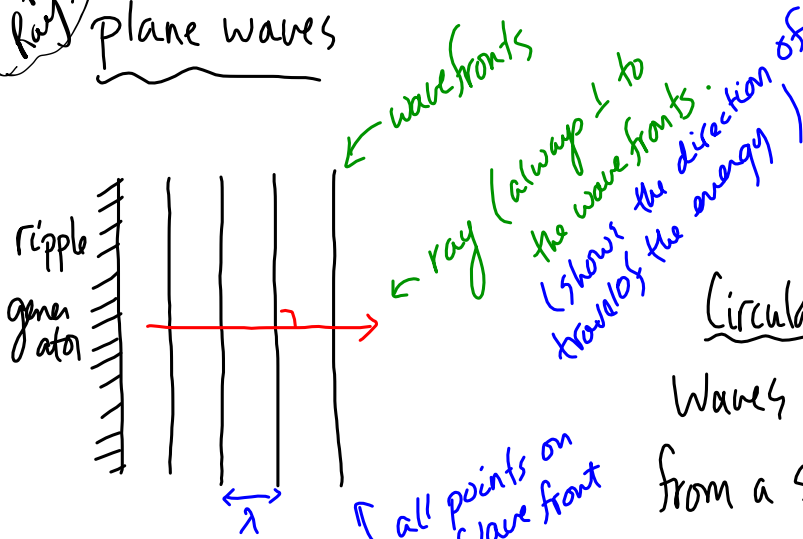


§4-3 Wave Characteristics

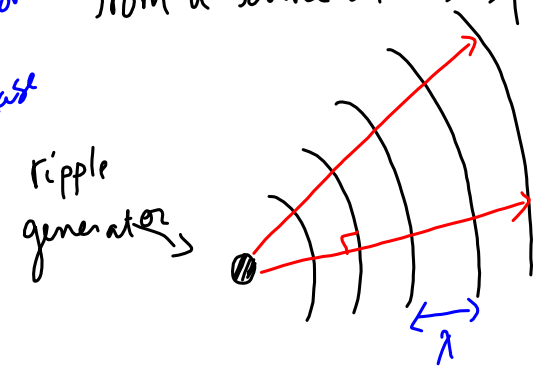
Wave Fronts + Rays - surface waves on water => study using a ripple tank.  
plane waves



Waves move out in a straight line in 2D space.  
 all points on the wave front are in the same phase

Circular Waves

Waves move out radially from a source in 2D space.



From yesterday: 103.9 MHz →

$$v = \lambda f$$

$$\lambda = \frac{v}{f}$$

$$T = \frac{1}{f}$$

$$T = \frac{1}{103.9 \times 10^6 \text{ s}^{-1}}$$

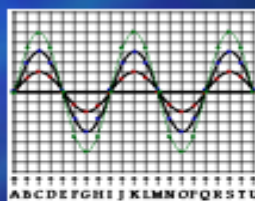
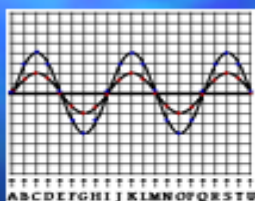
$$T = 9.62 \times 10^{-9} \text{ s}$$

$$\lambda = \frac{3.00 \times 10^8 \text{ m s}^{-1}}{103.9 \times 10^6 \text{ s}^{-1}}$$

$$\lambda = 2.89 \text{ m}$$

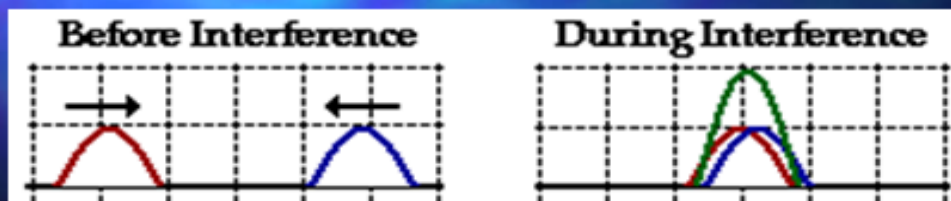
## Superposition of Waves

- **PRINCIPLE OF SUPERPOSITION** ~  
*the algebraic sum of the displacements  
caused by the individual waves*



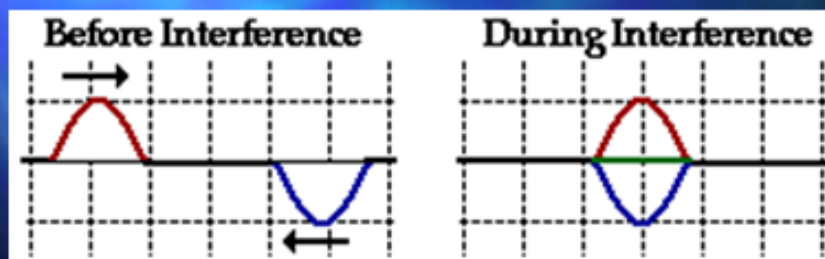
- [animation](#)

- **CONSTRUCTIVE INTERFERENCE** ~  
*results in a larger amplitude than either  
of the individual waves*



**■ DESTRUCTIVE INTERFERENCE ~**

*results in a smaller amplitude than one, sometimes both, of the waves*



Amplitude and Intensity

Amplitude is the maximum displacement from the equilibrium position (A).

The Intensity of a wave is proportional to the square of the amplitude:

$$I \propto A^2$$

comes from:

$$E_e = \frac{1}{2}kx^2$$

$$E_e = \frac{1}{2}kA^2$$

max energy:

If you double the amplitude, the intensity quadruples

If you decrease the amplitude by a factor of 3, the intensity is decreased by a factor of  $3^2 = 9$



Intensity and Distance

Intensity decreases as the distance from the source of the wave increases.

Consider a styrofoam ball with 1000 skewers stuck in it:

in it:



$$SA = 4\pi r^2$$

# of skewers	r	SA	# skewers / SA
1000	1	$4\pi$	$\frac{1000}{4\pi}$
1000	2	$16\pi$	$\frac{1000}{16\pi}$
1000	3	$36\pi$	$\frac{1000}{36\pi}$
1000	4	$64\pi$	$\frac{1000}{64\pi}$

Annotations: Red arrows show r doubling from 1 to 2, SA increasing by x4, and skewers per SA decreasing by x1/4. Green arrows show r tripling from 1 to 3, SA increasing by x9, and skewers per SA decreasing by x1/9. Blue arrows show r quadrupling from 1 to 4, SA increasing by x16, and skewers per SA decreasing by x1/16.

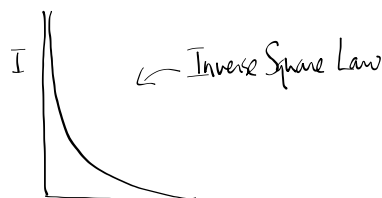
Intensity varies inversely with the square of the distance:

$$I \propto \frac{1}{r^2}$$

$$(I \propto r^{-2}) \leftarrow \text{Data Booklet}$$

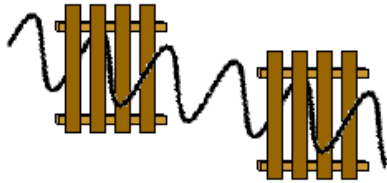
If the distance from the source is doubled the Intensity is decreased by a factor of 4.

If the distance from the source is decreased by a factor of 5, the intensity is increased by a factor of  $5^2 = 25$ .

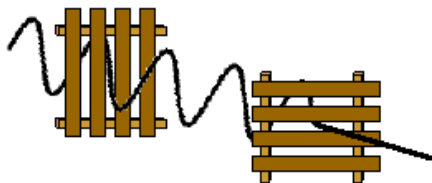


# Polarization of Light

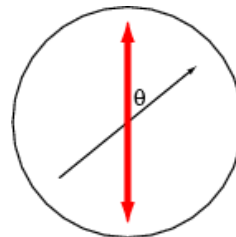
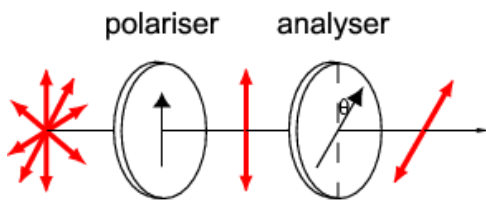
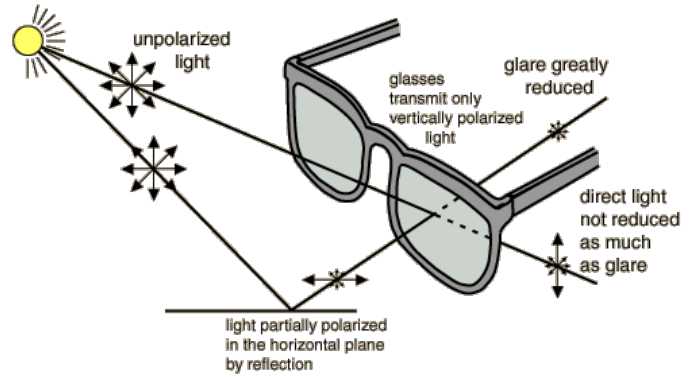
## The Picket Fence Analogy



When the pickets of both fences are aligned in the vertical direction, a vertical vibration can make it through both fences.



When the pickets of the second fence are horizontal, vertical vibrations which make it through the first fence will be blocked.



$$A = A_0 \cos \theta$$

$$A^2 = (A_0 \cos \theta)^2$$

$$A^2 = A_0^2 \cos^2 \theta$$

$$I \propto A^2$$

$$I = I_0 \cos^2 \theta$$

Malus' Law  
(Data Booklet)