CLASS 9 CBSE SCIENCE MASTER NOTES

Session 2026–2027 | Chapter 10: Sound Waves: Characteristics and Applications

1. Chapter Overview

Chapter Introduction

Sound is a form of energy that produces a sensation of hearing in our ears. In our daily lives, we hear sounds from various sources like human speech, birds chirping, bells ringing, and musical instruments. This chapter explores how sound is produced, how it travels through different mediums, its physical characteristics, phenomena like reflection and echo, and its technological applications.

Learning Objectives

- Understand the production of sound through vibrations.
- Explain the nature of mechanical and longitudinal waves.
- Differentiate between characteristics of sound: pitch, loudness, and quality.
- Analyze the reflection of sound and its applications (Echo, SONAR, Ultrasound).
- Solve numerical problems based on wave velocity, frequency, and wavelength.

2. Complete Theory

Sound and its Production

Sound is produced by **vibrating bodies**. A vibration is a rapid to-and-fro or back-and-forth motion of an object. When a stretched string is plucked, it vibrates and sets the surrounding air particles into motion, creating sound.

Mechanical Waves

Sound is a **mechanical wave**, meaning it requires a material medium (solid, liquid, or gas) for its propagation. It cannot travel through a vacuum because there are no particles to transfer the energy.

Longitudinal Waves and Propagation

Sound travels in the form of **longitudinal waves**. In a longitudinal wave, the individual particles of the medium vibrate in a direction **parallel** to the direction of propagation of the disturbance.

- **Compression (C):** Regions of high pressure where particles are pushed close together.
- **Rarefaction (R):** Regions of low pressure where particles are spread apart.

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[Speaker] ---> C R C R C R ---> [Ear]
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Speed of Sound

The speed of sound depends on the properties of the medium through which it travels:

1. **State of Matter:** Sound travels fastest in **solids**, slower in **liquids**, and slowest in **gases** because the elasticity and particle packing are highest in solids.
2. **Temperature:** The speed of sound increases with an increase in the temperature of the medium.
3. **Humidity:** Sound travels faster in moist air than in dry air.

Speed of sound in air at 0°C is approximately 332 m/s and at 20°C is 343 m/s.

3. Definitions

- **Vibration:** The rapid to-and-fro motion of an object about its mean position.
- **Wavelength (λ):** The distance between two consecutive compressions or two consecutive rarefactions.
- **Frequency (f):** The number of complete oscillations per unit time. Unit: Hertz (Hz).
- **Time Period (T):** The time taken to complete one full oscillation. Unit: Second (s).
- **Amplitude (A):** The maximum displacement of the particles of the medium from their mean position.
- **Echo:** The repetition of sound caused by the reflection of sound waves from a rigid obstacle.
- **Reverberation:** The persistence of sound in a large hall due to repeated reflections from the walls, floor, and ceiling.
- **Ultrasonic Waves:** Sound waves with frequencies greater than 20,000 Hz.

4. Important Formula Sheet

FORMULA	MEANING OF SYMBOLS	SI UNIT
$v = \lambda \cdot f$	v = Wave speed, λ = Wavelength, f = Frequency	m/s
$f = 1 / T$	f = Frequency, T = Time period	Hz or s^{-1}
$v = 2d / t$	v = Speed, d = Distance to obstacle, t = Total time taken	m/s

> **Short Trick:** $v = \lambda f$ can be remembered as *Velocity = Lambda × Frequency*.

5. Tables & Comparisons

Echo vs. Reverberation

FEATURE	ECHO	REVERBERATION
Definition	Distinct repetition of sound due to single reflection.	Persistence/blurring of sound due to multiple reflections.
Minimum Distance	Requires a minimum distance of 17.2 m.	Occurs in closed, enclosed, or small-to-medium halls.
Clarity	Sound is clear and distinct.	Sound becomes confused or muddled.

Music vs. Noise

FEATURE	MUSIC	NOISE
Pleasantness	Pleasing to the ears.	Unpleasant and jarring to the ears.
Waveform	Regular and periodic oscillations.	Irregular and random oscillations.

6. Everyday Applications & Numericals

- **Stethoscopes:** Used by physicians to listen to heartbeat sounds via multiple reflections inside a rubber tube.
- **Megaphones:** Designed with conical tubes to send sound in a specific direction.
- **SONAR:** Used by ships to measure ocean depth.
- **Ultrasonic Cleaning:** Used for delicate electronic parts and spiral tubes.

Numerical Example

Problem: A sound wave has a frequency of 2 kHz and a wavelength of 35 cm. How much time will it take to travel 1.4 km?

Given: *f = 2 ext{ kHz} = 2000 ext{ Hz}*, *λ = 35 ext{ cm} = 0.35 ext{ m}*, Distance *d = 1400 ext{ m}*.

Step 1 (Find Speed): *v = f imes λ = 2000 imes 0.35 = 700 ext{ m/s}*.

Step 2 (Find Time): *t = d / v = 1400 / 700 = 2 ext{ s}*.

7. Quick Revision Sheet

- **Key Formula:** $v = \lambda f$

- **Min Distance for Echo:** 17.2 meters
- **Audible Range:** 20 Hz to 20,000 Hz
- **Medium Requirement:** Mandatory (Mechanical Wave).
- **Pitch vs Amplitude:** Pitch depends on frequency; Loudness depends on amplitude.