Al-Mustaqbal University

College of Engineering & Technology

Biomedical Engineering Department

Subject Name: Physics

1st Class, First Semester

Subject Code: [Insert Subject Code Here]

Academic Year: 2024-2025

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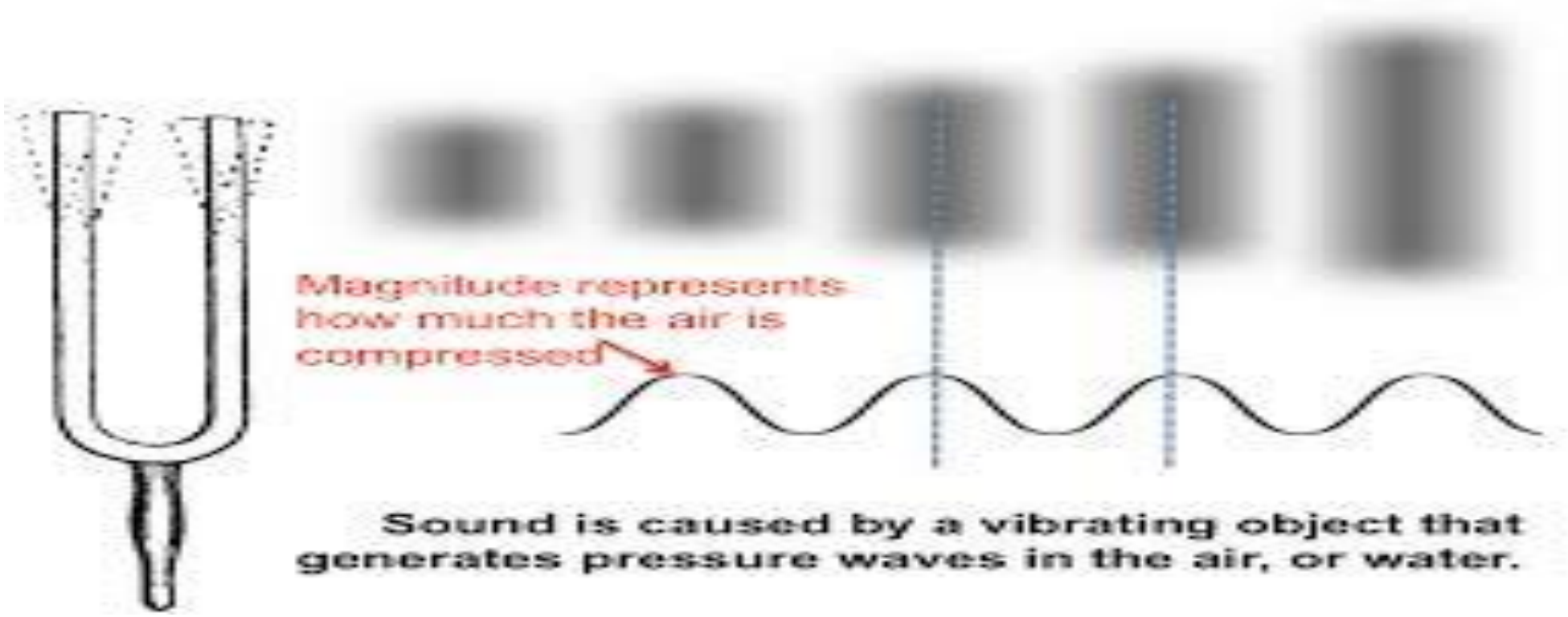
Lecture No.:-6

Lecture Title: [Sound]

Sound is a form of mechanical wave that propagates through a medium (such as air, water, or solids) by compressions and rarefactions. It is created by vibrating objects and requires a medium to travel, meaning it cannot propagate in a vacuum.



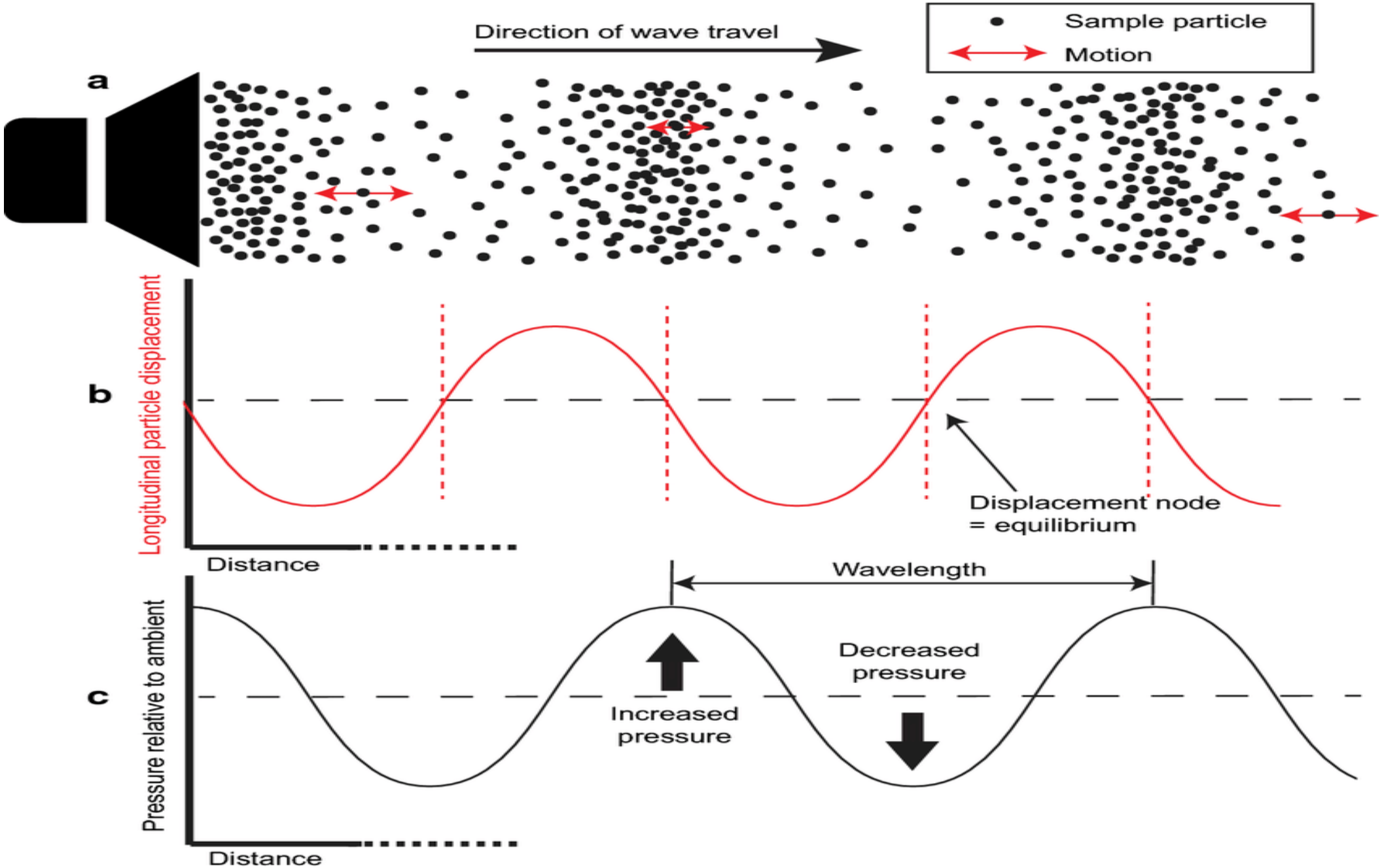
Properties of Sound Waves

1.Type of Wave:

1. Sound waves are **longitudinal waves**, meaning the particles in the medium move parallel to the direction of wave propagation.
2. In some cases, sound can exhibit transverse wave properties when traveling in solids.

2.Speed of Sound:

1. The speed of sound depends on the medium:
    1. **Air (at 20°C):** ≈ 343 m/s
    2. **Water:** ≈ 1500 m/s
    3. **Steel:** ≈ 5000 m/s
2. Sound travels fastest in **solids**, slower in **liquids**, and slowest in **gases** because of the difference in particle density and elasticity.


Direction of wave travel
Sample particle
Motion
a
b
Longitudinal particle displacement
Distance
Displacement node
= equilibrium
Wavelength
c
Pressure relative to ambient
Increased
pressure
Decreased
pressure
Distance

Frequency and Pitch:

- **Frequency (f)** is measured in **Hertz (Hz)** and determines the pitch of the sound.
- **Human hearing range:** 20 Hz – 20,000 Hz.
- **Infrasound:** Below 20 Hz (e.g., earthquakes, elephant communication).
- **Ultrasound:** Above 20 kHz (e.g., medical imaging, sonar).

Amplitude and Loudness:

- Amplitude is related to the **energy** of the sound wave and determines its **loudness**.
- Measured in **decibels (dB)**:
  - Whisper: ≈ 30 dB
  - Normal conversation: ≈ 60 dB
  - Jet engine: ≈ 120 dB (pain threshold).

Wavelength and Frequency Relation:

•The speed of sound (v) is related to its **frequency** (f) and **wavelength** (λ) by the equation: $v=f\lambda$

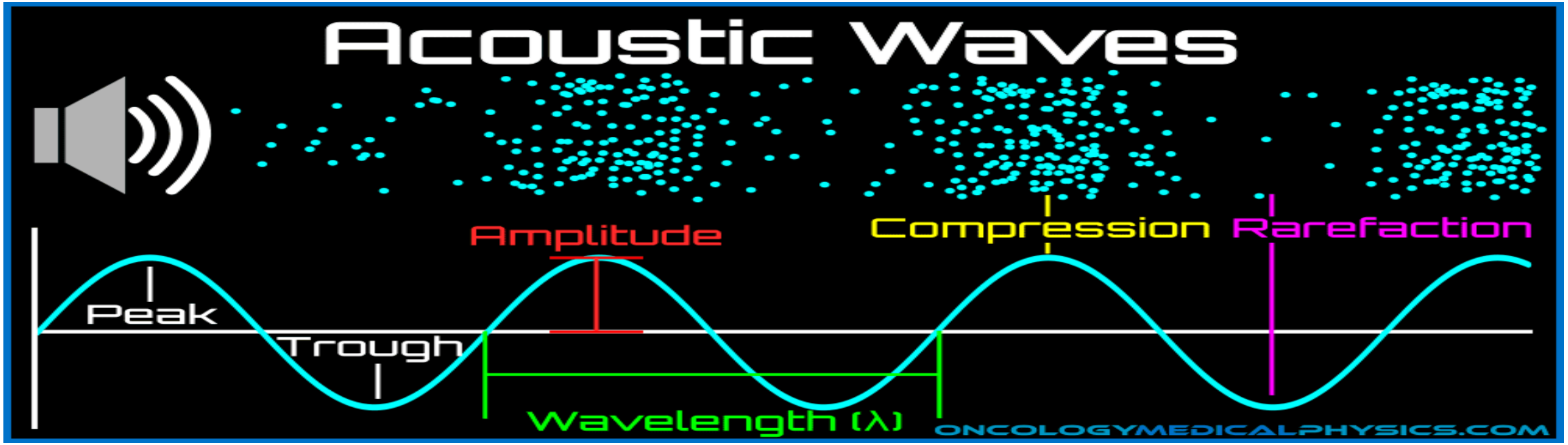
•Higher frequency = shorter wavelength, and vice versa.

Reflection, Refraction, and Diffraction:

•**Reflection:** Sound waves bounce off surfaces (e.g., echoes).

•**Refraction:** Sound bends when it passes through different media.

•**Diffraction:** Sound spreads out when passing through small openings.



1.Doppler Effect:

1. The change in frequency of a sound wave due to the motion of the source or observer.
2. Example: An ambulance siren sounds higher when approaching and lower when moving away.+

Applications of Sound in Physics

- **Medical Imaging (Ultrasound):** Uses high-frequency sound waves for diagnostic imaging.
- **Sonar:** Used in submarines to detect objects underwater.
- **Noise Cancellation:** Uses interference principles to reduce unwanted sound.
- **Musical Instruments:** Produce sound through vibrations of strings, air columns, or membranes.