

KARACHI EDU COACHING CENTER

Unit 11: Sound Waves & Acoustics

Secondary School Physics (Class 10 – Sindh Textbook Board)

Production & Propagation

Characteristics

Ultrasound & Noise

Production of Sound



Vibrating Bodies

Sound is produced by vibrating sources such as tuning forks, vocal cords, or guitar strings.



Longitudinal Nature

Travels as a series of compressions (high pressure) and rarefactions (low pressure) through a medium.

Conditions for Sound Propagation

1. Vibrating Source

An initial mechanical disturbance or vibrating body to create energy.

2. Material Medium

Requires solid, liquid, or gas to transmit particle collisions. Cannot travel in a vacuum.

3. Receiver / Ear

A detector or human ear to receive and interpret the pressure variations.

Bell Jar Experiment (Vacuum Test)

Experimental Setup

An electric bell is placed inside an airtight glass bell jar connected to a vacuum pump.

As air is pumped out, the sound of the ringing bell gradually fades to silence, proving sound needs a medium.

Scientific Conclusion

Sound is a mechanical wave.

Without air molecules to pass compressions and rarefactions, energy transmission stops entirely.

Speed of Sound in Various Media

Medium State	Substance	Speed (v at 20°C)
Gases	Air	343 m/s
Liquids	Water	$1,482\text{ m/s}$
Solids	Iron / Steel	$\approx 5,130\text{ m/s}$

Characteristics of Sound

1. Loudness

Depends on amplitude. Larger amplitude means louder sound. Measured in decibels (dB).

2. Pitch

Depends on frequency. Higher frequency gives shriller/higher pitch (e.g., women vs. men voice).

3. Quality (Timbre)

Distinguishes between two sounds of same loudness and pitch due to waveform differences.

Reflection of Sound & Echo

Echo Formation

When sound is reflected from a distant hard obstacle, the returning sound is heard as an echo.

Minimum distance required in air for distinct echo is $\approx 17\text{ m}$ (persistence of human ear is 0.1 s).

Echo Calculation Formula

$$s = \frac{v \times t}{2}$$

Where s is distance to reflector, v is sound speed, and t is total time taken.

Audible Frequency Range

20 Hz – 20,000 Hz

Standard normal human ear audible frequency limits.

Frequency Classifications

- **Infrasound:** Below 20 Hz (Earthquakes, whales).
- **Audible:** 20 Hz to 20 kHz (Human speech & music).
- **Ultrasound:** Above 20 kHz (Medical imaging, sonar).

Ultrasound & Its Uses

Medical Imaging

Used in sonography to examine internal organs and developing fetuses safely without harmful radiation.

SONAR Navigation

Sound Navigation and Ranging used by ships to measure ocean depth and locate underwater obstacles or fish schools.

Industrial Flaw Detection

High-frequency ultrasonic waves detect cracks and hidden defects inside metal blocks and bridges.

Noise Pollution & Control

Health Hazards

- Hearing impairment & temporary/permanent deafness.
- Hypertension, anxiety, and sleep disorders.
- Communication interference and fatigue.

Control Measures

- Installing soundproofing and acoustic absorbers.
- Using silencers on vehicle exhausts and machinery.
- Planting trees along highways as natural barriers.

Unit 11 Complete

Master sound properties, echo calculations, audible frequency ranges, and noise pollution control for your board exams.

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