WAVES & WAVE MOTION

Dr Muhammad Adeel

CONTENTS

- Waves & Type of Waves
- Properties of Wave

  (Frequency, Amplitude,Phase,Wavelength)
- Mathematical Representation of a Wave

Visualize this image and tell what happens?

Visualize this image too and tell what happens?


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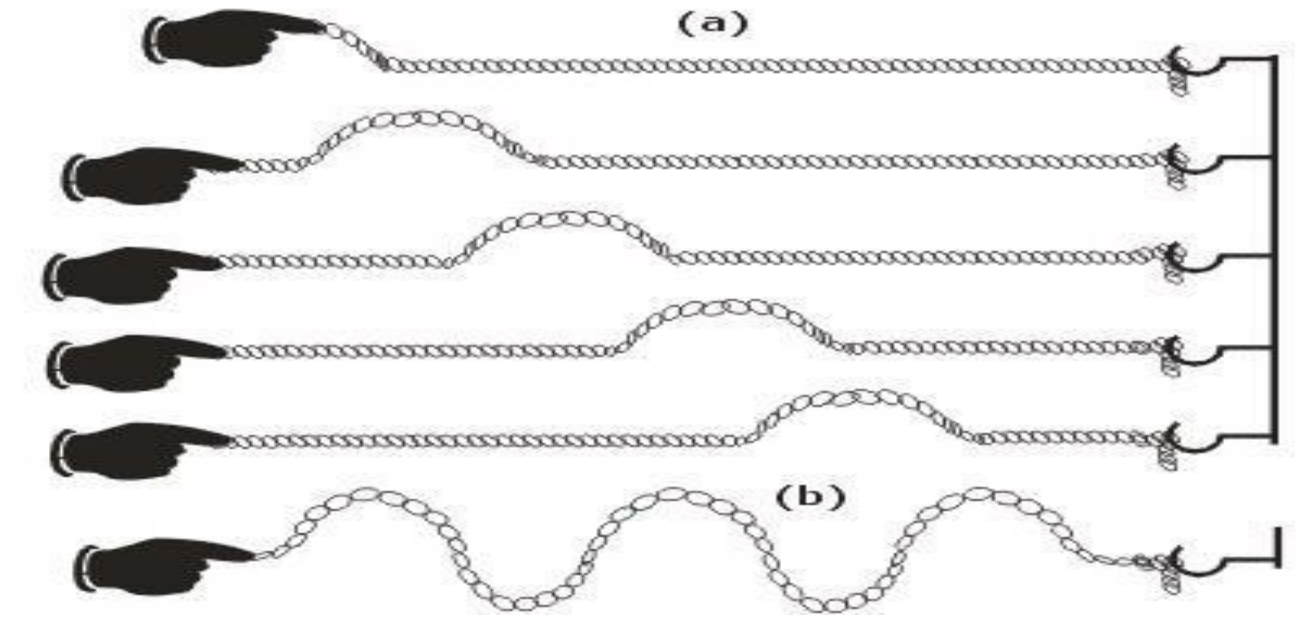
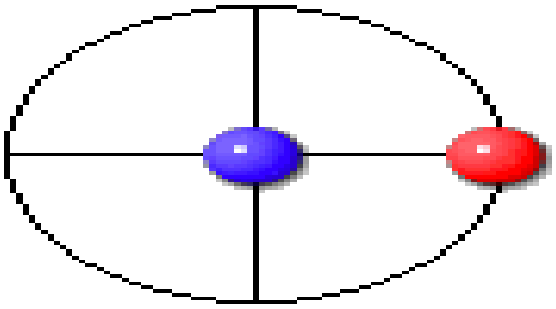
Q…What is a Wave?

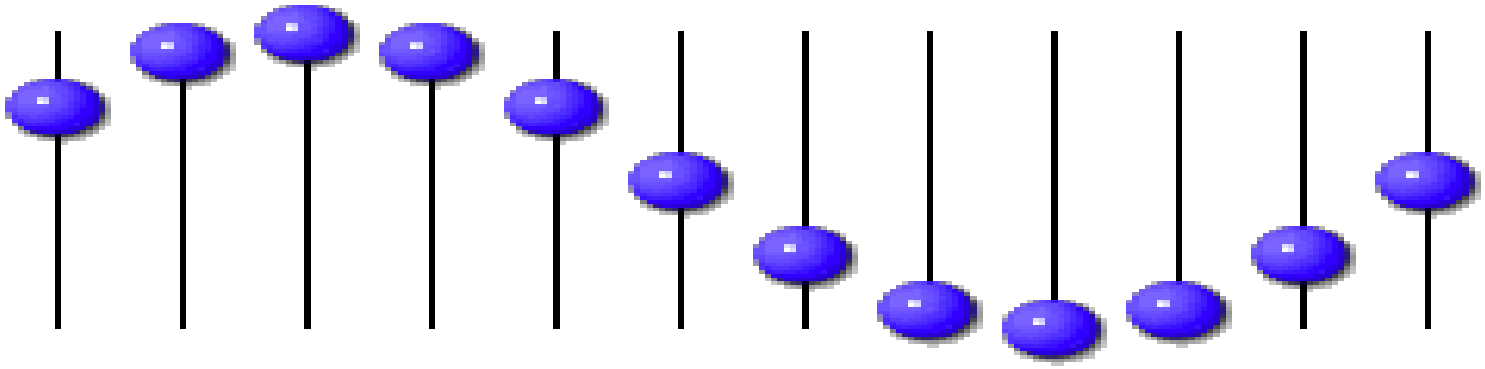
Ans…Wave is… pattern of motion of particles of the medium which transport disturbance without transporting the medium.



MOTION OF PARTICLES IN THE MEDIUM

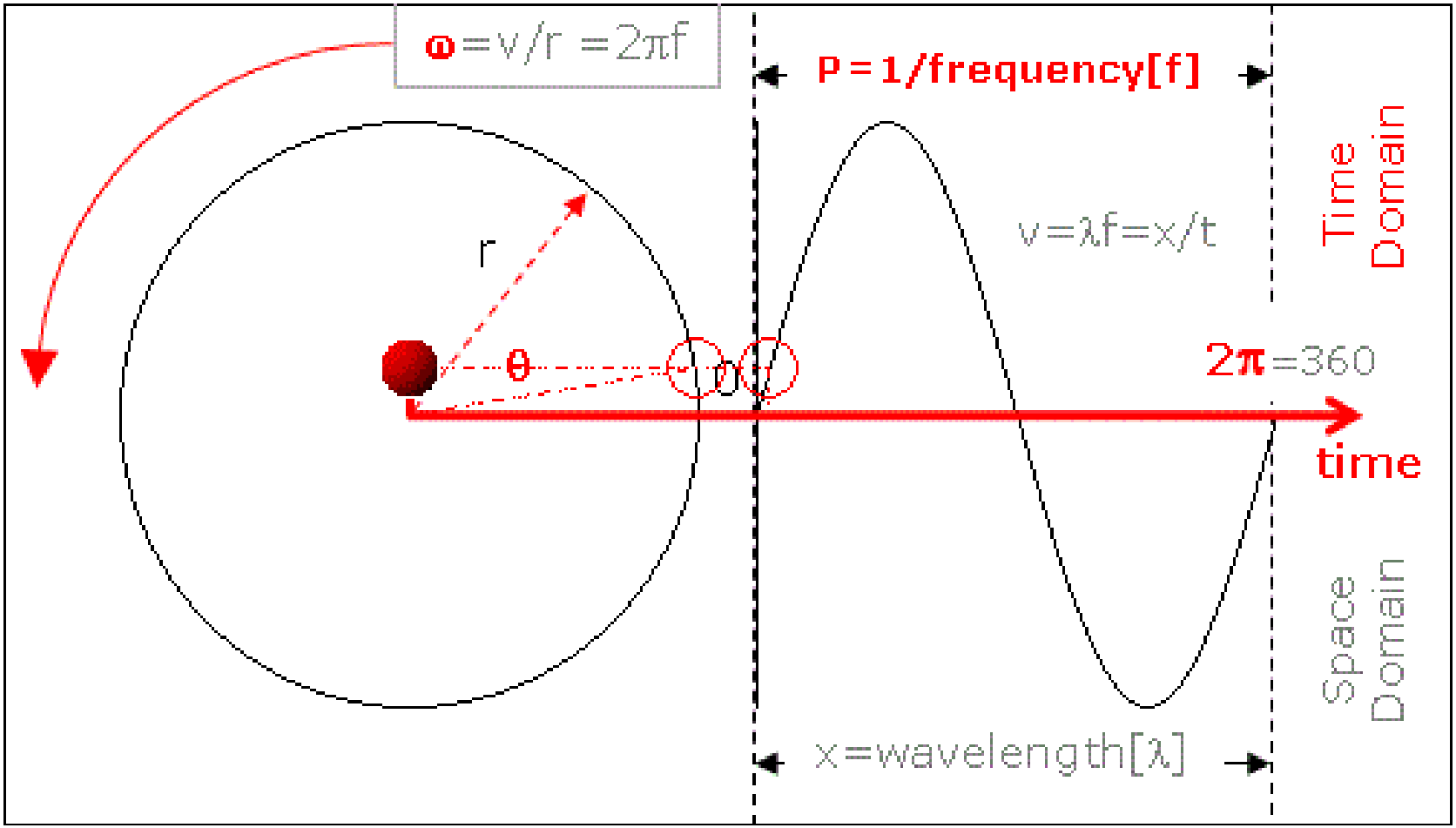


θ : angular distancement
ω : angular velocity
(angular frequency)
t : time
$\theta = \omega t$
$y(t) = \sin(\theta) = \sin(\omega t)$



It is a sinusoidal graph because particles oscillate according to the Sin

FORMATION OF SINUSOIDAL WAVE



TYPES OF WAVES

1. MECHANICAL WAVES
2. ELECTROMAGNETIC WAVES(EMW)
3. MATTER WAVES

MECHANICAL WAVES

- These waves are most familiar because we encounter

them almost constantly; common examples include water waves, sound waves, and seismic waves.

- All these waves have **two central features**:

1. They are governed by Newton's laws,
2. and they can exist only within a material medium,

Examples: water, air, and rock.

ELECTROMAGNETIC WAVES

- The disturbance of Electric and Magnetic Field is transported.
- These waves require no material medium.
- Examples include visible and ultraviolet light, radio and television waves, microwaves, x rays, and radar waves.
- All electromagnetic waves travel through a vacuum at speed c = 299 792 458 m/s.

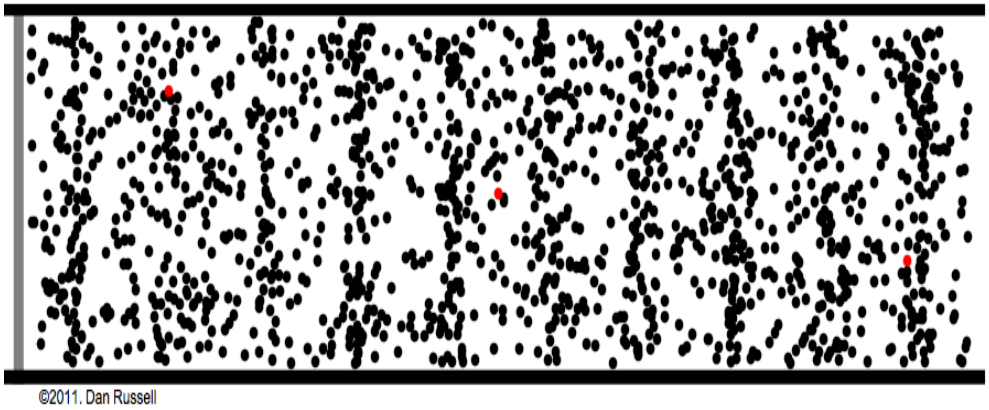
MATTER WAVES

- Although these waves are commonly used in modern technology, they are probably very unfamiliar to you.
- These waves are associated with electrons, protons, and other fundamental particles, and even atoms and molecules. Because we commonly think of these particles as constituting matter, such waves are called matter waves.(study in modern physics)

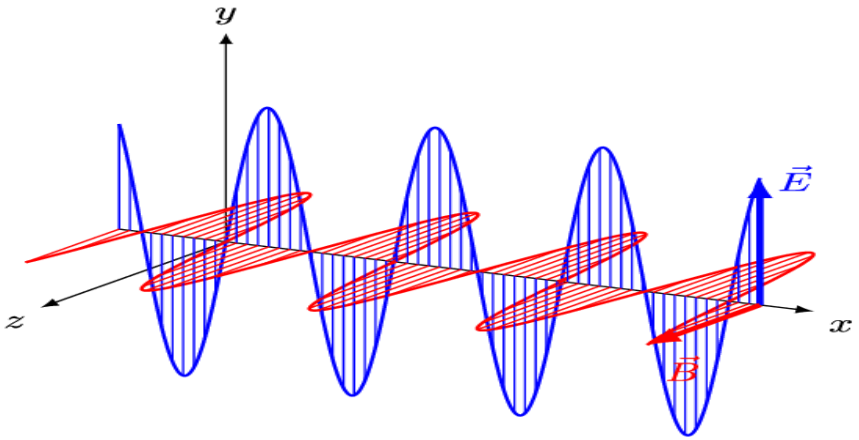
CLASSIFICATION OF WAVES

On the basis of Medium

Mechanical waves: require medium to travel



Electromagnetic waves:
do not require medium to travel.
Travel in free space

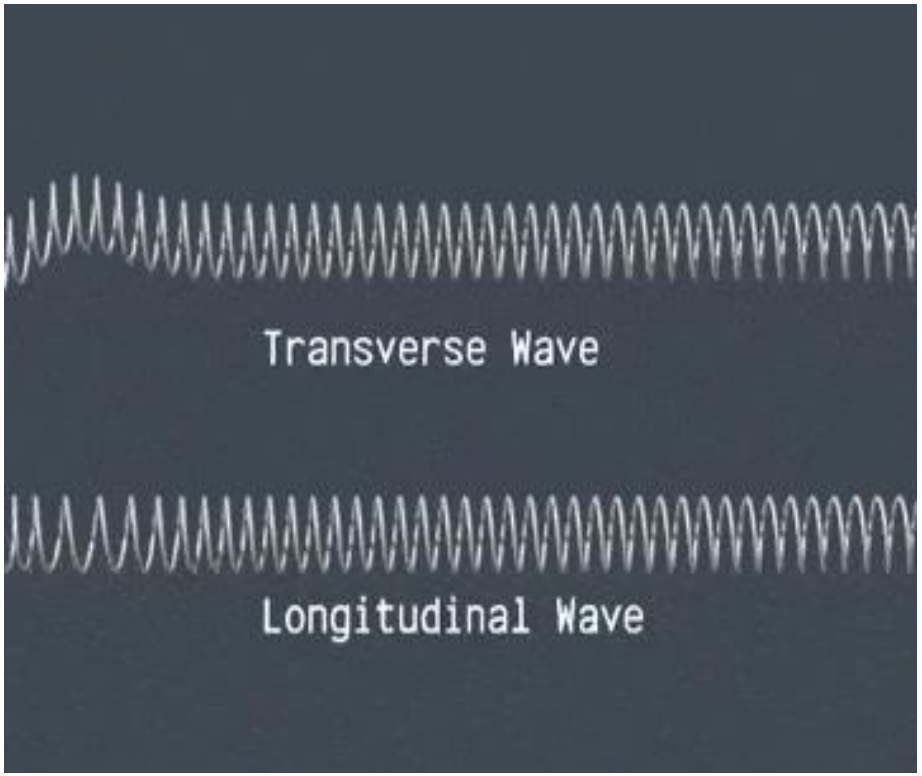


Classification of Waves

On the basis of vibration of particles

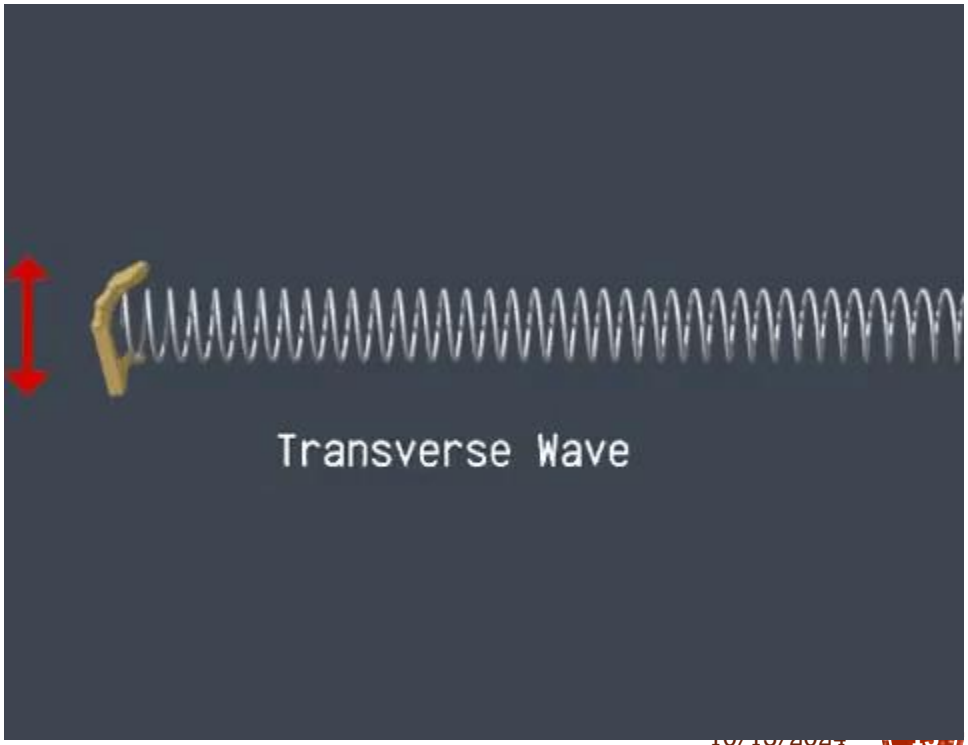
(in material/mechanical wave)

- Transverse Waves
- Longitudinal Waves



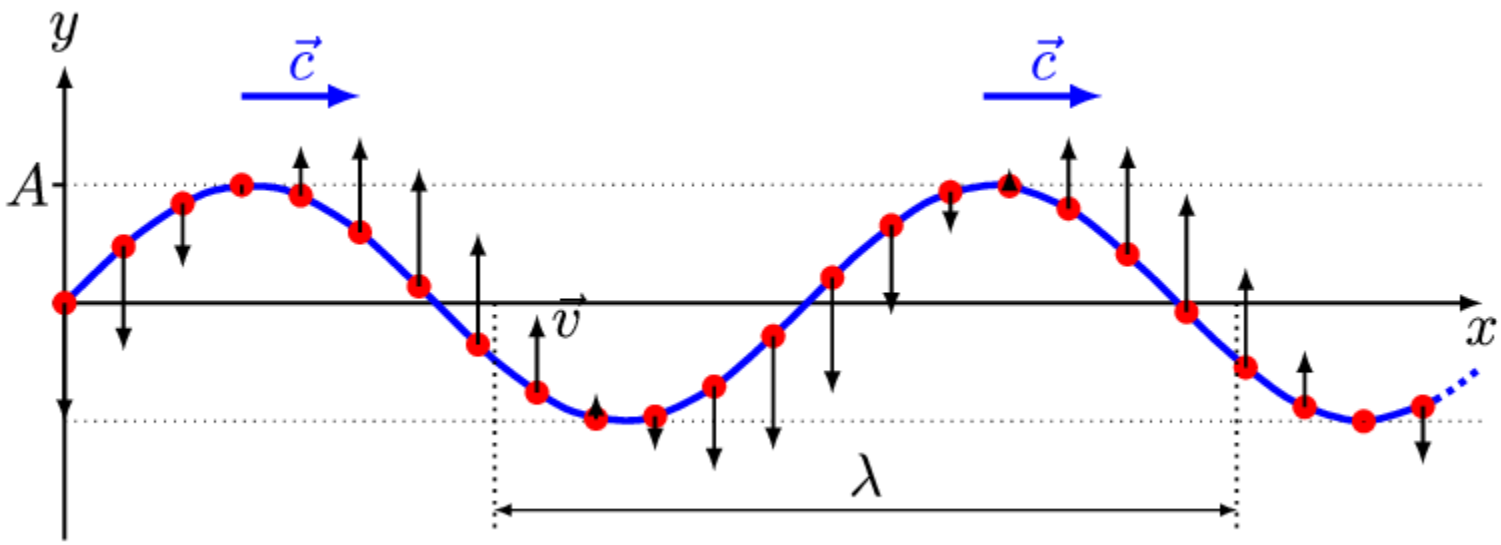
TRANSVERSE WAVES

- The waves in which particles of the medium vibrates perpendicular to the direction of propagation of wave are said to be transverse waves.
- It travels in the form of crest and trough.



Transverse Waves

Transverse waves vibrate at right angles to the direction of travel of the wave.



Light and radio waves are transverse waves.

TRANSVERSE WAVES(TW) …CONT'D

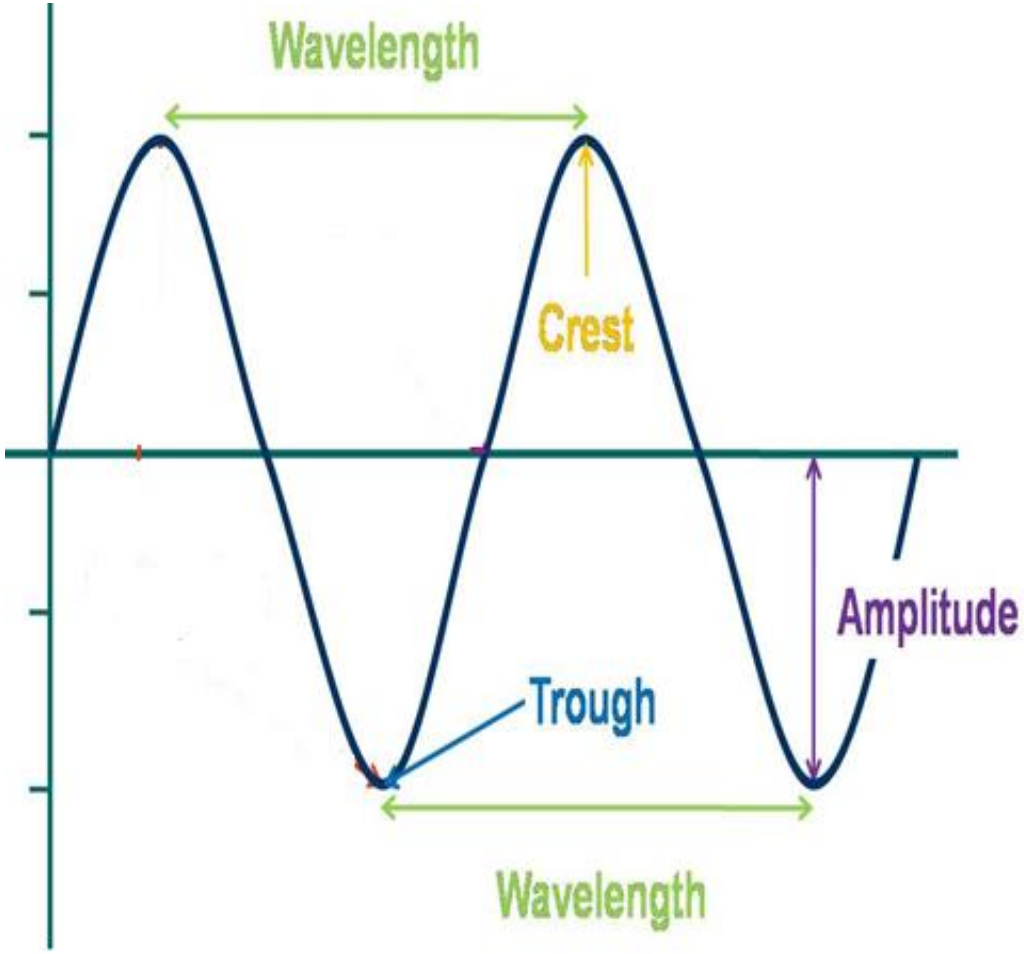
Limitation for the propagation of TW:

- It transmits **only** in the medium having **rigidity** , means in solid and on the surface of liquids **except gases.**

- There is **no effect** on Temperature and Pressure of the Medium while the transverse waves is being processed on it(medium).

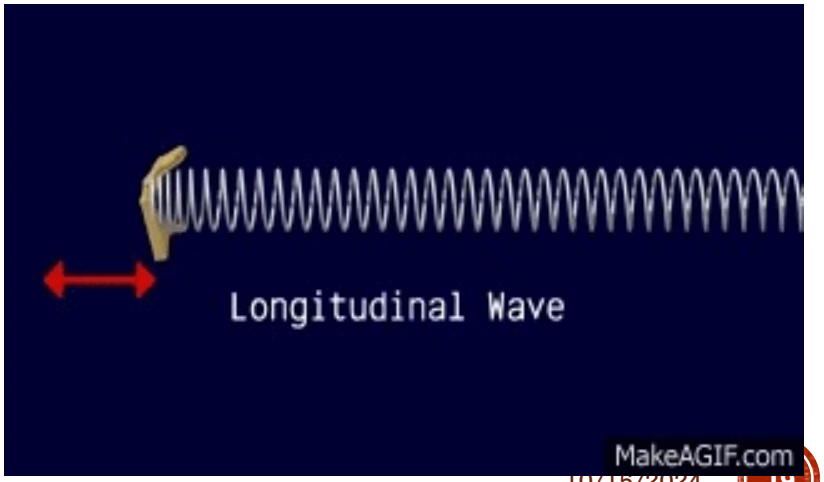
PARAMETERS OF TW

- Amplitude (~A)
- Frequency($\nu_{(neu)}$)
- Time Period(~ T)
- Wavelength(λ)
- Crest & Trough



LONGITUDINAL WAVES

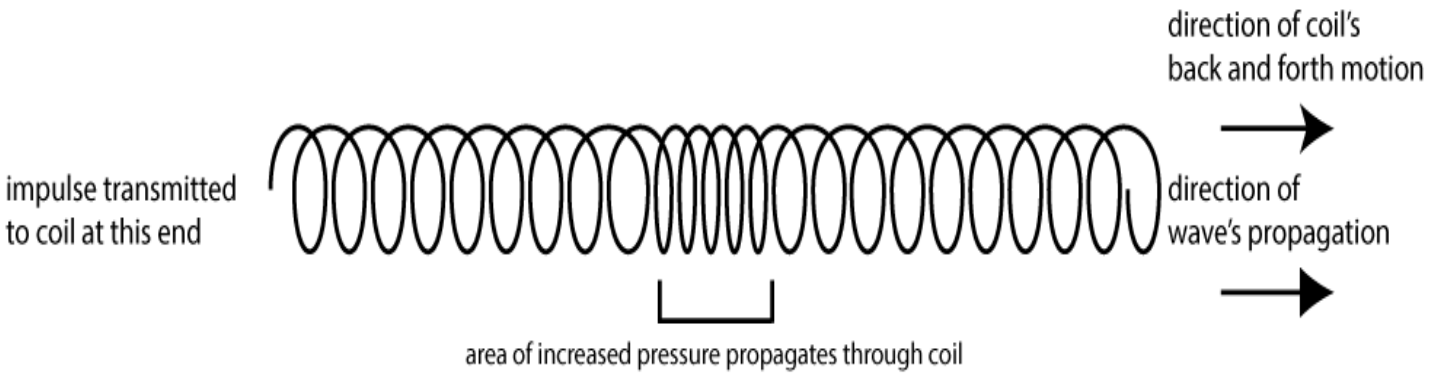
- Waves in which particles of the medium vibrates in the same direction of propagation of the wave are said to be longitudinal waves.
- It travels in the form of compression and rarefaction.



LONGITUDINAL WAVES (LW) …CONT'D

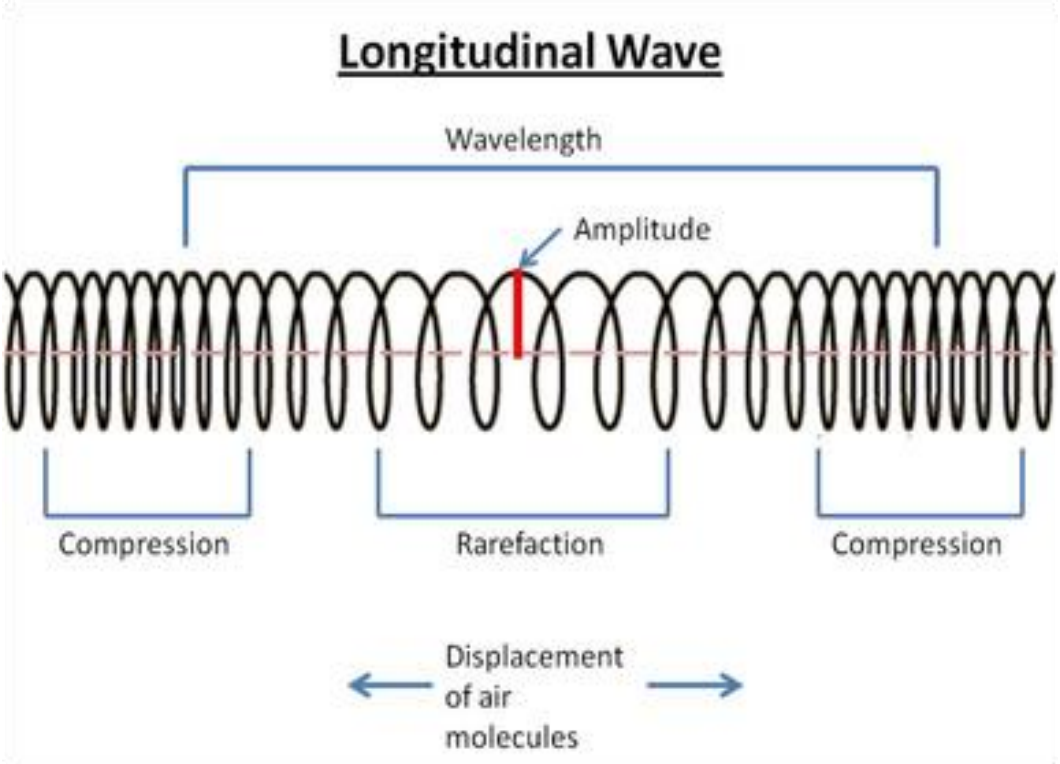
Limitation for the propagation of LW:

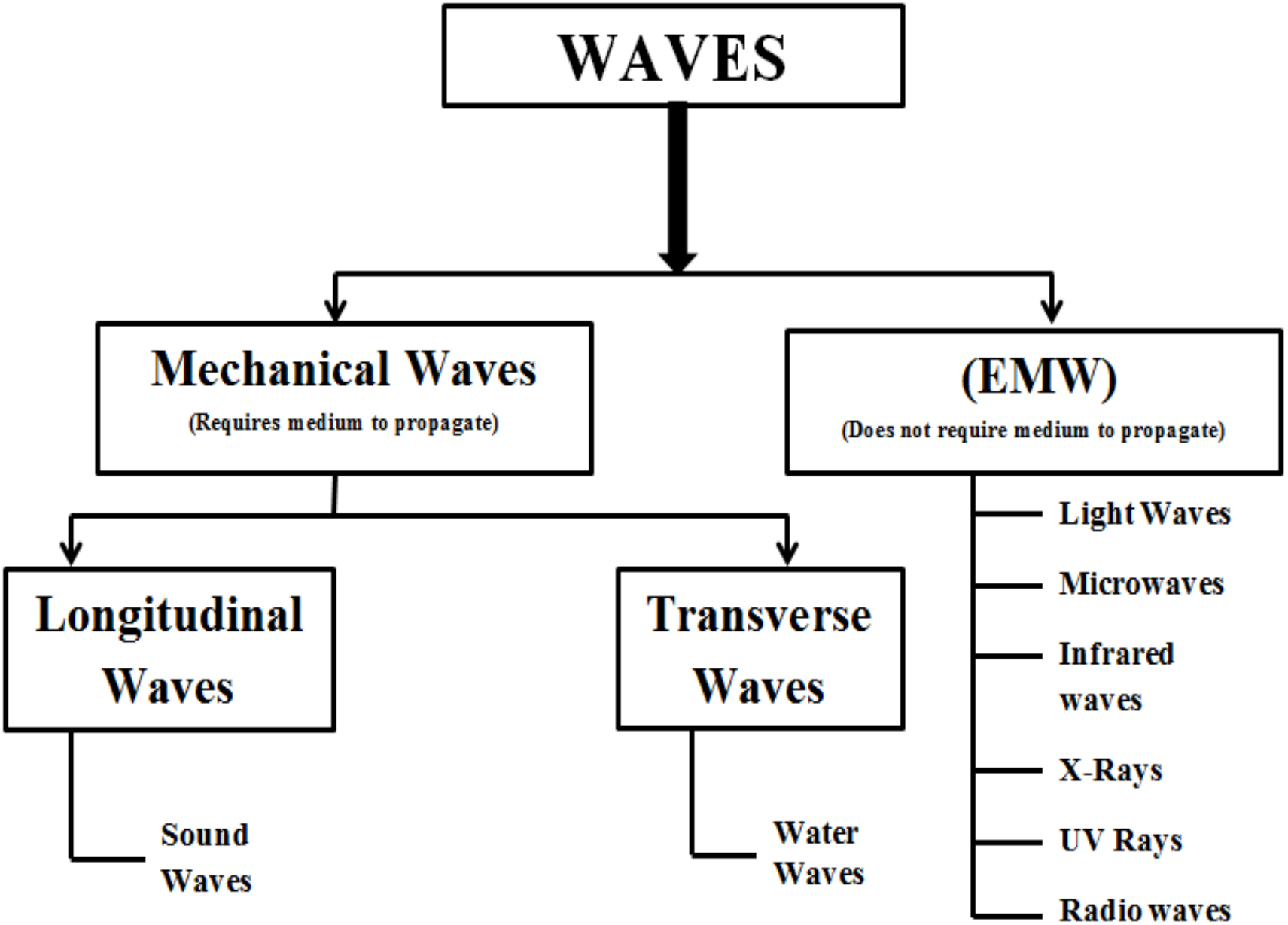
- It travels in all types of medium i.e, solid, liquid and gases.
- Temperature and Pressure of the Medium rises when the longitudinal waves is being processed on it.



PARAMETERS OF LW

- Amplitude (~A)
- Frequency(~$\nu_{(neu)}$)
- Time Period(~ T)
- Wavelength(~λ)
- Compression & Rarefaction

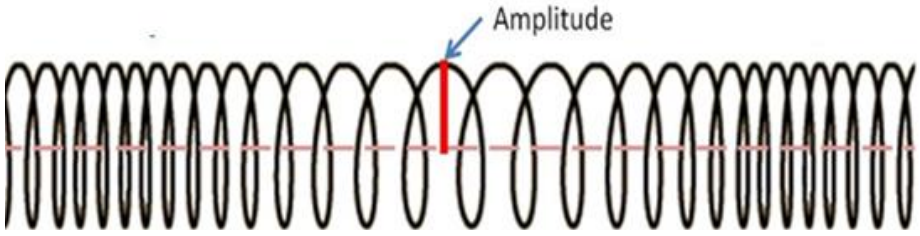



WAVES
Mechanical Waves
(Requires medium to propagate)
(EMW)
(Does not require medium to propagate)
Longitudinal Waves
Transverse Waves
Sound Waves
Water Waves
Light Waves
Microwaves
Infrared waves
X-Rays
UV Rays
Radio waves

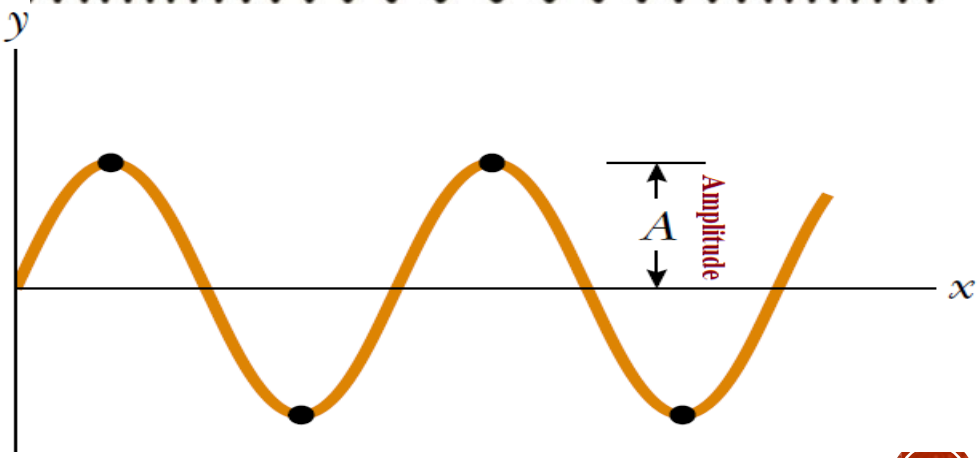
AMPLITUDE (A)

- The maximum displacement from equilibrium of an element of the medium is called the amplitude *A of the wave.*
- Larger amplitude more energ

In case of Longitudinal Wave



In case of Transverse Wave



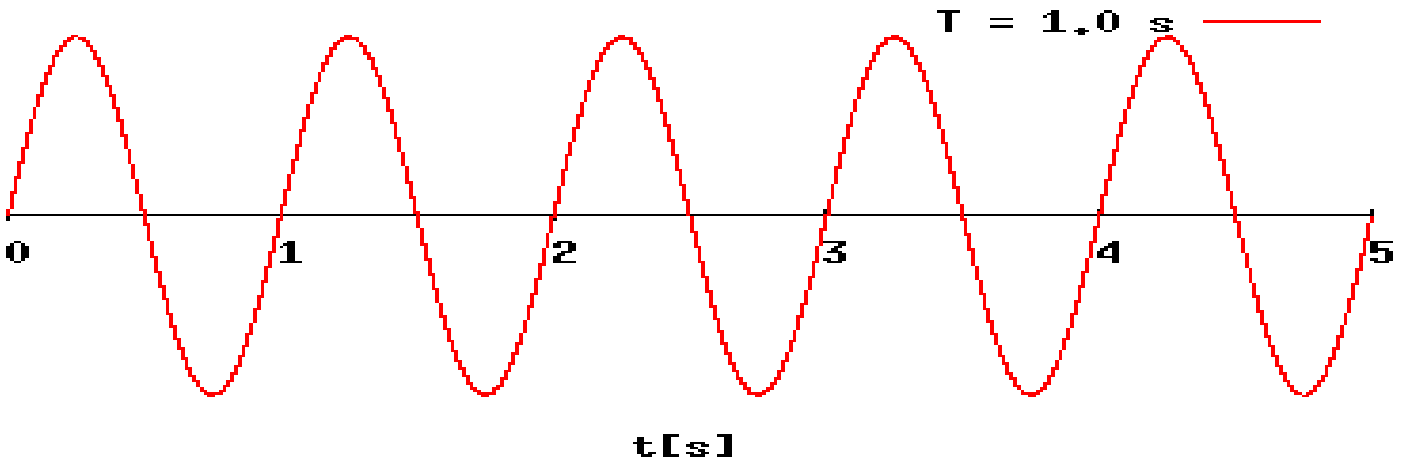
TIME PERIOD (T) & FREQUENCY : $\nu_{(neu)}$

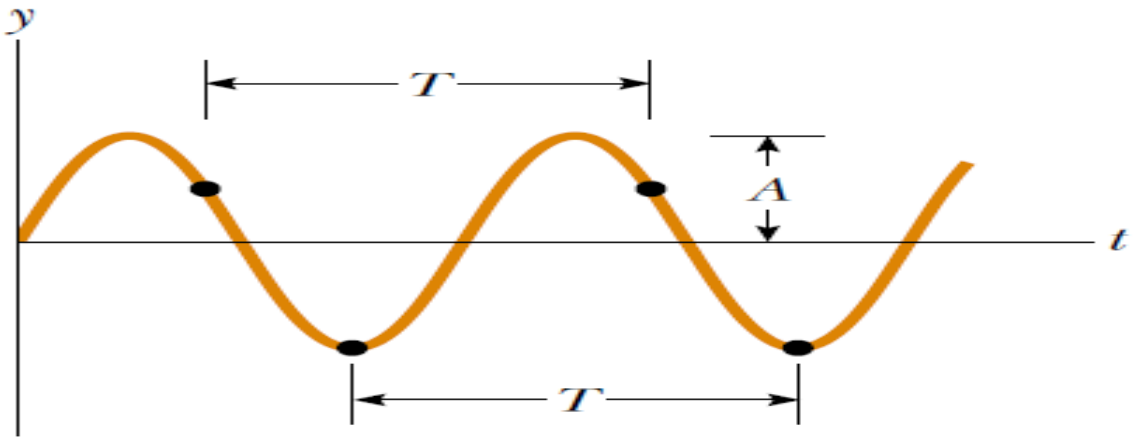
- **The period** is the time interval required for two identical points (such as the crests) of adjacent waves to pass by a point.
- The period of the wave is the same as the period of the simple harmonic oscillation of one element of the medium.
- The **inverse** of the **period**, is called the **frequency *f.***
- In general, the frequency of a periodic wave is the number

  of crests (or troughs, or any other point on the wave) that pass a given point in a unit time interval.

$$f = 1/T \text{ (hertz)}$$

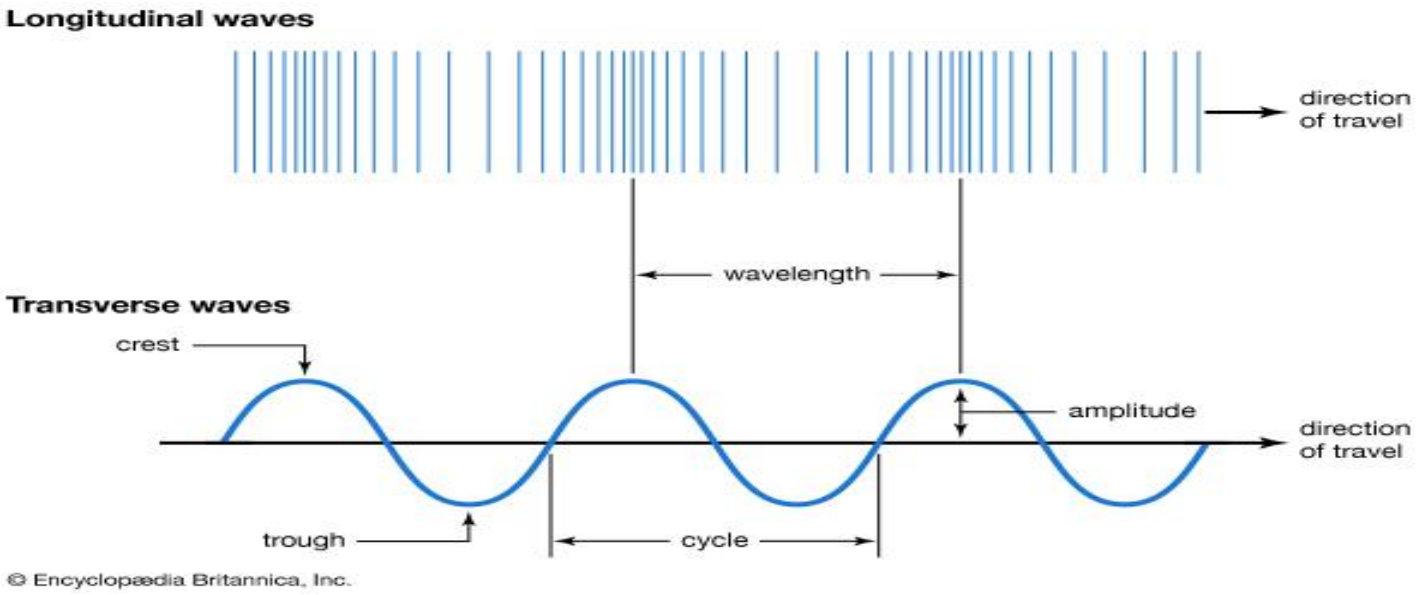
VISUAL CONCEPT OF TIME PERIOD & FREQUENCY





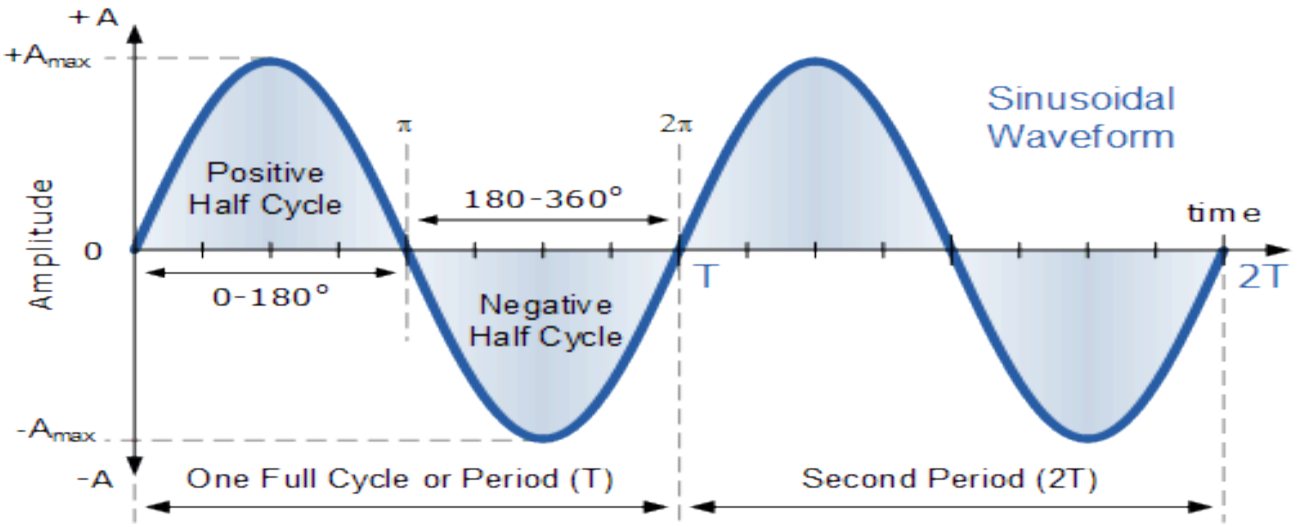
WAVE LENGTH (λ)

- (In terms of TW)**The wavelength** is the minimum distance between any two identical points (such as the crests) on adjacent waves.
- (In terms of LW) **The Wavelength** is the minimum distance between any two identical points (such as the compressions) on adjacent waves.



PHASE OF WAVEFORM

- **Phase** is the position of a point in time (an instant) on a waveform cycle. A complete cycle is defined as the interval required for the waveform to return to its arbitrary initial value.
- The graph below shows how one cycle constitutes 360° of phase.



COMPARISON OF LW & TW

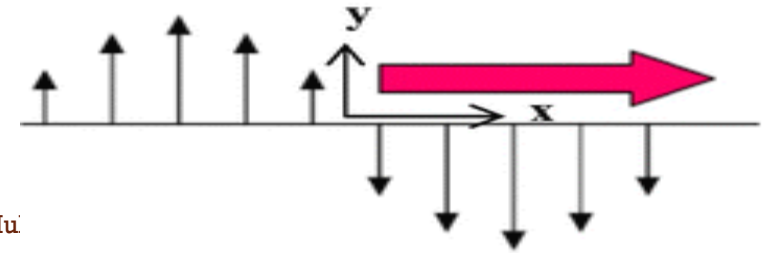
Transverse Waves

- Travels perpendicular to direction of propagation.
- Travels in the form of crests and troughs.
- It does not effect medium's temperature and pressure.
- Travels through only in solid and surface of liquids except gases.

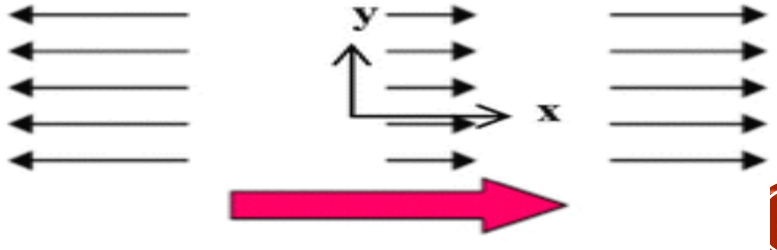
Longitudinal Waves

- Travels parallel to direction of propagation.
- Travels in the form of compression and rarefactions.
- Temperature and pressure rises in its propagation.
- Travels through all type of medium except plasma.

Transverse wave

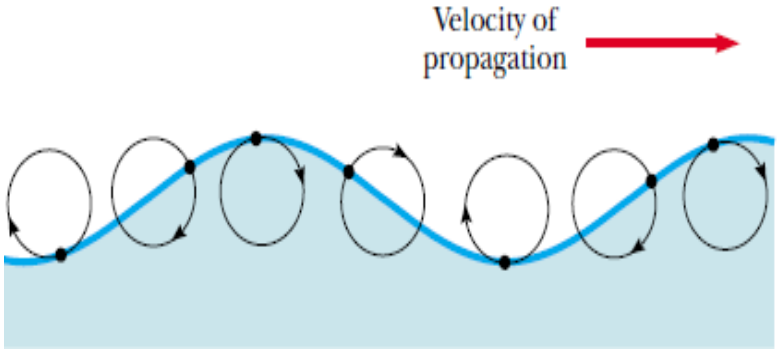


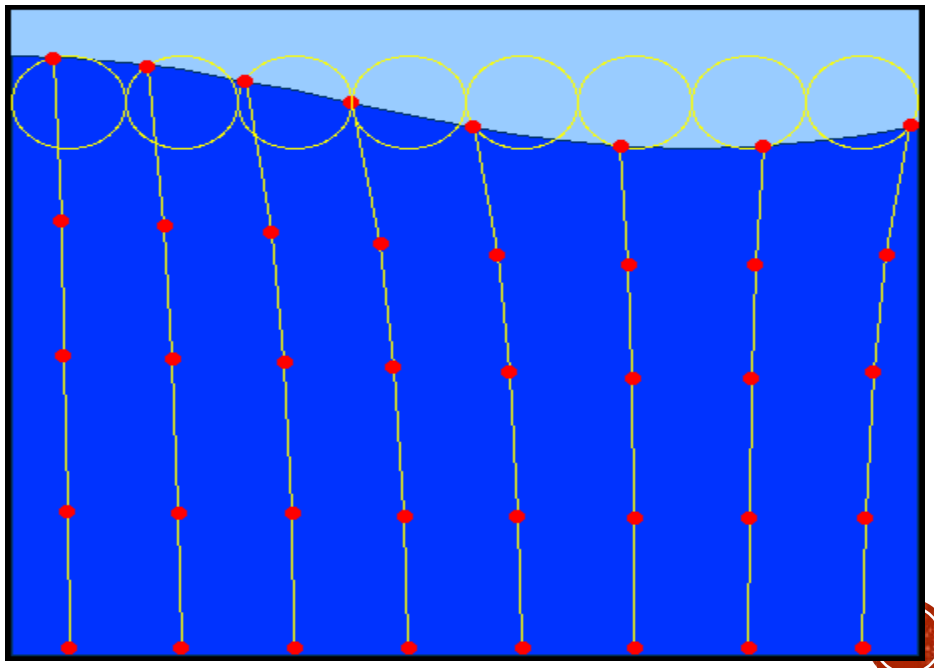
Longitudinal wave



COMBINATION OF TRANSVERSE AND LONGITUDINAL WAVES

- Some waves in nature exhibit a combination of transverse and longitudinal displacements.(eg.Sound Waves in water)
- Surface water waves are a good example.
- Note that in this disturbance has both transverse and longitudinal waves.





Question :

Think of some other examples in nature in which they exhibit both the features (TW & LW) at a time.

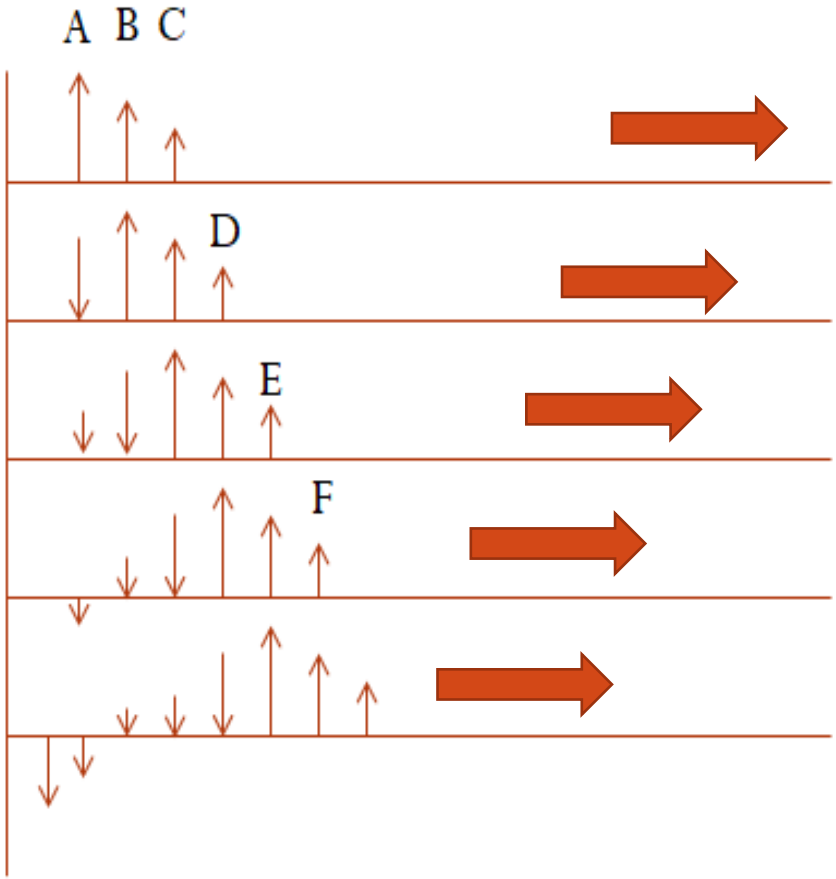
FORMATION OF WAVE

- In order to have a wave, our medium should have two properties

1. Elasticity
2. Inertia(measure of mass)

Or

we can say that …..for oscillation our particle should have inertia and elasticity.



BRAINSTORMING

- Can you tell what is the direction of wave?

  Ans: Left to right

  (Watch the movement of crest)

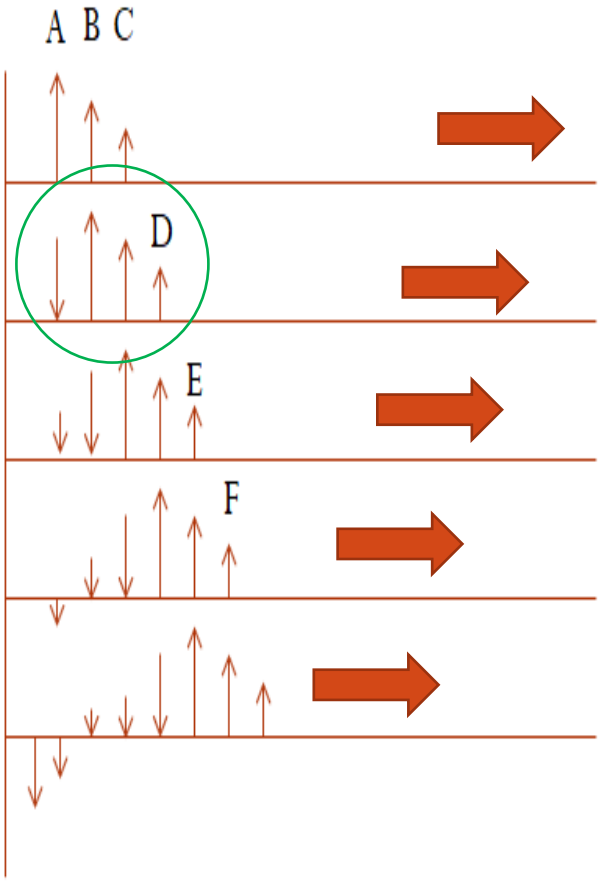
- Which particle has the maximum phase? B,C or A

  Ans: **A** has the maximum phase.

- To which size of phase is wave travelling?

  Ans: Wave moves towards minimum

  phase forming particle i.e, C.



EFFECT OF TRAVELLING WAVE ON PARTICLE