Waves

Waves carry energy!
There are 3 basic types.

Mechanical Waves(sound)

Electromagnetic Waves(light)

Matter Waves(atomic particles)

Mechanical Waves

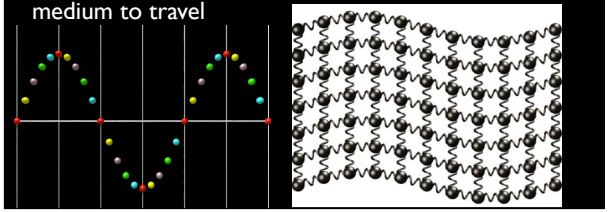
- Require a medium for the wave to propagate
  - Water
  - Sound
  - Slinky
  - Bridges

Mechanical Waves

- Are classified by the way that they move (displace) the medium they are in.
- The three types of mechanical waves are:
  - Transverse
  - Longitudinal
  - Surface

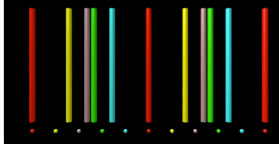
Transverse Waves(light)

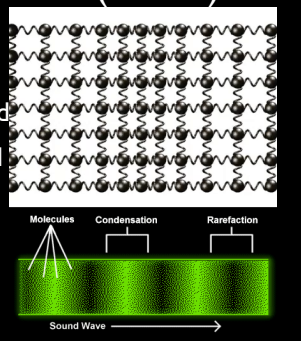
- Causes the medium in which the wave moves through to move perpendicularly to the direction the wave is traveling
- Light waves travel in straight lines and do not need a medium to travel



Longitudinal Waves(sound)

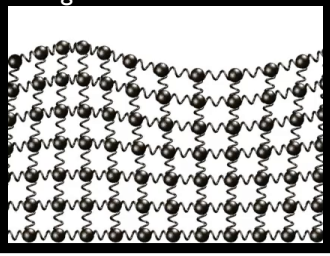
- Medium moves in the same direction as the wave
- Particles get compressed
- Sound waves travel in all directions





Surface waves

- Exhibit characteristics of both Transverse and longitudinal waves
- Water wave



Electromagnetic Waves

- NO MEDIUM REQUIRED
- Travel at the speed of light (299,792,458m/s)
  - Light
  - Radio x-rays
  - microwave

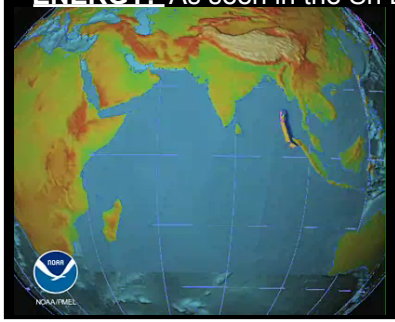
Matter Waves

- Electrons and other particles show wave-like behavior.
- This is some freaky stuff we will study in Quantum Physics.

Keep in mind

- Even though particles in the medium of a mechanical wave move in response to the wave, **they do not move along with the wave!**
- The wave only transfers energy

It happens to be a very effective means of transferring **ENERGY!** As seen in the Sri Lanka Tsunami.



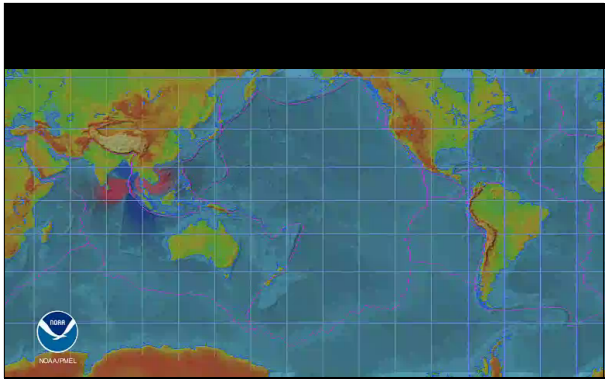
Define:

Transmission

Absorption

Reflection

Defraction



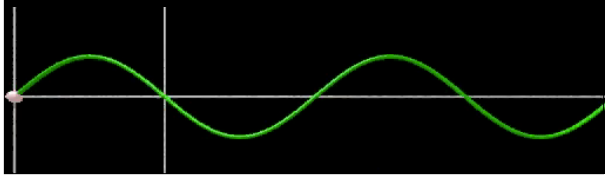
Vocabulary terms common to all waves.

Pulse

- Single disturbance that travels through a medium

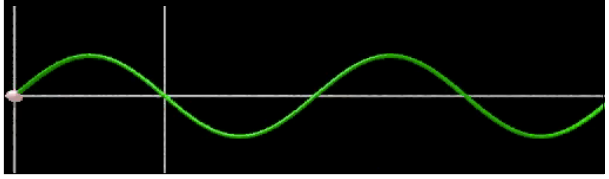
Periodic Wave

- A series of pulses moving in a regular repeating manner.



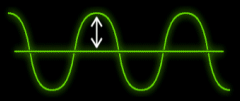
Crest and Trough

- The crest is the high point
- The trough is the low point



Amplitude

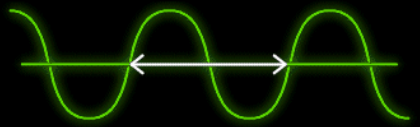
The amplitude of a wave is the distance from a crest to where the wave is at equilibrium. The amplitude is used to measure the energy transferred by the wave. The bigger the distance, the greater the energy transferred



Amplitude:
The maximum value of the wave function. The higher the amplitude, the louder the sound.

Period (T) (in seconds)

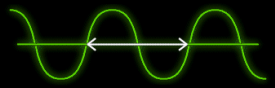
- How long it takes one cycle of a wave to repeat itself.



Period:
The *time* required for one wavelength to pass a certain point. Generally, a longer period indicates a lower pitch.

Frequency (f) (in Hertz Hz)

- The amount of wave cycles per second
- $f = 1/T$ therefore $T = 1/f$
- Find the frequency of a wave with a period of 0.5 seconds.



Period:
The *time* required for one wavelength to pass a certain point. Generally, a longer period indicates a lower pitch.

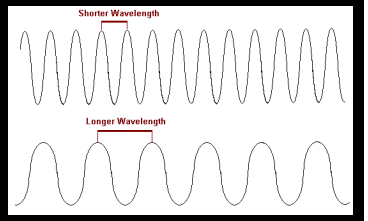
Wavelength (λ) (in meters)

Distance between repeating parts of a wave

Crest to crest

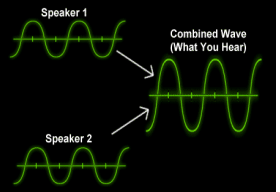
Trough to trough

Beginning to end



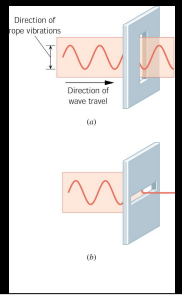
Phase

- Points on successive wave cycles of a periodic wave that are displaced by the same amount and in the same direction (away or towards) equilibrium, are said to be in phase.



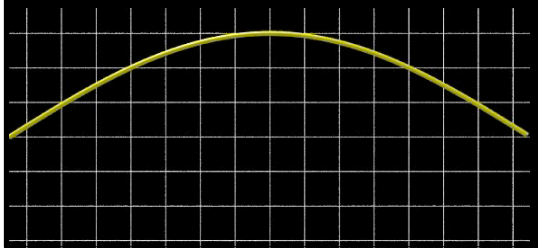
Polarization of a Wave

Any transverse wave can be polarized



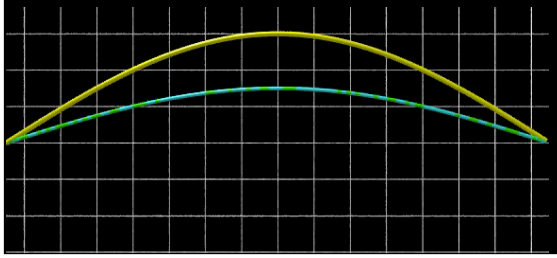
Standing Waves

- Wave appears to be standing still as the result of identical waves, 180^0 out of phase, moving in opposite directions

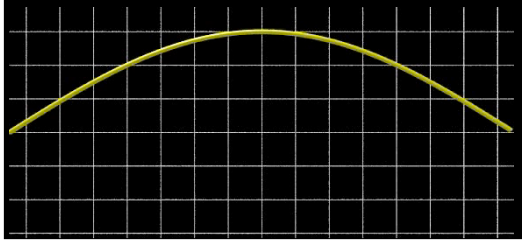


Looks Something Like This

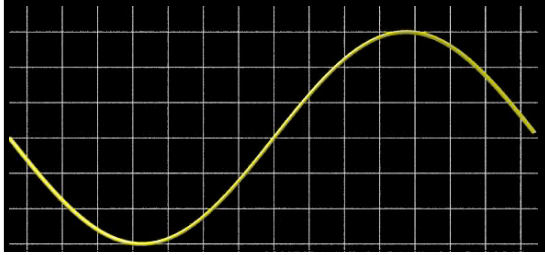
- The blue and green waves are traveling in opposite directions and the yellow is the result of the blue and green combined



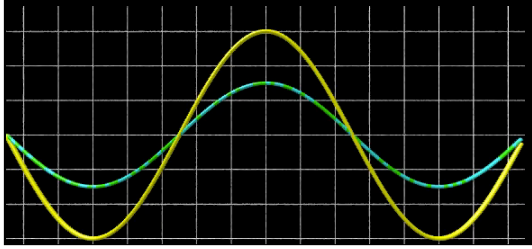
- This one is called the 1^{st} harmonic
- Where are the nodes and antinodes?
- How many waves are there?



- 2nd harmonic
- How many nodes, antinodes and waves?



- 3rd harmonic
- How many nodes, antinodes and waves?



Speed of a Wave

- Can be found by
- $v = \lambda/T$ = meters/seconds
- therefore
- $v = f \cdot \lambda$

The speed of any particular wave depends ONLY on the medium it is in.

Wave Interaction
Superposition

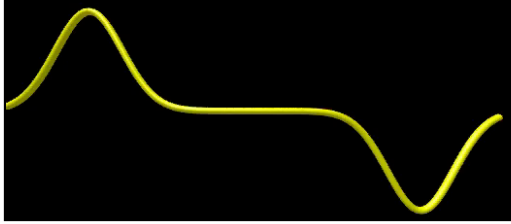
When Two Waves Meet, Two Things Can Happen

Constructive Interference

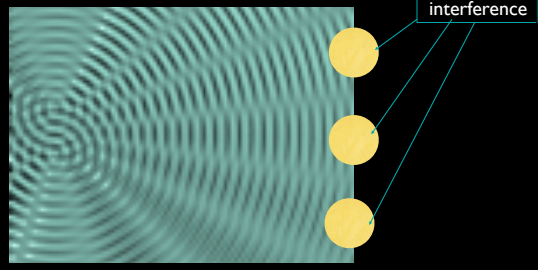
- When the peak of one wave matches up with the peak of another wave
- The new amplitude is the sum of the amplitudes of both waves

Destructive Interference

- When the crest of one wave and the trough of another line up you have total destructive interference
- The level of destructive interference depends on how well



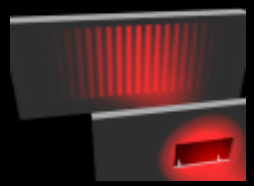
Both Types of Interference



The Telltale Sign of a Wave!

- When this experiment is performed, and the result is the appearance of these "**maxima**", you know that the thing in question moves as a wave.
- It turns out that this works for light too.
- This lead people to believe light travels as a wave!

Young's Double Slit Experiment

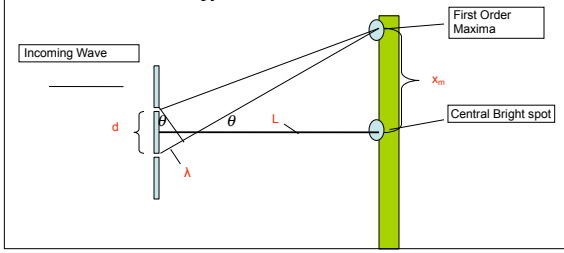


$$x_m = \frac{m\lambda L}{d}$$

$$x_m = \frac{m\lambda L}{d}$$

Good For small

$$d \sin\theta = m\lambda$$



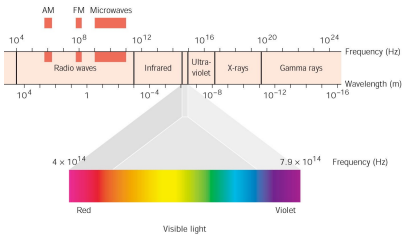
- Coherent violet light falls on two slits separated by 1.9×10^{-5} m. A first order maxima appears 13.2 mm from the center bright line on a screen 0.6 m from the slits. What is the wavelength of the light? What is it's frequency?

$\lambda=4.18\times10^{-7}$m

$f=7.18\times10^{14}$Hz

How do you know if this is correct?

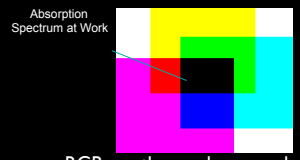
Frequency Dictates Color



AND THEN THERES THIS

LETS TALK ABOUT COLOR

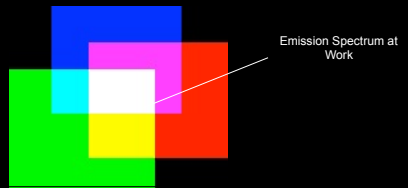
CMY ink can be used as the primary pigment palette to make secondary RGB



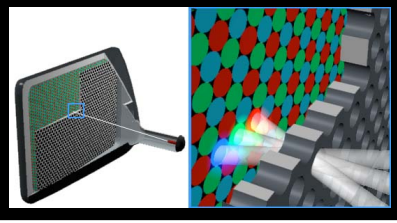
RGB can then make secondary colors.

RGB ink could never make a good cyan, magenta or yellow, so CMY ink serves as a superior set of primary colors over the traditional RGB. It's a lighter palette.

RGB light beams are superior as primary light beams because they are the darker set of primaries and can make the lighter CMY on a computer screen when



That's why there are 3 beams of light firing in your monitor. Rather the screen is coated with 3 layer of phosphorescent powder per pixel; each if hit by an electron beam glows either red, green or blue.



So we all have **RGB monitors** using additive color mixing (emission spectrum), and **CMY printers** using subtractive color mixing (absorption spectrum).