

Chapter 7: Sound

Sound: A Form of Energy

- **Definition:** Sound is a form of energy that causes the sensation of hearing.
 - **Production:** Sound is produced by vibrating bodies.
 - **Medium Required:** Needs a material medium (solid, liquid, gas) to propagate.
 - **Audible Range:**
 - 20 Hz – 20,000 Hz
 - < 20 Hz → Infrasonic
 - 20,000 Hz → Ultrasonic
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Wave Nature of Sound

- **Type:** Mechanical/Elastic Waves.
 - **Formula:**
 - $v = f\lambda$ (Speed = Frequency $\times$ Wavelength)
 - $f = 1/T$ (Frequency = 1 / Time Period)
 - **Types of Waves:**
 1. **Longitudinal Waves:** Vibrations parallel to wave direction (e.g., sound in air, solids, liquids).
 2. **Transverse Waves:** Vibrations perpendicular to wave direction (e.g., sound in solids and liquid surfaces).
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Reflection of Sound

- Follows the laws of reflection (angle of incidence = angle of reflection).
 - **Applications:** Megaphone, Soundboards, Ear Trumpets.
 - **Condition:** Reflecting surface size > wavelength of sound.
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Echo

- Sound heard after reflecting from a distant object.
- **Conditions for hearing an echo:**
 1. Minimum distance = 17 m

2. Reflector should be large
 3. Sound must be loud enough
- **Formula:**
 - $\text{Distance} = (\text{Speed} \times \text{Time}) / 2$
 - **Reverberation:** Prolonged sound due to multiple reflections (e.g., in tombs).
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✍ Applications of Echo

- **Determining Speed of Sound:** Use time taken for echo to calculate.
 - **Used by Animals:** Bats, dolphins use echoes (ultrasonic) for navigation and hunting.
 - **SONAR:** Uses ultrasonic waves to detect underwater objects and measure sea depth.
 - **Medical Use:**
 - **Ultrasonography:** Imaging organs.
 - **Echo cardiography:** Imaging heart.
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🔔 Types of Vibrations

1. **Natural Vibrations:** Occur without external force. Ideal case in vacuum.
 2. **Damped Vibrations:** Amplitude decreases due to resistive forces.
 3. **Forced Vibrations:** Caused by an external periodic force.
 4. **Resonance:** When forced frequency = natural frequency → max amplitude.
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🎵 Characteristics of Sound

1. **Loudness**
 - Depends on amplitude.
 - Related to energy/intensity:
 - $L = K \log_{10} I$ (Weber-Fechner law)
 - Measured in **decibels (dB)**
 - Affected by amplitude, distance, surface area, medium, and resonance.
 2. **Pitch (Shrillness)**
 - Depends on frequency.
 - High pitch = high frequency, shrill sound.
 3. **Quality (Timbre)**
 - Depends on waveform.
 - Helps distinguish same pitch & loudness from different sources.
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Music vs Noise

- **Music:** Pleasant, regular sound (10–30 dB).
 - **Noise:** Unpleasant, irregular sound (>120 dB).
 - **Noise Pollution:** Harmful sound; safe limit = below 80 dB.
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Important Numericals

- Concepts used:
 - $V = f\lambda$
 - $\text{Distance} = (\text{speed} \times \text{time}) / 2$
 - Understand graphs to extract frequency & wavelength
 - Apply echo concept to real-world problems (claps, guns, sonar)
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