Class 9 Science – Chapter 11: Sound

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1. What is Sound?

- Sound is a form of energy that produces a sensation of hearing.
- It is produced by the **vibration** of objects.
- Example: When you pluck a guitar string, it vibrates and produces sound.

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2. Production of Sound

- Sound is produced by **vibrating bodies**.
- **Vibration** is the to-and-fro motion of an object.
- Sound cannot be produced without vibration.

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3. Propagation of Sound

- Sound travels in the form of **waves** through a medium (solid, liquid, or gas).
- It **cannot travel in vacuum**.
- The medium particles transfer energy by **colliding** with neighboring particles.

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4. Sound Waves

- Sound waves are **longitudinal waves** (particles move parallel to the wave direction).
- It consists of:
    - **Compression**: High-pressure region.
    - **Rarefaction**: Low-pressure region.

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5. Characteristics of Sound Waves

Quantity	Symbol	Unit	Description
Wavelength	λ	meter (m)	Distance between two compressions
Frequency	f	hertz (Hz)	Vibrations per second
Time Period	T	second (s)	Time for one vibration (T = 1/f)
Amplitude	A	meter (m)	Maximum displacement of a particle
Velocity	v	m/s	Speed of sound wave ($v = f \times \lambda$)

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6. Speed of Sound in Different Media

Medium	Speed (approx.)
Air	343 m/s
Water	1482 m/s
Steel	5960 m/s

Note: Sound travels fastest in solids, slower in liquids, and slowest in gases.

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7. Audible and Inaudible Sounds

- **Audible Range**: 20 Hz – 20,000 Hz
- **Infrasonic**: Less than 20 Hz (e.g., elephants)
- **Ultrasonic**: More than 20,000 Hz (e.g., bats, SONAR)

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8. Reflection of Sound

- Sound reflects like light.
- **Laws of reflection**:
  - Angle of incidence = Angle of reflection
  - Incident wave, reflected wave, and normal lie in the same plane

Echo

- Reflected sound heard after the original.
- Time gap ≥ 0.1 s; minimum distance = 17.2 m (at 343 m/s)

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9. Reverberation

- Prolonged sound due to multiple reflections.
- Reduced using soft materials (curtains, carpets, etc.)

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10. Applications of Reflection of Sound

- **Megaphones**: Direct sound in one direction.
- **Stethoscope**: Doctors hear heartbeat.

- **Sound boards**: Used in auditoriums.
- **SONAR**: Used in submarines to detect objects.

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11. Range of Hearing

Species	Hearing Range
Humans	20 Hz – 20,000 Hz
Dogs	Up to 45,000 Hz
Bats	Up to 100,000 Hz

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12. SONAR (Sound Navigation and Ranging)

- Uses **ultrasonic waves** to detect underwater objects.
- Principle: **Reflection of sound**
- **Formula**: Distance = (Speed × Time) / 2

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13. Structure of Human Ear

- **Outer Ear (Pinna)**: Collects sound
- **Auditory Canal**: Carries sound to eardrum
- **Eardrum**: Vibrates with sound
- **Middle Ear**: Three bones amplify sound
- **Inner Ear**: Converts vibration to electrical signals for the brain

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Important Formulas

1. **Speed of Sound**:

   $$\mathbf{V = f \times \lambda}$$

2. **Time Period**:

   $$\mathbf{T = 1/f}$$

3. **Echo Distance**:

   $$\mathbf{D = (v \times t) / 2}$$