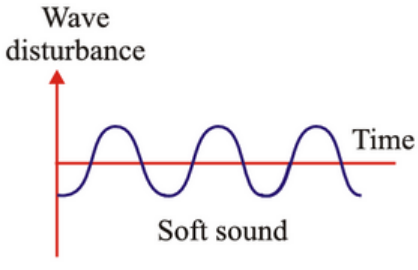


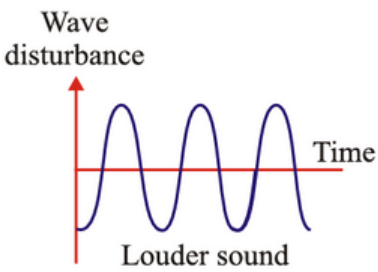
Wave shape for a high pitched sound

Pitch: Pitch of a sound depends upon:
1. ***the frequency of the sound***
2. ***size of the object producing the sound***
3. ***type of the object producing the sound***

Timbre: 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.

Loudness: It depends on the amplitude of the sound wave.
Two sounds with same intensity can vary in loudness only because we can detect one sound easier than the other.





Velocity: The distance travelled by a wave in one second is called velocity of the wave.
SI unit: metre per second (m/s).

$$\text{Wave velocity} = \frac{\text{Distance}}{\text{Time}}$$

$$\Rightarrow \quad v = \frac{\lambda}{T}$$

$$\Rightarrow \quad u = v\lambda \qquad \left[\because \frac{1}{T} = \text{frequency}\,(v)\right]$$

$$\therefore \text{ Wave velocity} = \text{Frequency} \times \text{ Wavelength}$$

This is the wave equation.

Speed of Sound in Various Mediums:

- Sound cannot travel at the same speed in different mediums. The speed of sound in a medium is affected by three things:
- The density of the medium. For instance, speed of sound is the maximum through solids.
- The temperature of the medium. As the temperature increases, the sound propagates easily.
- Humidity in the air also affects the travel of sound. As the humidity increases, so does the propagation of sound.

Sonic Boom:

- When an object travels in the air with a speed greater than that of the sound, it produces a sound with high energy.
- These objects exert a large amount of pressure on the air which causes the production of shock waves in the air. These shock waves produce extremely large and loud sound waves which are called Sonic booms.

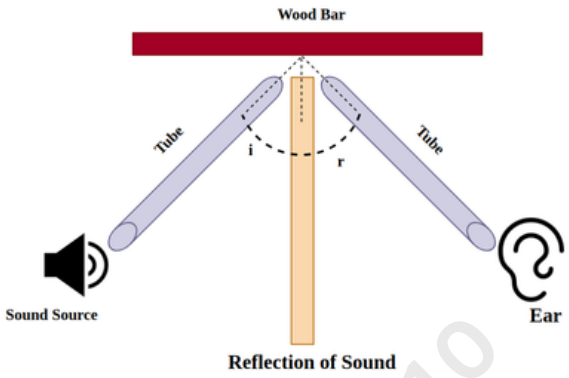
- Some aircrafts, bullets, rockets etc. have 'supersonic speed'.
- This energy is loud enough that it can break glasses or damage the buildings. The sound produced is similar to the sound of an explosion or thunderclap.

Reflection of Sound

Like light, sound also bounces back when it falls on a hard surface. It is called reflection of sound. The laws of reflection of light are also applicable to reflection of sound.

i. The incident sound wave, the reflected sound wave and normal at the point of incidence lie in the same plane.

ii. Angle of reflection of sound is always equal to the angle of incidence of sound.



Echo

The repetition of sound caused by the reflection of sound waves is called an echo e.g. Clapping or shouting near a tall building or mountain.

- To hear a distinct echo sound, the time interval between the original and reflected sound must be at least 0.1s, as sound persists in our brain for about 0.1s.
- The minimum distance for obstruction or reflective surface to hear an echo should be 17.2 m.
- Rolling of thunder is due to multiple reflection of sound of thunder from a number of reflecting surfaces such as clouds and the earth.

Reverberation

- The persistence of sound in a big hall due to repeated or multiple reflections of sound from the walls, ceiling and floor of the hall is called reverberation.
- If its too long, sound becomes blurred, distorted and confusing.

- To reduce reverberation in big halls, heavy curtains are put on doors and windows, carpets are put on the floor and seats are made of sound absorbing material.

Application of reflection of sound

i. Megaphone, loudspeakers, bulb horns, etc. are designed to send sound in a particular direction without spreading all around. All these have funnel tube which reflects sound waves repeatedly towards audience.
ii. Stethoscope - It is a medical instrument used for listening the sounds produced in human body mainly in heart and lungs. The sound of heartbeats reaches the doctor's ears by the multiple reflection of the sound waves.
iii. Sound board - In big halls, a curved board(cause multiple reflections) is placed behind the speakers so that his speech can be heard easily by audiences.
iv. The ceiling of concert halls are made curved, so that the sound after reflection from ceiling reaches all the parts of the hall.

Range of hearing

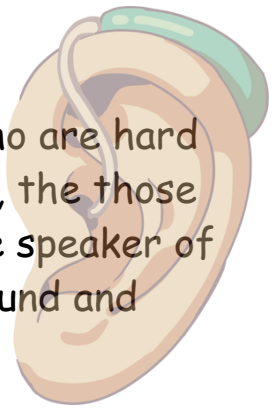
i. Range of hearing in human is 20 Hz to 20000 Hz.
- Children younger than 5 years and dogs can hear upto 25 KHz.

ii. The sounds of frequencies lower than 20 Hz are known as 'infrasonic sounds'.
- A vibrating simple pendulum produces infrasonic sounds.
- Rhinoceroses communicate with each other using frequencies as low as 5 Hz.
- Elephants and Whales produce infrasonic sounds.
- Earthquake produce infrasonic waves which some animals can hear and get disturbed.

iii. The sounds of frequencies higher the 20 KHz are known as 'ultrasonic' waves.
- Dogs, dolphins, bats, and rats can hear ultrasonic sounds.
- Bats and rats can produce ultrasonic sounds.

Hearing Aid

It is battery operated electronic device used by persons who are hard of hearing. Microphone convert sound into electrical signals, the those are amplified by amplifier. Amplified signals are send to the speaker of hearing aid. The speaker converts the amplified signal to sound and sends to ear for clear hearing.



Application of ultrasound

i. It is used to detect cracks in metal blocks in industries without damaging them.
ii. It is used in industries to clean 'hard to reach' parts of objects such as spiral tubes, odd shaped machines.
iii. It is used to investing the internal organs of human body such as liver, gall bladder, kidneys, uterus and heart.
iv. **Echocardiography:** These waves are used to reflect the action of heart and its images are formed.
v. **Ultrasonography:** The technique of obtaining pictures of internal organs of the body by using echoes of ultrasound waves.
vi. Ultrasound is used to split tiny stones in kidneys into fine grains, which then get flushed out with time.

Sonar (Sound navigation and ranging)

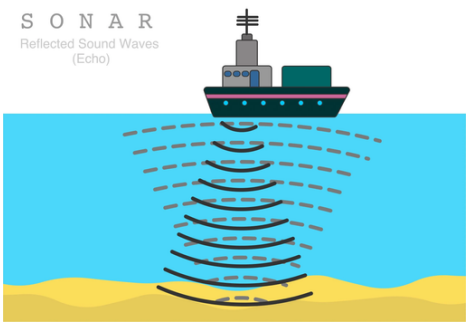
SONAR is a device which is used to find distance, direction and speed of underwater objects.

How does it work?

- SONAR consists of a transmitter and a receptor or detector that is installed at the bottom of a ship.
- The transmitter produces and transmits ultrasonic waves.
- These waves travel through water and after striking the objects on the bottom of sea, are reflected back and received by detector.
- These reflected waves are converted into electric signals by detector.
- The sonar device measures the time taken by ultrasound waves to travel from ship to bottom of sea and back to ship.

Uses of SONAR

The sonar is used to find the depth of sea, to locate underwater hills, valleys, submarines, icebergs and sunken ships etc.

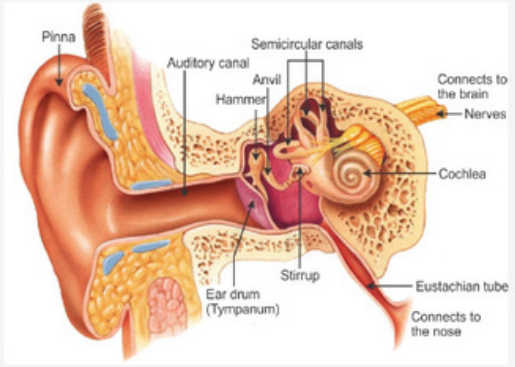


Structure of Human Ear:

The ear consists of three parts : outer ear, middle ear and inner ear.
The ears are the sense organs which help us in hearing sound.

- **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 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.
- The lower part of middle ear has a narrow **'Eustachian tube'**.
- **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.

Working of Human Ear:



- When compression of sound wave strike
- the ear drum, the pressure on the
- outside of ear drum increases and pushes
- the ear drum inwards.
- While during refraction ear drum moves outwards. Thus, ear drum starts vibrating back and forth.
- These vibrations are increased by three bones and middle ear transmits these amplified pressure variations received from sound waves to inner ear.
- In the inner ear the pressure variations are turned into electric signals by the cochlea.
- These electric signals are sent to the brain via auditory nerve and the brain interprets them as sound.

Sound wave >> Pinna >> Ear canal >> Vibrate ear drum >> Hammer >> Anvil >> Oval window >> Cochlea >> Auditory nerve >> Brain (which interprets these electrical impulses as sound and we get the sense of hearing).