Sound

These notes are your ultimate revision weapon to revise Sound . We've distilled years of previous exam questions (PYQs) into one powerful, concise resource. Everything you need to know, nothing you don't.

- **PYQs, Decoded:** All key concepts from past exams, organized and simplified.
- **Revise in Record Time:** Short, precise, and designed for last-minute review.
- **Focus on What Matters:** Master high-probability topics and boost your confidence.

Sound: Fundamental Principles

1. Nature of Sound Waves

- **Definition:** Sound is a mechanical wave that requires a material medium to travel.
- **Wave Types:**
    - In gases, liquids, and plasma: **Longitudinal waves**.
    - In solids: Can be both **longitudinal and transverse waves**.
- **Cannot Travel in a Vacuum:** It requires particles to vibrate. (e.g., sound cannot travel on the moon).

2. Characteristics of Sound

- **Pitch:** Determines how high or low a sound is.
    - **Depends solely on frequency.**
    - Higher frequency = Higher pitch.
    - *Fact Check:* A shorter flute (shorter air column) produces a **higher frequency**, not a lower one.
- **Loudness (Intensity):** Determines the volume of a sound.
    - **Depends on the amplitude** of the sound wave.
    - **Unit of Measurement:** Decibel (dB).

- **Quality (Timbre):** The characteristic that allows us to distinguish between the same note played on different instruments (e.g., a sitar vs. a flute), even when the pitch and loudness are the same.

3. Behavior of Sound Waves

- **When Changing Medium:**
  - **Frequency remains constant.**
  - **Speed and wavelength change.**
- **Reflection:**
  - **Echo:** A reflected sound heard separately from the original.
    - To hear a clear echo, the minimum distance to the reflecting surface is **~17 meters** (allowing a time gap of ~1/10th of a second).
  - **Reverberation:** The effect of multiple, fast sound reflections in an enclosed space (e.g., a church).
  - **Application:** Concert hall walls are designed to **absorb sound** to prevent echoes and reverberation for clarity.
- **Loudness decreases** as the sound travels away from the source due to energy spreading out.

Speed of Sound

1. Dependence on the Medium

- **General Rule:** Solid > Liquid > Gas.
- **Reason:** Depends on the elasticity and density of the medium.
- **Examples:**
  - **Gas (Slowest):** Nitrogen / Air ≈ **343 m/s** at 20°C.
  - **Liquid (Faster):** Seawater ≈ **1531 m/s**.
  - **Solid (Fastest):** Iron ≈ **5950 m/s**.
- **Order of Speed:** Nitrogen (Gas) < Water (Liquid) < Steel (Solid). Air < Water < Steel.
- **Comparison:** Speed is greater in aluminum than in glass. Faster through a steel rail than through air.

2. Dependence on Temperature

- The speed of sound **increases with an increase in temperature**.
- At higher altitudes (e.g., 15 km) where the temperature is lower, the speed **decreases**.

3. Measurement: Mach Number

- The **Mach Number** is the ratio of an object's speed to the speed of sound in the surrounding medium.
- **Mach 1** means the object is traveling at the **speed of sound** (supersonic).

Classification by Frequency

1. Audible Sound

- **Range: 20 Hz to 20,000 Hz** (the typical range of human hearing).

2. Ultrasonic Sound

- **Definition:** Sound with a frequency **greater than 20,000 Hz**. Humans cannot hear it.
- **Applications:**
  - **Medical:** Sonography/Ultrasonography (imaging internal body structures, monitoring pregnancy).
  - **Cleaning:** Ultrasonic cleaners (for clothes, objects).
  - **Detection & Ranging:** SONAR (detecting submarines, measuring sea depth), detecting aircraft, controlling automatic doors.
  - **Other:** Destroying insects.
- **Biological Use:** Bats use ultrasonic waves for **echolocation** (navigation and hunting).

3. Infrasonic Sound

- **Biological Example:** The vibration of the heart produces sound in the **infrasonic** range.

Sound Measurement and Impact

1. Sound Levels (Decibels - dB)

- **Comfortable Level: ~60 dB** (Optimum for humans).
- **Tolerable Limit: ~85 dB**.
- **Hazardous Pollution:** Sound above **80 dB** is considered hazardous noise pollution.
- **WHO Safe City Level: 45 dB**.
- **Common Examples:**
  - Rustling leaves: ~20 dB
  - Normal conversation: ~30-60 dB
  - Machine shop: ~100 dB

2. Environmental Impact

- Supersonic jets release nitrogen oxides at high altitudes, contributing to the **depletion of the ozone layer**.

Applications and Specific Contexts

1. Music

- **Musical Scale:** The **diatonic scale** consists of 8 notes (an octave).
- **Frequency Ratio:** The ratio between the first and last note (the octave) is **2:1**.
  - *Example:* If 'Sa' (C) = 256 Hz, the next 'Sa' (C1) = 512 Hz. The note 'Ni' (B) just before it is 480 Hz.

2. Medical Technology

- **Stethoscope:** Works through the **multiple reflections** of sound waves inside its tube.

3. Television Broadcast Technology

- **Analog TV:**
  - **Picture (Video):** Transmitted using **Amplitude Modulation (AM)**.
  - **Audio (Sound):** Transmitted using **Frequency Modulation (FM)**.
- **Modern TVs:** Audio and video start **simultaneously**.

4. Linguistics

- **Phonemes:** The basic, smallest units of sound in a language. They have no meaning themselves, but changing one can change the meaning of a word.

Know More About Sound:

- Sound – Old Year Questions
- Sound One Liner Questions & Answers