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Class 7 - ICSE
PHYSICS

Sound

Notes

Sound

Sound is a form of energy that produces the sensation of hearing in our ears.

E.g. ringing of school bell, honking of vehicles, sound of playing guitar, etc.

Sound is produced due to vibrations

- Sound is produced by a vibrating object. When an object vibrates, it creates sound waves that travel through a medium (like air, water, or solids).
- To- and fro- motion of a body from its rest positions is called oscillatory motion.
- E.g. motion of a swing and motion of the pendulum of wall clock
- Body from its rest position moves to one side, comes back to the rest position, then moves to the other side and then again comes back to the rest position.
- When the body stops vibrating, the sound produced by it also ceases.

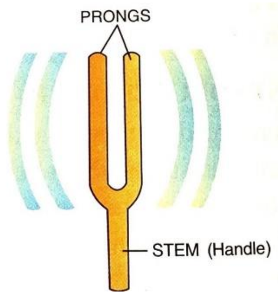
Sources of Sound

1. Tuning Fork

- U-shaped metallic pieces with a stem in the middle.

- Arms are called prongs.

- When either of two are struck gently on the rubber pad, sound is produced.



2. Musical Instruments

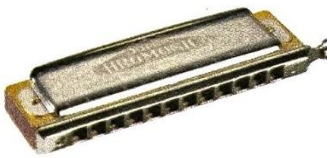
- Instruments like whistle, flute, clarinet in form of pipe, produce sound when air is blown into them.
- Air column inside them vibrates producing sound.


CLARINET


FLUTE

- Instruments like harmonium, mouth organ contain reeds and they produce sound when air is blown through them.


HARMONIUM


MOUTH-ORGAN

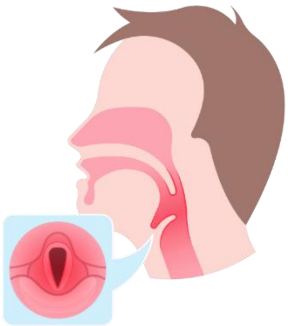
- Instruments like sitar, guitar, violin have strings stretched in them. This makes string vibrate and produce sound.


VIOLIN


PIANO


GUITAR

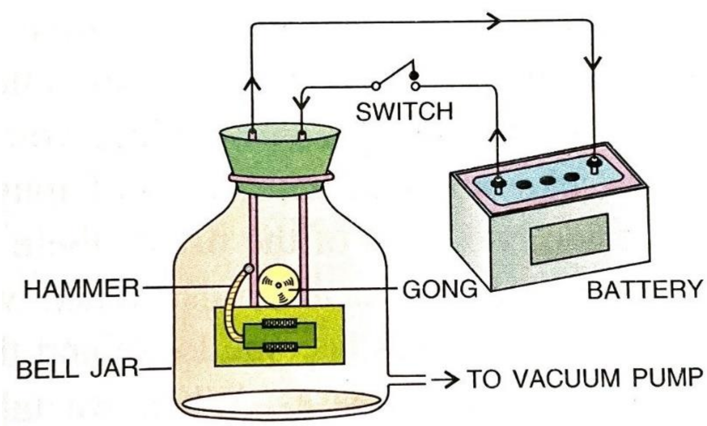
3. Human Beings



- We have vocal cords which vibrate to produce sound on blowing air through them by our lungs.
- The vocal cords (or vocal folds) are two bands of muscle tissue located in the larynx (voice box) at the top of the trachea.
- When we speak or sing, air from the lungs is pushed through the trachea and flows between the vocal cords.
- The vocal cords are brought together and tightened. As air passes through the narrow gap between the cords, they vibrate.
- These vibrations produce sound waves. The frequency of the vibrations determines the pitch of the sound.

Sound needs a medium for propagation

- Sound cannot travel in vacuum.
- Sound requires a medium for its propagation i.e. for travelling from one point to another.

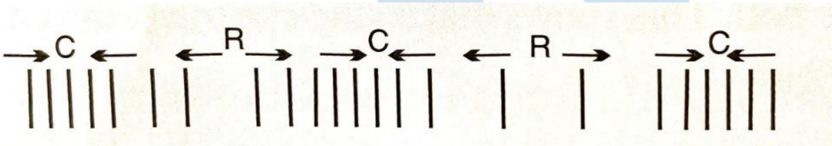


- Place an electric bell inside an air-tight glass jar connected to a vacuum pump.
- Suspend the bell in the jar and connect it to a battery through a switch.
- When you press the switch, the bell starts ringing, and the sound travels through the air in the jar.
- Begin operating the vacuum pump to remove the air from the jar. As the air is evacuated, the sound gradually becomes fainter.
- Eventually, when all the air is removed from the jar, no sound is heard despite the bell still ringing. This is because sound requires a medium, such as air, to travel.
- Without air, sound waves cannot propagate, so although the bell’s hammer strikes the gong, we cannot hear it.

Sound travels in air in the form of longitudinal waves

- Sound travels in the form of longitudinal waves, which are different from transverse waves (like those in water).
- In a longitudinal wave, the vibrations of the particles in the medium are parallel to the direction of the wave's travel.

- Compressions and Rarefactions: As the sound wave travels, it creates regions where particles are closely packed together (compressions) and regions where they are spread apart (rarefactions).
- When an object vibrates, it pushes and pulls on the particles of the medium (such as air), creating compressions (high-pressure areas) and rarefactions (low-pressure areas).
- These compressions and rarefactions move away from the source in the direction of the wave's travel, transferring sound energy through the medium.
- Sound requires a medium (solid, liquid, or gas) to travel because the particles in the medium must vibrate and transfer the energy of the sound wave.
- When you speak, your vocal cords vibrate and create compressions and rarefactions in the air, which travel as longitudinal waves to your listener's ears.

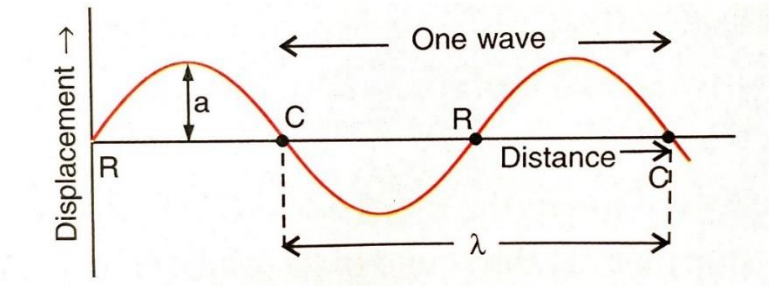


<u>Terms related to a Wave</u>

<u>One Vibrations</u> – To and fro motion which constitute one full wave.

<u>Wavelength</u> – Length of a wave corresponding to one vibration.

<u>Amplitude</u> – Maximum displacement of a wave on either side of its mean position.



Time period – Time taken by a wave to complete one vibration.

Frequency – Number of vibrations produced by the source of sound wave in one second.

Types of Sounds

Audible Sound

Human ear cannot hear sounds of all frequencies.

Audible sound range: 20 Hz to 20,000 Hz

Ultrasonic (Supersonic) Sound

- Sounds of frequency higher than 20,000 Hz.
- Human ears can't hear them.
- Animals like dogs, bats, monkeys can hear.

- Bats use ultrasonic sound waves for echolocation, a method to navigate and hunt in the dark.
- Emission of Ultrasound: Bats emit high-frequency ultrasonic clicks or calls using their vocal cords or mouth.
- Reflection: These sound waves travel through the air, bounce off objects, and return as echoes.
- Detection: Bats have specialized ears that detect the returning echoes. By analyzing the time delay and frequency of these echoes, bats can determine the distance, size, shape, and even texture of objects around them.

Benefits:

- Navigation: Echolocation allows bats to navigate through complete darkness.
- Hunting: It helps bats locate prey such as insects, even when the prey is flying or hiding.

Infrasonic (Subsonic) Sound

- Sounds of frequency lower than 20 Hz.
- Humans can't hear these sounds.

- E.g. pendulum of a clock makes one vibration in 2 s. The frequency of sound produced due to its vibrations is 0.5 Hz.

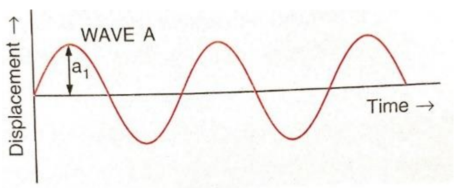
Frequency Range	Sound
Below 20 Hz	Infrasonic/Subsonic
20 Hz – 20,000 Hz	Audible
Above 20,000 Hz	Ultrasonic

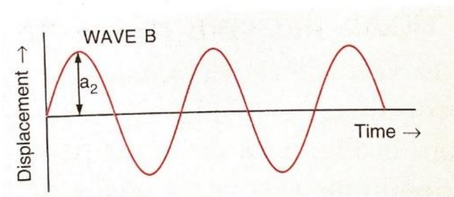
Characteristics of Sound

1. Loudness
2. Pitch

Loudness

- Depends on amplitude of vibration of the vibrating body producing sound.
- Greater the amplitude of vibrations, louder is the sound produced.

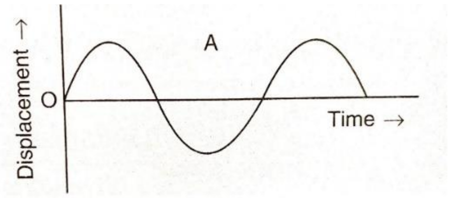




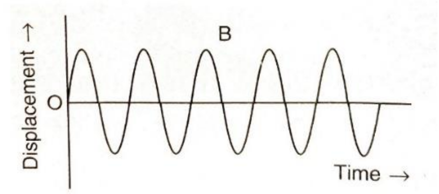
Pitch

- Pitch is the high or low frequency of a sound.
- Depends on its frequency.
- Higher the frequency, higher the pitch & vice-versa.

- Pitch is a characteristic of sound which distinguishes a shrill sound from a flat sound.



Wave with lower frequency
(Low pitch sound)



Wave with higher frequency
(High pitch sound)

<u>Speed of Sound</u>

The speed of sound is the rate at which sound waves travel through a medium.

- Air: In dry air at room temperature (about 20°C), the speed of sound is approximately 343 meters per second (m/s).
- Water: Sound travels faster in water, around 1,480 m/s.
- Solids: Sound travels even faster in solids. For example, in steel, the speed is about 5,000 m/s.

<u>Factors Affecting Speed</u>

- <u>Medium</u>: Sound travels faster in denser and more elastic materials. This is because particles in solids and liquids are closer together and can transmit vibrations more quickly.
- <u>Temperature</u>: In air, the speed of sound increases with temperature because warmer air has lower density and molecules move faster, making it easier for sound waves to travel.

E.g. When you see a lightning flash and then hear the thunder, the delay between the two is due to the time it takes for sound to travel from the lightning to you.

Speed of Sound, V = $\frac{\boldsymbol{Distance\ (d)}}{\boldsymbol{Time\ (t)}}$ = $\frac{\boldsymbol{d}}{\boldsymbol{t}}\ \boldsymbol{m/s}$

Reflection of Sound

- Reflection of sound takes place obeys the two laws of reflection:
- Angle of incidence is equal to angle of reflection.
- Incident sound, reflected sound and normal are all in one plane.

Echo

Echo is the distant sound heard after reflection from a distant rigid surface such as cliff, hillside.

How Echoes Occur:

- Sound Reflection: When sound waves hit a hard surface (like a wall, mountain, or building), they bounce back towards the source. This reflected sound is heard as an echo.
- Time Delay: The time delay between the original sound and the echo depends on the distance of the reflecting surface from the source.

Conditions for Echoes:

- Distance: To hear an echo clearly, the reflecting surface must be at least 17 meters away from the source. If the surface is too close, the echo may blend with the original sound.

- Surface Type: Hard, smooth surfaces reflect sound waves better than soft or irregular surfaces.

Practical Examples:

- Mountains: When you shout towards a mountain, you may hear your voice reflected back as an echo.
- Empty Rooms: In large, empty rooms or auditoriums, echoes can be heard because the sound waves reflect off the walls and other surfaces.

Uses of Echoes:

- Sonar and Radar: Echoes are used in technologies like sonar and radar to detect objects and measure distances.

Absorption of Sound

- When sound waves strike a material, some of the sound energy is absorbed by the material rather than being reflected. This absorption reduces the intensity of the sound.
- The absorbed sound energy is converted into heat, which is why the sound may seem quieter in a room with absorbing materials.

1. Roof – thermocol & POP
2. Walls – covered with wooden strips
3. Floor – Thick carpets
4. Machine parts to be placed in enclosures
5. Thick curtains
6. Closed doors
7. Thick stripping to cover openings of doors & windows.

Practical Examples:

- Placing carpets and curtains in a room can help absorb sound, making it quieter and reducing noise from outside.
- Special panels designed for sound absorption are used in studios and auditoriums to control sound reflections and improve acoustics.

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