AL-MUSTAQBAL UNIVERSITY
Babylon–Iraq

Department of Biomedical Engineering

- Subject : Physics
- Grade: 1th Class

- Lecture 7 : **Vibrations and Waves**
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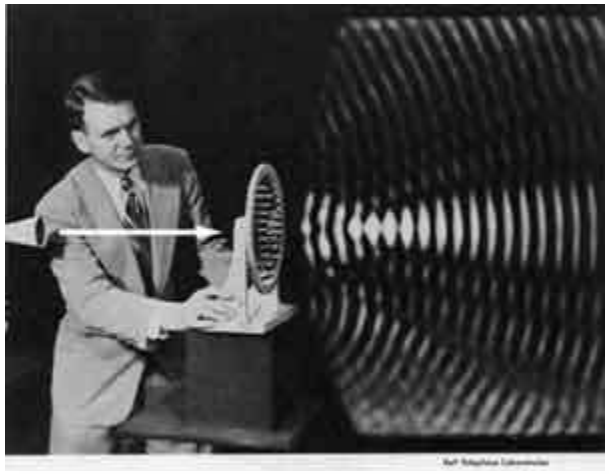
What is a wave

A **WAVE** is a vibration or disturbance in space.

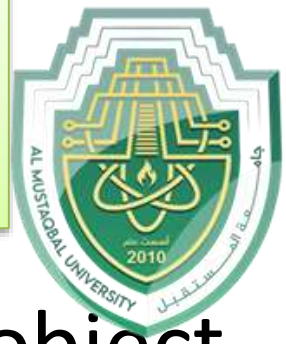


A **MEDIUM** is the substance that all SOUND WAVES travel through and need to have in order to move.

Key characteristic of these waves

- Energy (in the form of motion) can be transmitted by the wave
- The medium (the string, the air, the water) does not move at the speed of the wave—it essentially “stays put”
- The energy of the wave is transmitted through the medium from one piece of matter to another
- Note that light waves travel without the need for a medium at all!

Vibrations and Waves



- Most waves are caused by a vibrating object, which will then cause other objects to vibrate
- Vibrations will transfer energy from PE to KE.
- simple harmonic motion--vibration would continue forever
- Damped harmonic motion transfers the energy and the vibration will fade out.
- Ex. Shock absorbers on cars and bikes

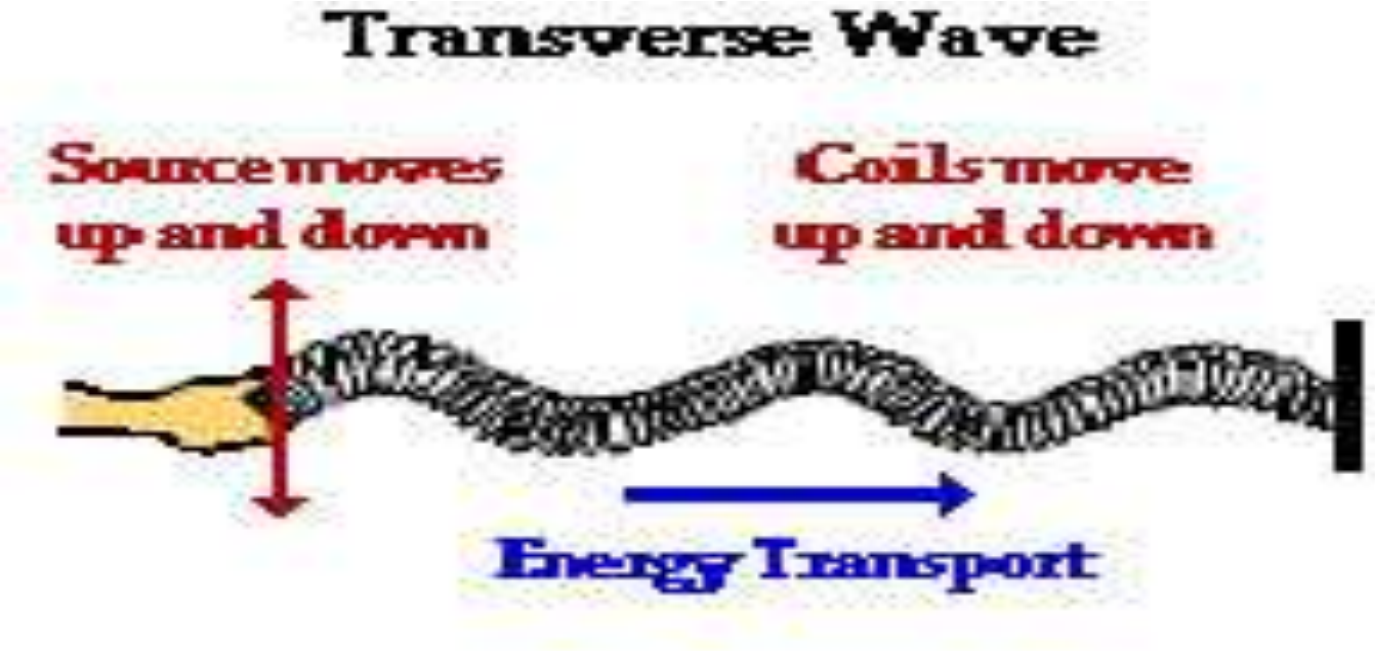
Wave Vibration Types

1. Transverse Waves

a wave that causes the particles of the medium to vibrate perpendicular to the direction of the wave.

"The Wave" at a stadium is a good illustration.

Ex. Light waves

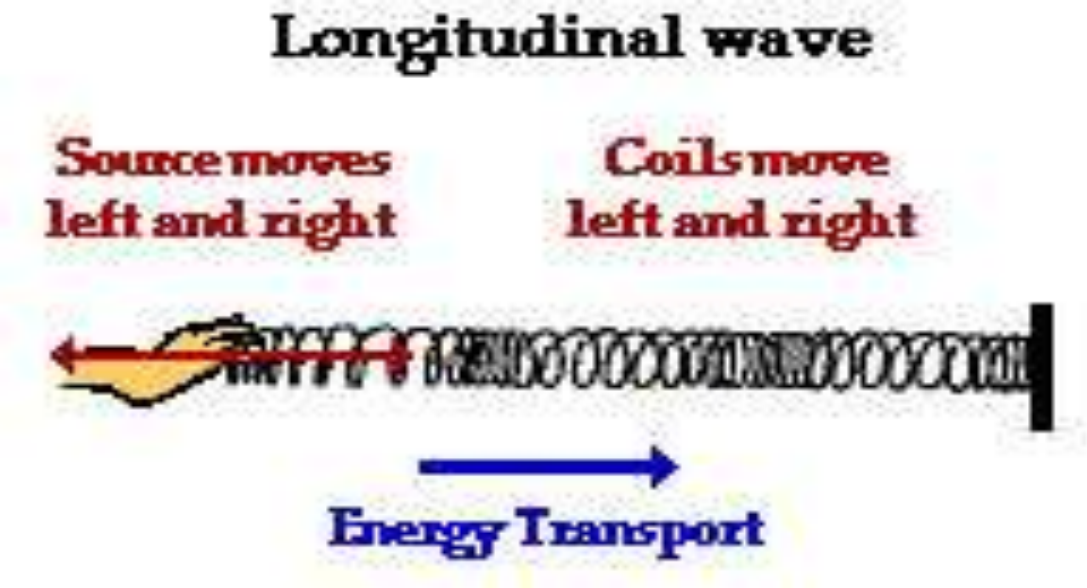


Wave Vibration Types

- **2. Longitudinal Waves**

-a wave that causes the particles of the medium to vibrate parallel to the direction of the wave.

- they expand and compress.
- Ex. Sound waves



Wave Vibration Types

- **3. Surface Waves**

-waves that are both transverse or longitudinal.

-Circular motion

-ex. Ocean waves

Wave Types

- Mechanical waves:

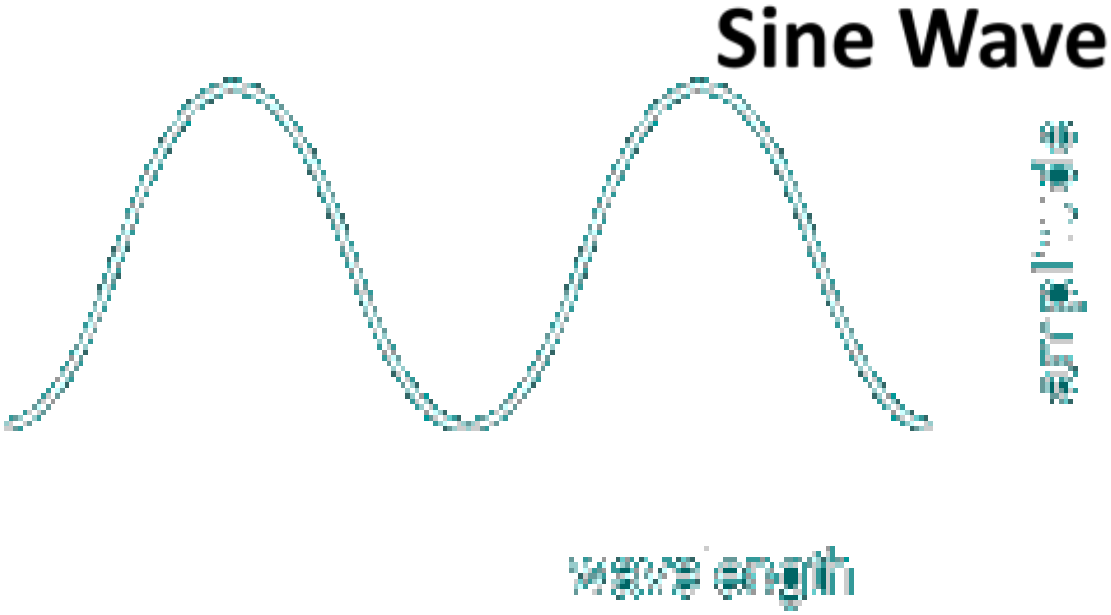
-can be transverse, longitudinal , or surface waves

- Electromagnetic (light):

-waves will only be transverse.

Wave Properties

- all transverse waves have similar shapes, no matter the size of the wave.
- The shape is called a sine curve or sine wave.



Wave Parts

- Amplitude

-The vertical distance that particles vibrate from their normal position when a wave passes

- measures the intensity of wave.

-ex.Loudness, brightness

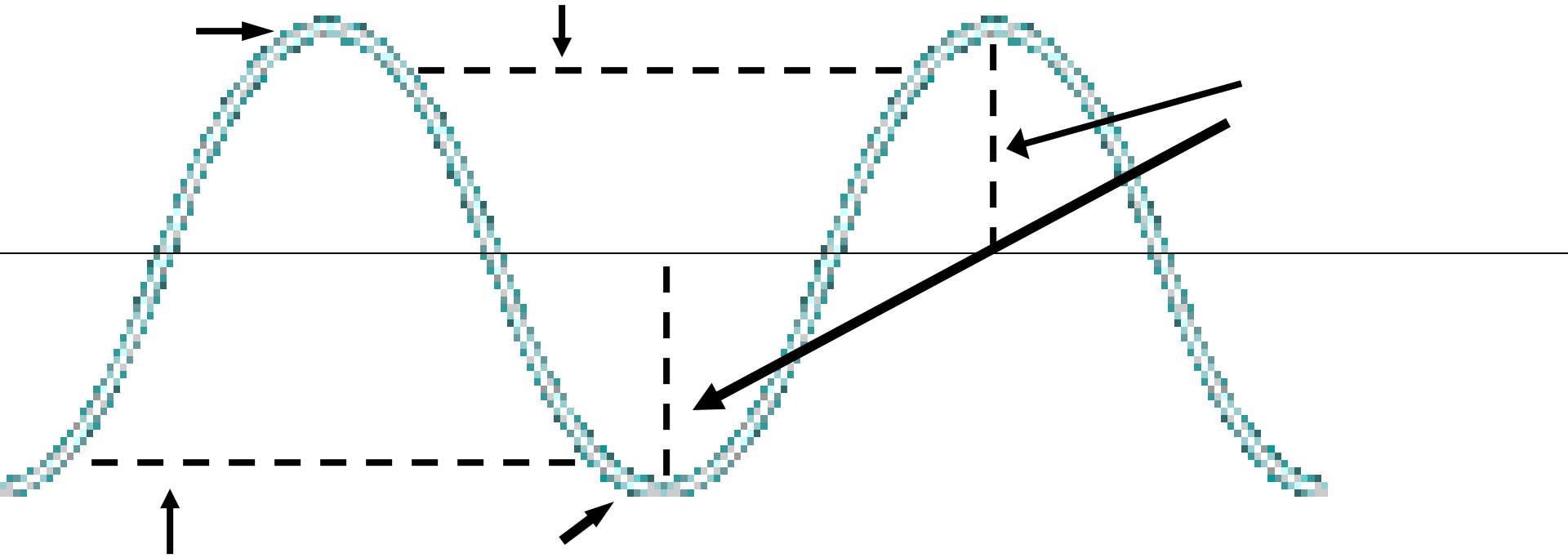
Wave Parts

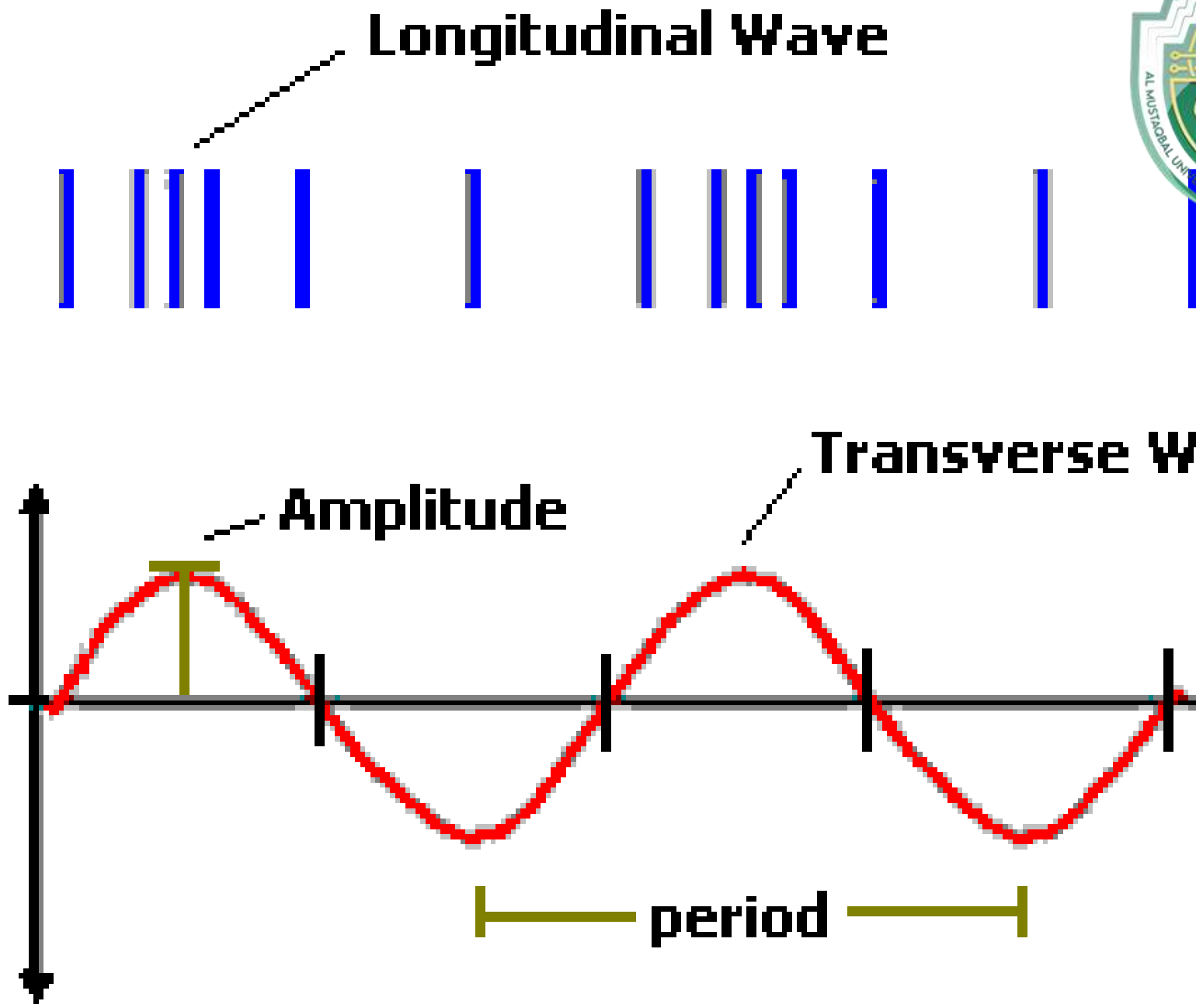
- Wavelength

-The distance between any two successive identical parts of a wave

- Represented by the symbol lambda (λ)
- Measured in a degree of meters

Wave Diagram




Longitudinal Wave
Transverse Wave
Amplitude
t
period

Wave Properties

- 1. Wavelength

-measures the size of the wave

2. Amplitude

-measures the intensity (strength) of the wave

Wave Properties

- 3. Frequency

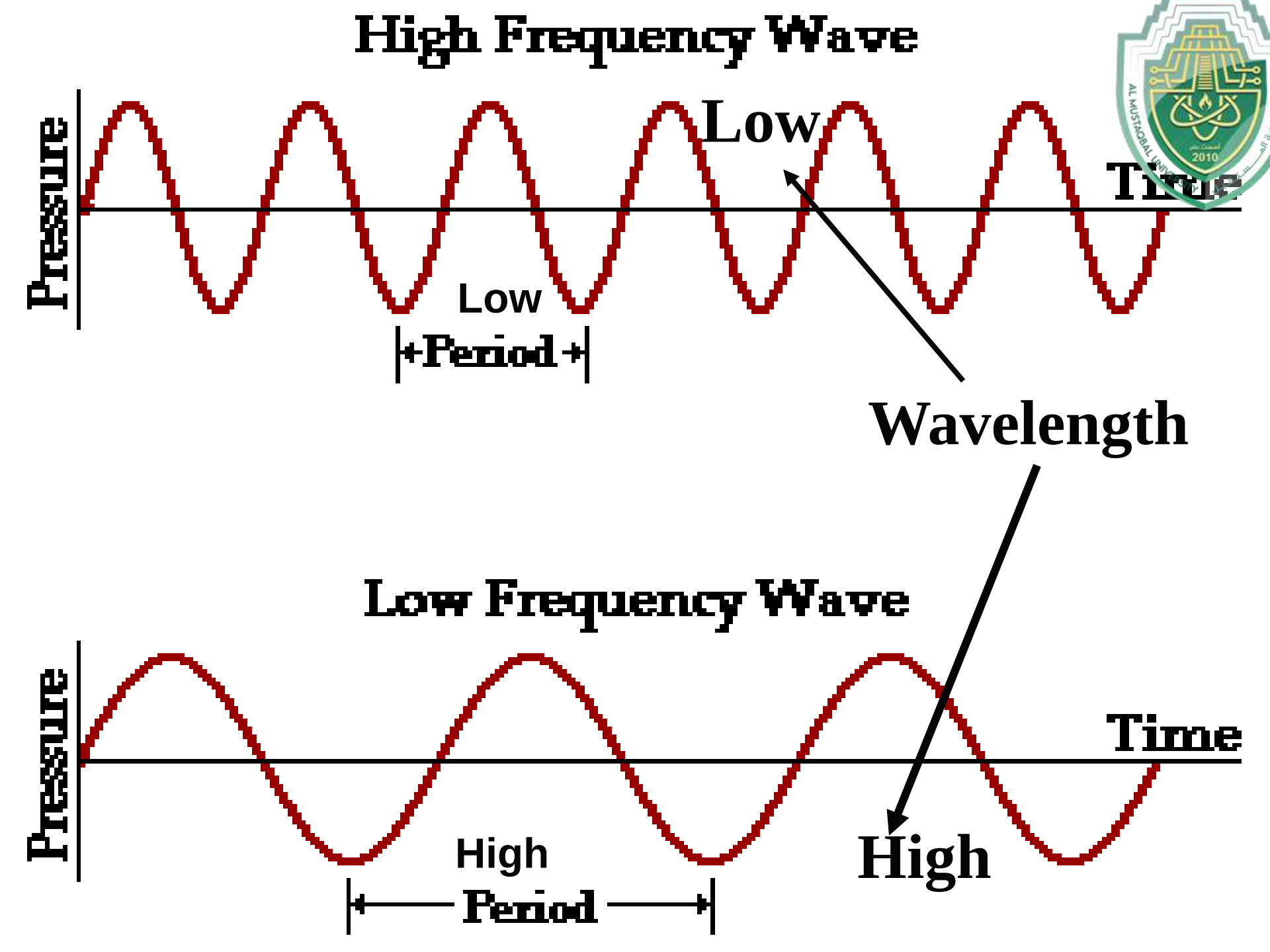
-the number of full wavelengths that pass a point in a particular period of time (rate)

-Represented by the symbol (ƒ)

-Measured in hertz (Hz) = beat/sec

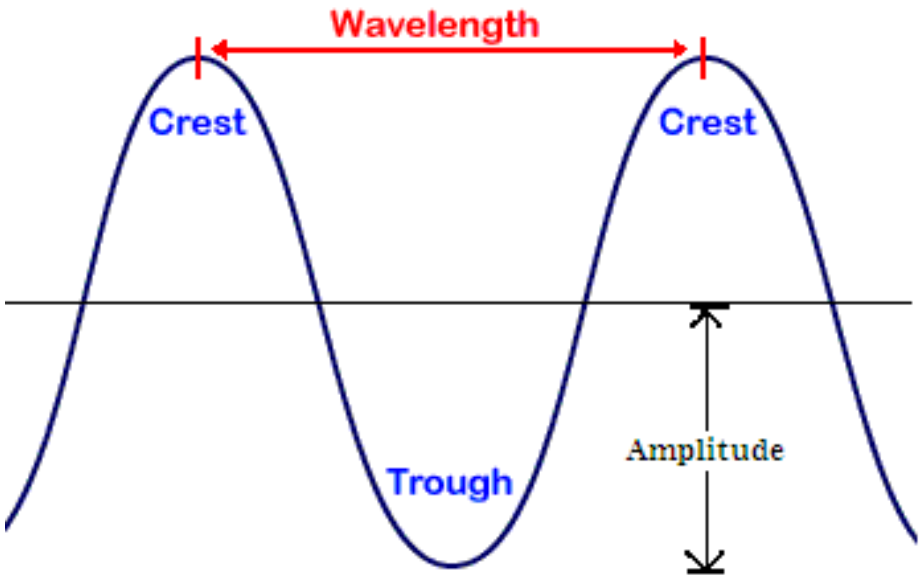
-Your radio dials are in megahertz

- 4. Period (time)
- -The time required for one full wavelength to pass a certain point
- -Represented by the symbol (T)
- -Measured in seconds


High Frequency Wave
Pressure
Low
Time
Low
Period
Wavelength
Low Frequency Wave
Pressure
Time
High
Period
High

Useful Definitions

- **Crest:** the highest point above the equilibrium position
- **Trough:** the lowest point below the equilibrium position
- **Wavelength λ** : the distance between two adjacent similar points of the wave



Speed of a Wave

- Speed of a wave= frequency x wavelength

$$v = f\lambda$$

Example Problem:

The piano string tuned to middle C vibrates with a frequency of 264 Hz. Assuming the speed of sound in air is 343 m/s, find the wavelength of the sound waves produced by the string.

$v = f\lambda$

$343\ m/s = (264\ Hz)(\lambda)$

$1.30\ m = \lambda$

Frequency, wavelength, and Period

- Wavelength and period will increase when frequency decreases.
- $\lambda \downarrow, T, \downarrow,$ then $f \uparrow$

Frequency and Period

- You can calculate frequency and period from each other
- $T=1/f$ or $f=1/T$

Example

The speed of sound waves in air is found to be 340 m/s. Determine the fundamental frequency (1st harmonic) of an open-end air column which has a length of 67.5 cm.

$$v = 2lf$$

$$340 = 2(0.675)\, f$$

$$f = \quad \textbf{251.85 HZ}$$

Examples

A string with a wavelength of 1.30 m and a period of 0.00379 s is played. What is the speed of the wave?

Examples

- $V = \lambda/T$
- speed=1.30 m/0.00379 s
- speed = 343 m/s

Examples

1- The reciprocal of the frequency of a periodic wave is the _____.

a) period b) wavelength

Answer:

a) period

2- A spring bounces up and down once every 2 seconds. What is its frequency?

a) 2 Hz b) 0.5 Hz

Answer:

b) 0.5 Hz

Examples

- **What is the frequency in vibrations per second of a 60-Hz wave?**
  Answer: 60 cycles per second
- **What is its period**?Answer: 1/60 second

Do You Have Any Questions?