



Engineering Physics

(BPHY101L)

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Contents

- Waves on a string
- Wave equation on a string (Derivation)
- Harmonic waves
- Reflection and transmission of waves at a boundary
- Standing waves and their Eigen frequencies
- Waves with dispersion
- Superposition of waves and Fourier method (qualitative)
wave packet
- phase velocity and group velocity



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Waves

Definition, Behavior, and Classification



What's the underlying theme?



What is a wave?

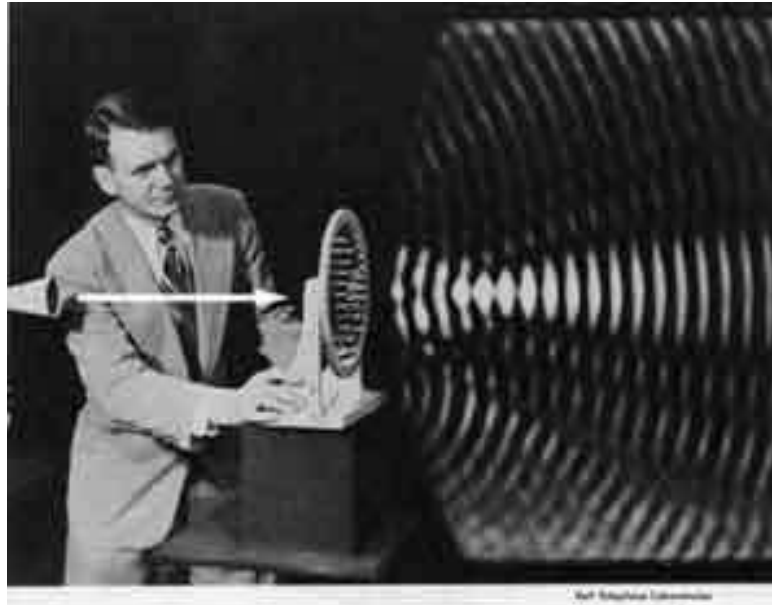
- **WAVE** - a vibration or disturbance in space.



- Waves *transfer energy* without transferring matter



Waves are classified by **WHAT** they move through or by **HOW** particles move through them.



MEDIUM-

The substance that waves travel through and need to have in order to move.

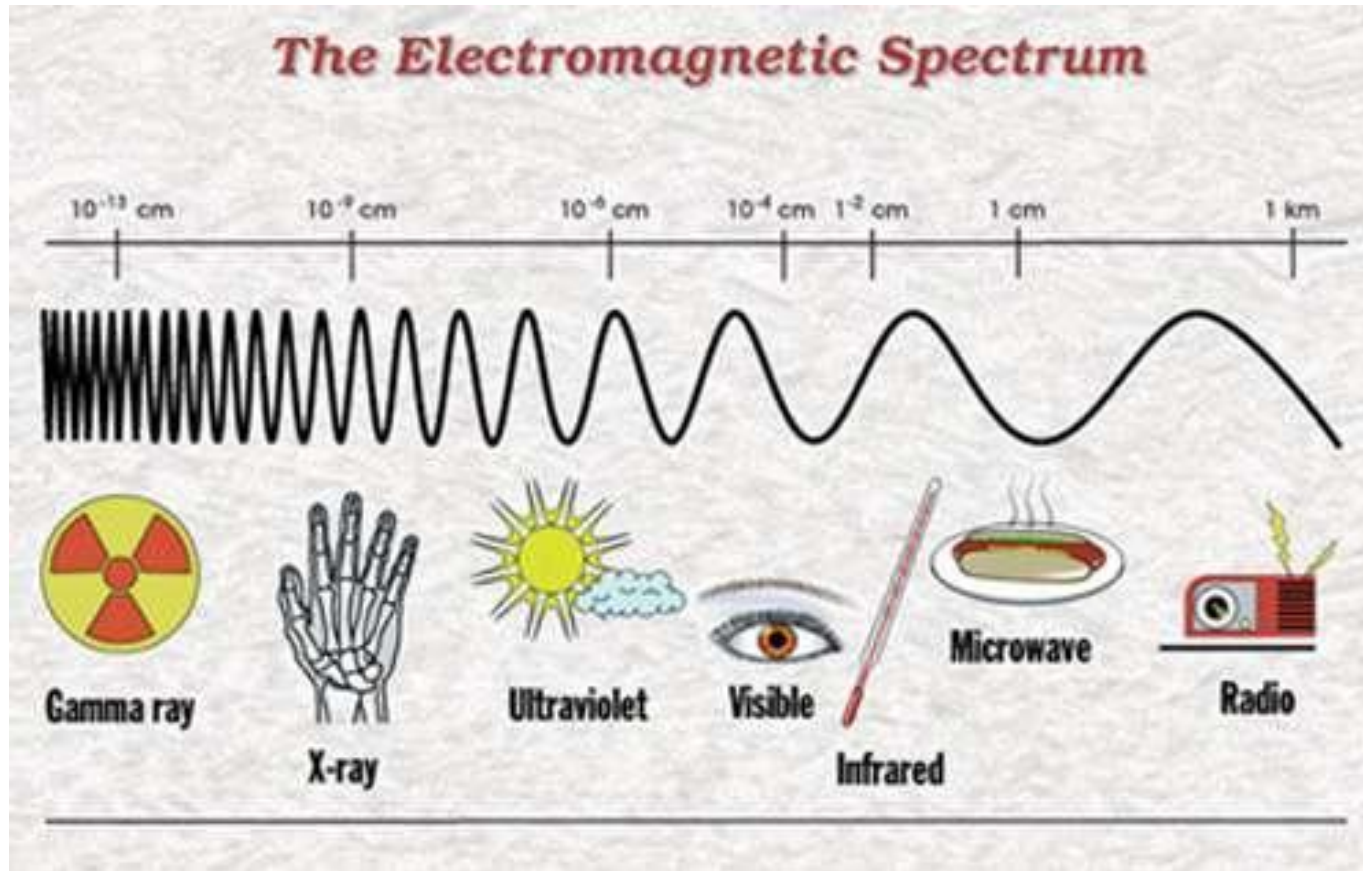


According to what they move through (Medium)

- Electromagnetic waves
- Mechanical Waves



Waves that can travel through matter or empty space where matter is not present.



- radio waves
- microwaves
- infrared waves
- visible light
- ultraviolet rays
- X-rays

- Needs a medium
- Require the particles of the medium to vibrate in order for energy to be transferred.

Types of Mechanical Wave

- water waves
- earthquake/seismic waves
- sound waves
- waves that travel down a rope or spring



According to how particles move through them

❖ Transverse waves

Examples:

- ripples on the surface of water
- vibrations in a guitar string
- electromagnetic waves
- seismic S-waves

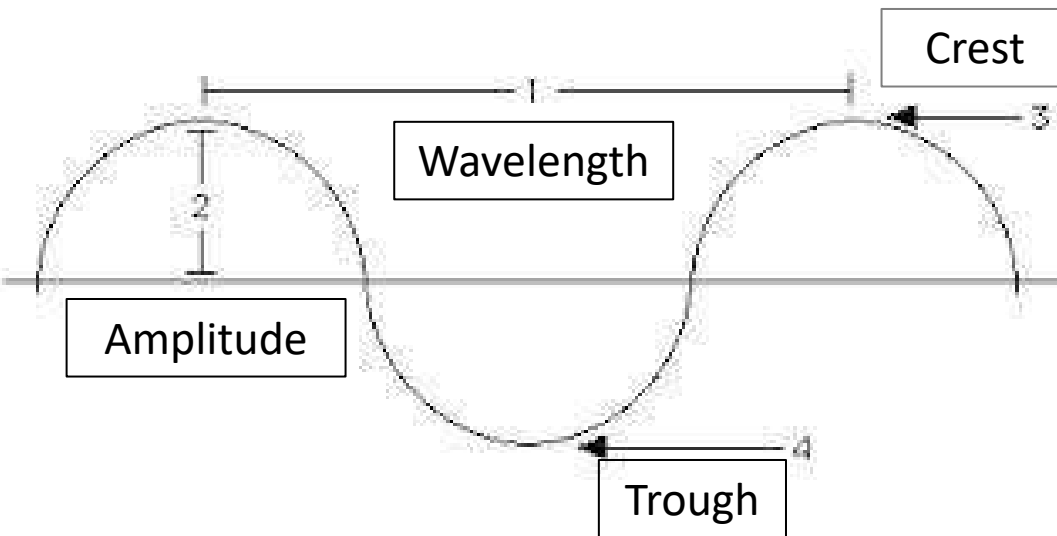
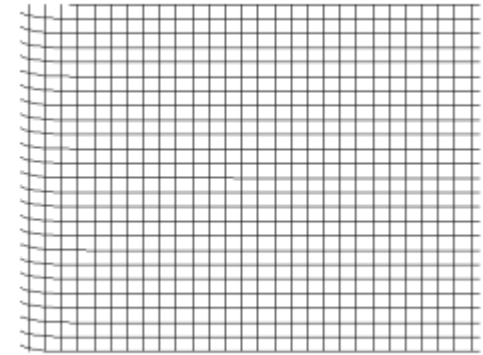
❖ Longitudinal waves

Examples:

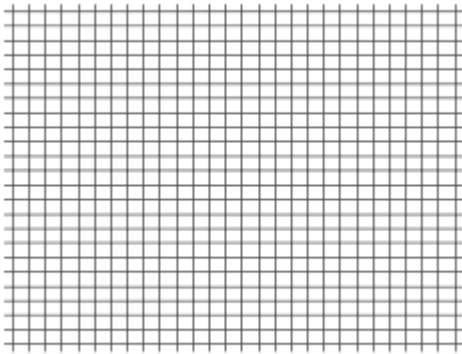
- sound waves
- ultrasound waves
- seismic P-waves



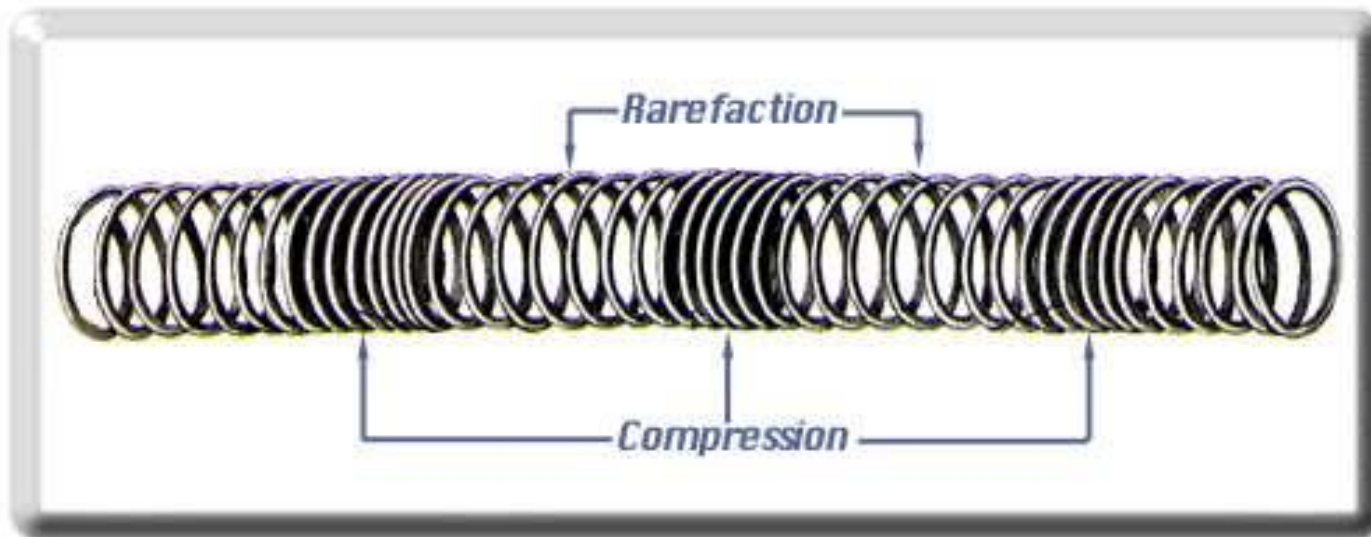
- Particles move perpendicular to the motion of the wave



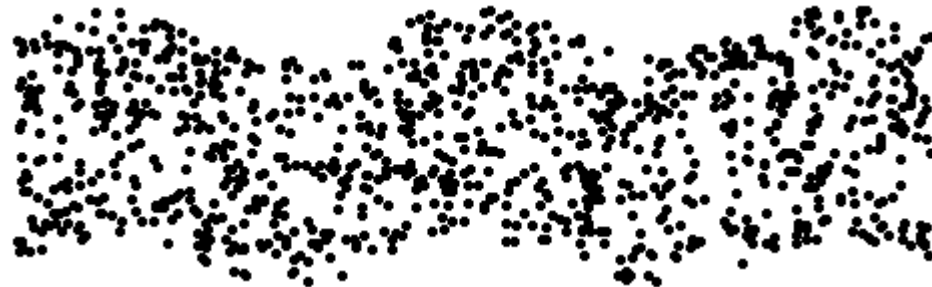
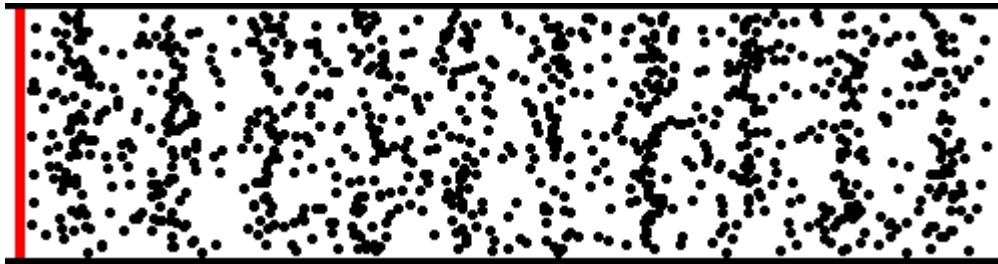
- **Wavelength (λ)** - The distance from crest to crest (or trough to trough); expressed in meters
- **Amplitude (A)** - The distance of crest (or trough) from the *midpoint* of the wave

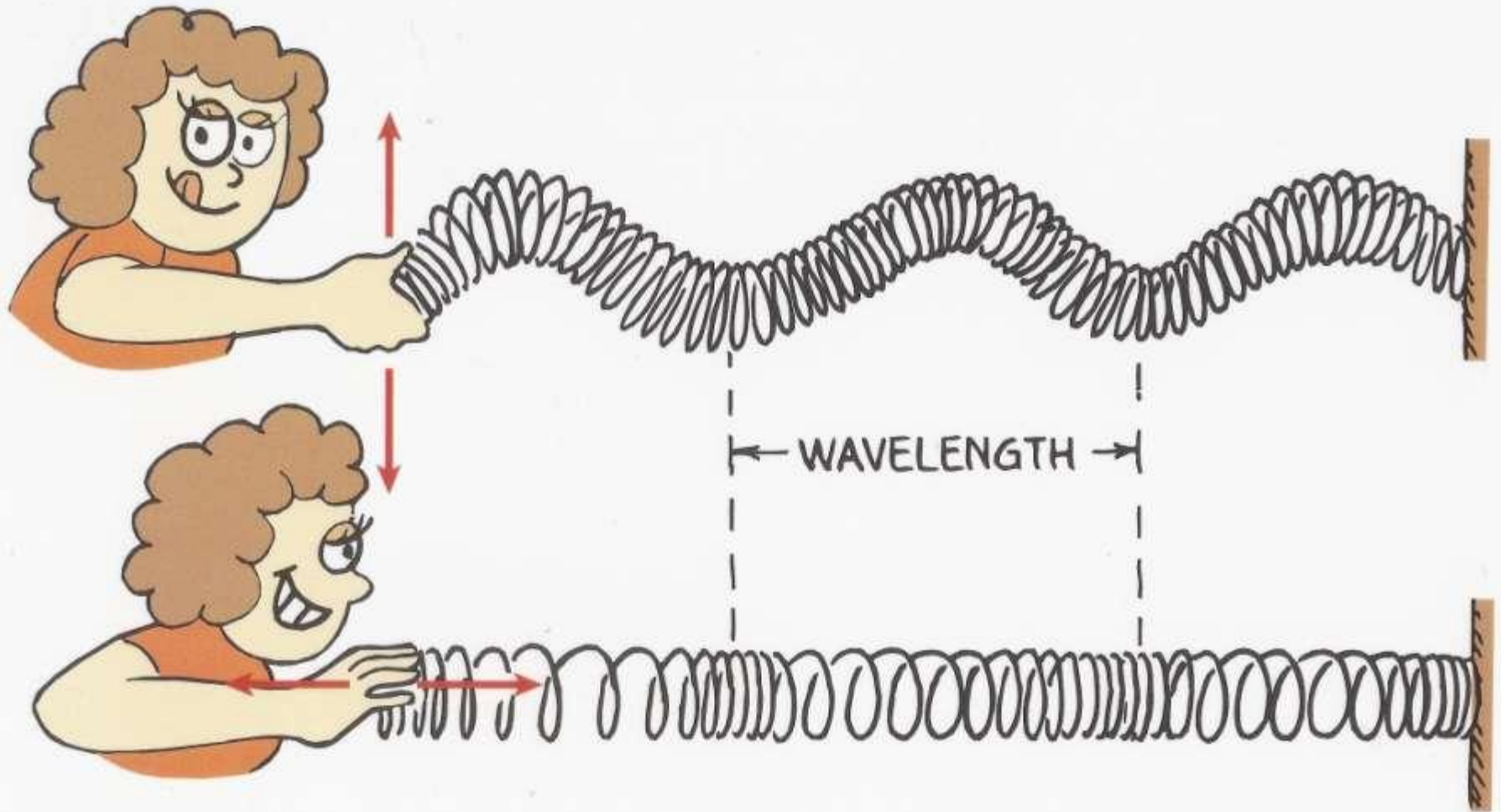


- Particles move parallel to the motion of the wave.
- **Compression**- a crowded area causing a high pressure region
- **Rarefaction**- a spread out area causing a low pressure region



Which is which?





- **Frequency (f)** - The number of waves that passed a fixed point per second

Unit: hertz (Hz)

$$f = 1/T$$

- **Period (T)** - The time it takes a wave to travel a distance equal to a wavelength

Unit: seconds

$$T = 1/f$$

- **Wave velocity (v)** - Distance travelled by a wave crest in one period.

Unit: m/s

$$v = \lambda/T$$

What happens when...

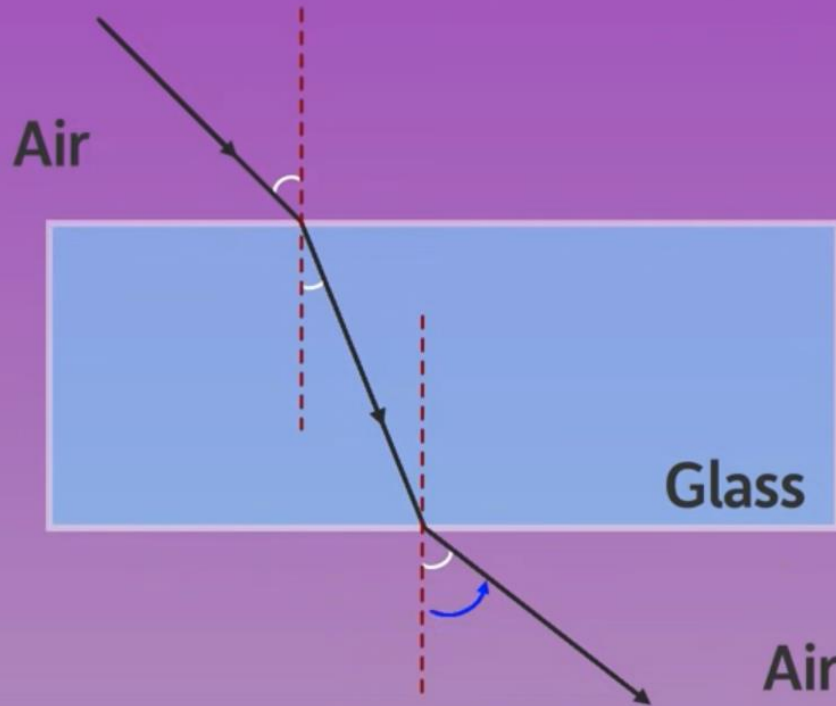
- A wave meets a hard surface like a wall?
- A wave enters a new medium?
- A wave moves around an obstacle?
- A wave meets another wave?

Reflection - When a wave hits a surface through which it cannot pass, it bounces back.



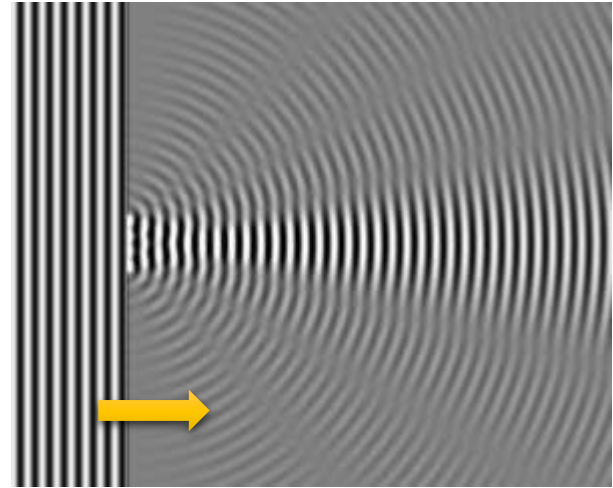
Refraction - The bending of a wave as it enters a new medium.

- It is caused by a change in the speed of the wave as it moves from one medium to another
- Greater change in speed = more bending of the wave



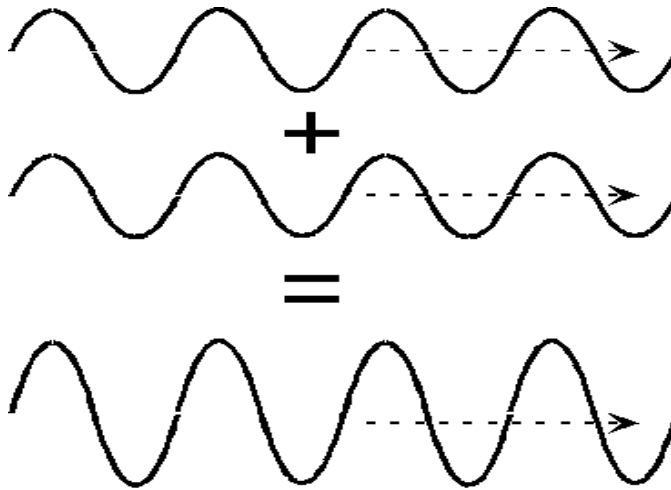
Optically (<i>rarer</i> to <i>denser</i>) (air to glass)	→	Speed ↓	→	Bends towards the normal
Optically (<i>denser</i> to <i>rarer</i>) (glass to air)	→	Speed ↑	→	Bends away from the normal

The bending of a wave as it moves around an obstacle or passes through a narrow opening

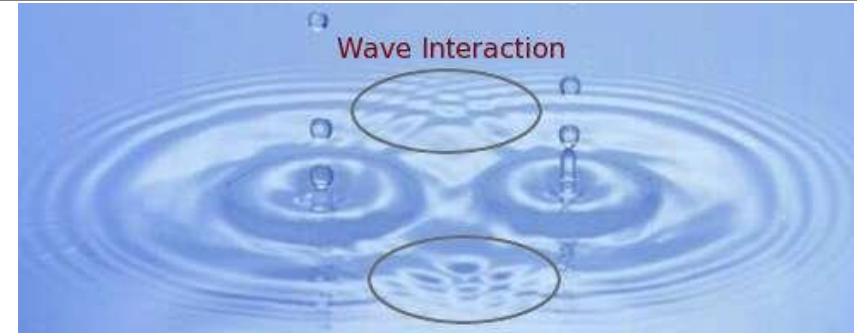


The wave will try to curve around the boundary or outward through the opening due to friction.

When two or more waves combine together.



Destructive Interference - Two or more waves combine to produce a smaller wave or destroy the wave completely. (crest & trough)



Constructive Interference - When two waves combine to make a larger wave. (crest & crest) or (trough & trough)

