Chapter 8: Sound

What is Sound?

- Sound is a form of **energy** that causes the **sensation of hearing**.
- It is produced when an object **vibrates**.
- A **vibrating body** is the **source of sound**.
- Sound travels as **waves** in a **medium** and is detected by our **ears**.

Sound Needs a Medium to Travel

- Sound **cannot travel in vacuum**; it needs a **material medium** like **air, water, or solids**.
- **Medium must be:**
    1. **Elastic** – to return to original position
    2. **Inertial** – to store energy
    3. **Low-friction** – to prevent energy loss

Types of Waves

- **Longitudinal Waves**: Particles vibrate **parallel** to wave direction (e.g., sound in air).
- **Transverse Waves**: Particles vibrate **perpendicular** to wave direction (e.g., water waves, waves on strings).

Key Characteristics of Wave Motion

1. Caused by **periodic disturbance**.
2. Particles **vibrate about mean position**, energy moves forward, not the particles.

Important Terms

- **Amplitude (a)**: Maximum displacement from mean position (unit: **m**).
- **Time Period (T)**: Time for one vibration (unit: **s**).
- **Frequency (f)**: Vibrations per second (unit: **Hz**).
- **Wavelength (λ)**: Distance travelled in one time period (unit: **m**).
- **Wave Velocity (v)**: Distance travelled by wave in 1 second (unit: **m/s**).

Wave Equation

$$v = f \times \lambda$$

Speed of Sound

- Depends on:
  - **Elasticity (E)**
  - **Density (ρ)**
- **More in solids**, **less in liquids**, **least in gases**.
- Example: Sound reaches faster through **steel rails** than air.

Factors Affecting Speed of Sound in Gases

- **Density**: Speed ↓ with ↑ density
- **Temperature**: Speed ↑ with ↑ temperature
- **Humidity**: Speed ↑ with ↑ humidity
- **Wind Direction**: Speed changes with wind

Factors That Do *Not* Affect Speed

- **Pressure**
- **Amplitude**
- **Wavelength/Frequency**

Speed of Sound vs. Speed of Light

Property	Sound	Light
Medium	Needs material	Can travel in vacuum
Speed	~330 m/s in air	~3×10^8 m/s
Type	Mechanical wave	Electromagnetic wave
Nature	Longitudinal	Transverse

Examples:

- Thunder & lightning: **Light** seen before **sound** heard.
- Gunshot: **Smoke** seen before **sound** heard.

Types of Sound (Based on Frequency)

Type	Frequency Range	Example
Infrasonic	< 20 Hz	Earthquakes, elephants
Sonic (Audible)	20 Hz – 20 kHz	Human speech, music
Ultrasonic	> 20 kHz	Bats, sonar, medical scans