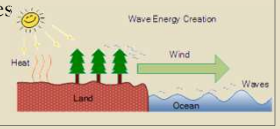
CHAPTER 15
WAVES

What is a wave?

- Wave- a disturbance that transmits energy through matter or space
- Energy may spread out as a wave travels.
- Kinetic theory explains differences in wave speed

- The speed of a wave depends on the medium
- Medium-matter through which a wave travels
  - Water, Air, Earth
  - Greatest in solids and least in gases

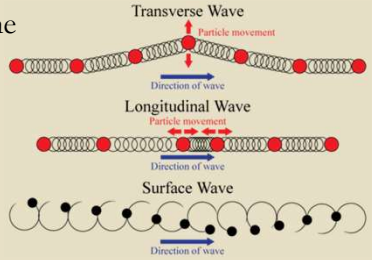


Intro to Waves Clip

Mechanical Waves

A wave that requires a medium through which to travel

- They are caused by the vibration of particles within the medium.

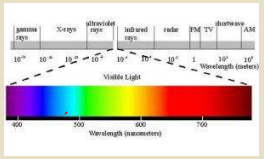


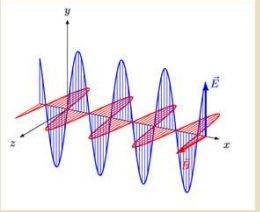
- **sound waves (air)**
- **water waves**
- **waves in a spring**

Electromagnetic Waves

- Wave caused by a disturbance in electric and magnetic fields by vibrating charged particles.
  - Does not require a medium
  - Also called a light wave
  - can transfer energy through a vacuum
  - can also transfer energy through a material medium

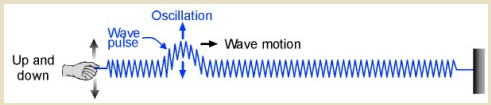
Example: light waves through space, through air, through glass





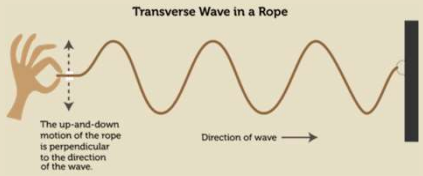
Transverse Waves

- Particles oscillate up and down about their equilibrium positions, perpendicular to the direction of wave propagation

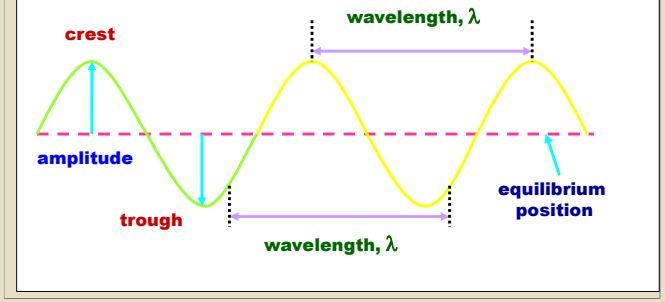


- Its oscillations perpendicular to the direction the wave moves

Examples: light waves, electromagnetic waves



A Transverse Waveform



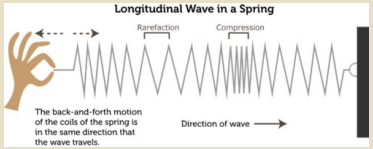
Longitudinal Waves

Compression

- Particles oscillate back and forth about their equilibrium positions, parallel to the direction of wave motion

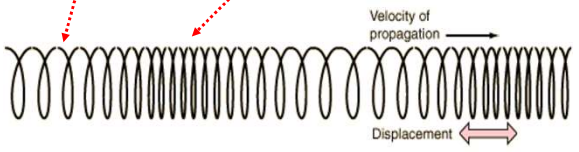
Ex: Sound waves

- Oscillations in the same direction as the wave moves



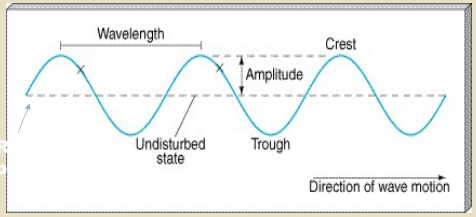
A Longitudinal Waveform

- A cycle consists of one compression and one expansion of the particles of the medium.



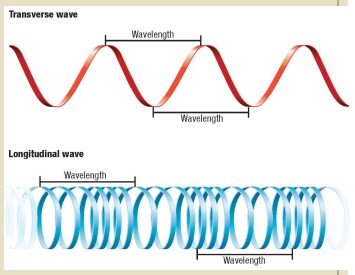
Wave Properties

- Crest-the highest point of a transverse wave
- Trough-the lowest point of a transverse wave
- A cycle consists of one crest and one trough.
- Amplitude-the greatest distance that particles in a medium move from their normal position when a wave passes



Wavelength

- Wavelength-the distance between any two successive identical parts of a wave
- Compressions: the crowded areas of a longitudinal wave
- Rarefactions: the stretched-out areas of a longitudinal wave

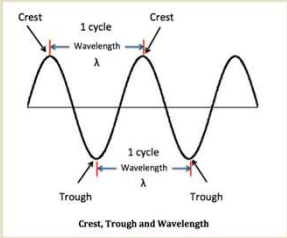


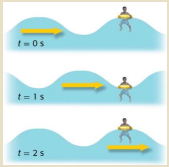
Amplitude and wavelength tell you about energy.

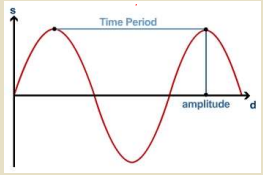
- **larger amplitude = more energy**
- **shorter wavelength = more energy**

Period (time)

- the time required for one full wavelength to pass a certain point
- complete cycle or wave oscillation to occur





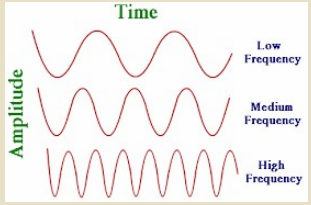


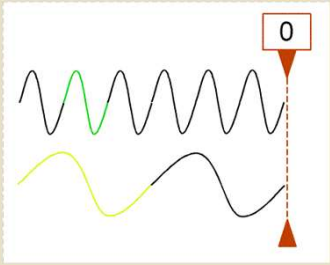
Frequency

The number of cycles or vibrations per unit of time.

The number of waves produced in a given amount of time.

- unit hertz (Hz)

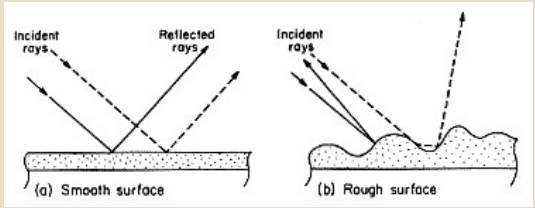




1. Reflection

The bouncing back of a wave as it meets a surface or boundary

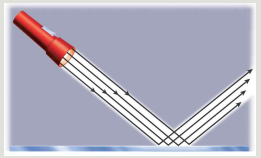
- Examples:
  - The reflection of light waves in a lake can create a mirror image of a landscape.
  - Water waves are reflected when they hit the side of a boat.



Reflection

Rough surfaces reflect light rays in many directions.

Smooth surfaces reflect light rays in one direction.



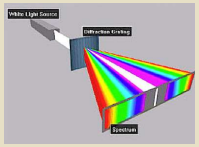
The *angle of reflection* is the light rays reflecting off the surface.

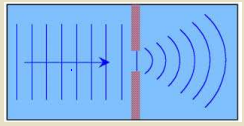
The *angle of incidence* is the light rays striking the surface

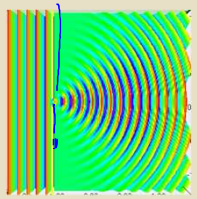
2. Diffraction

The bending of a wave as it passes an edge or an opening

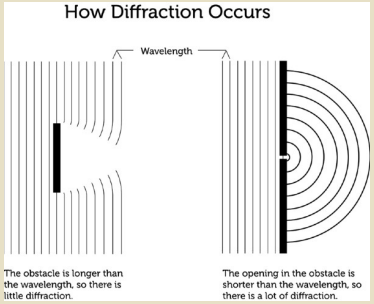
- Examples:
  - Water waves diffract around a block in a tank of water.
  - Sound waves passing through a door diffract.

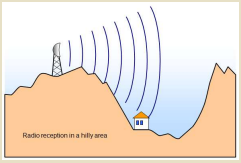


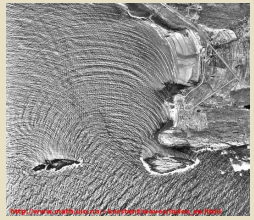




Diffraction

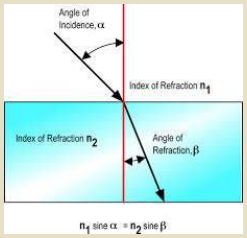


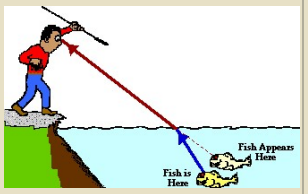




3. Refraction

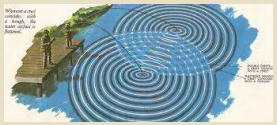
- The bending of waves as they pass from one medium to another
- All waves are refracted when they pass from one medium to another at an angle.

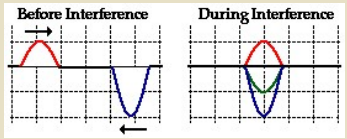


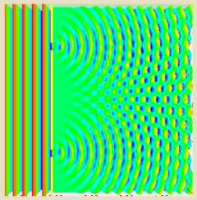


4. Interference

- The combination of two or more waves that exist in the same place at the same time
- Occurs in all waves
- Two types
  - Constructive interference
  - Destructive interference

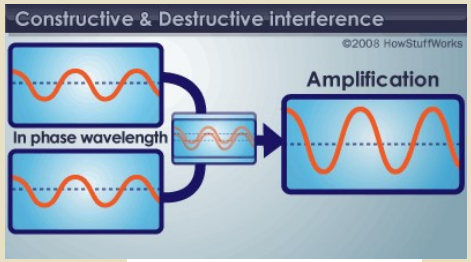






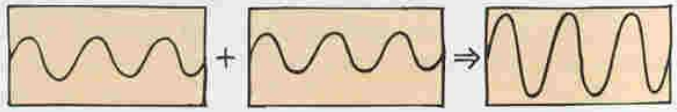
Type 1: Constructive Interference

- Waves combine without any phase difference
- Waves combine to form a bigger wave
- Increases amplitude



Wave Addition — Constructive Interference

Amplitude ~ Intensity



The superposition of two identical transverse waves in phase produces a wave of increased amplitude.

The superposition of two identical longitudinal waves in phase produces a wave of increased intensity.

Type 2: Destructive Interference

- Waves combine differing by multiples of 1/2 wavelength
- waves combine to form a wave smaller than the largest of the original waves
- Decreases amplitude