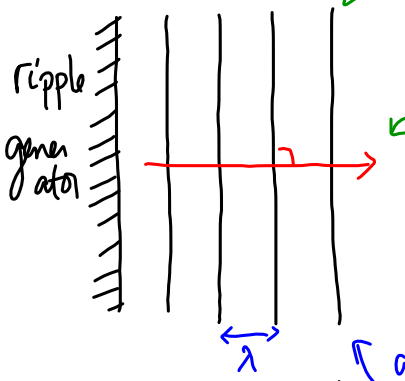
§4.3 Wave Characteristics

wave fronts + rays

- surface waves on water => study using a ripple tank.

Plane waves

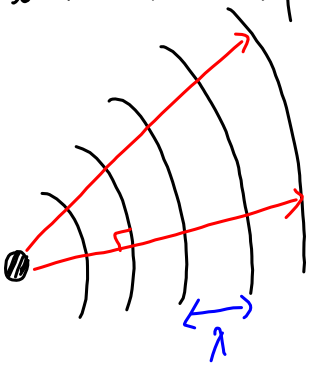


Waves move out in a straight line in 2D space.

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 →

$$v = \lambda f$$

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

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

$$\lambda = 2.89\ m$$

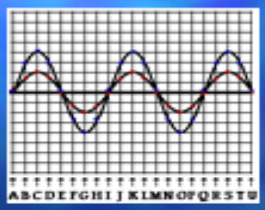
$$T = \frac{1}{f}$$

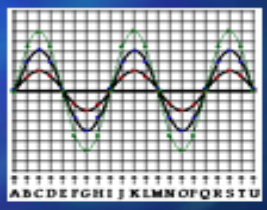
$$T = \frac{1}{103.9 \times 10^{6}\ s^{-1}}$$

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

Superposition of Waves

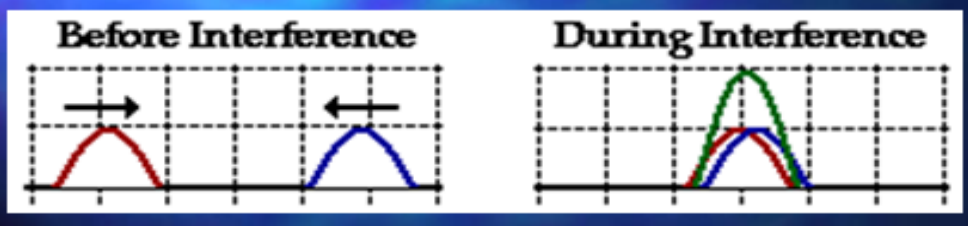
- **PRINCIPLE OF SUPERPOSITION** ~ *the algebraic sum of the displacements caused by the individual waves*



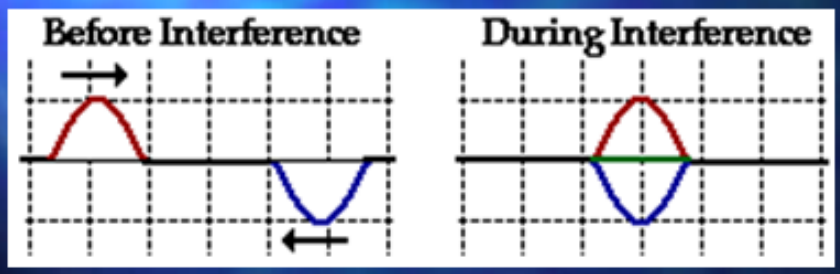


- animation

- **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:

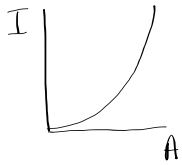
$$E_e = \frac{1}{2}kx^2$$

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

max energy

If you double the amplitude, the intensity quadruples

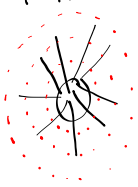
If you decrease the amplitude by a factor of 3, the intensity is decreased by a factor of $3^2 = 9$



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:



$SA = 4\pi r^2$

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

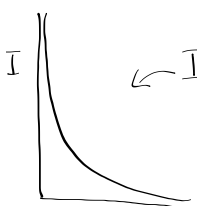
x2, x3, x4; x4, x9, x16 (4^2); x $\frac{1}{4}$, x $\frac{1}{9}$, x $\frac{1}{16}$, $\frac{1}{4^2}$

Intensity varies inversely with the square of the distance:

$$I \propto \frac{1}{x^2} \qquad \left(I \propto x^{-2}\right)$$ Data Booklet

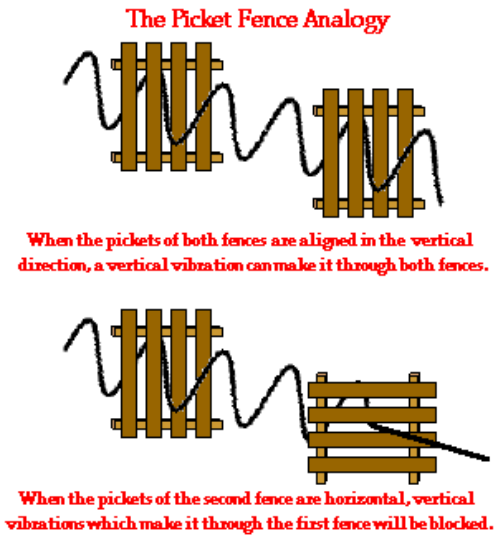
If the distance from the source is doubled the Intensity is decreased by a factor of 4.

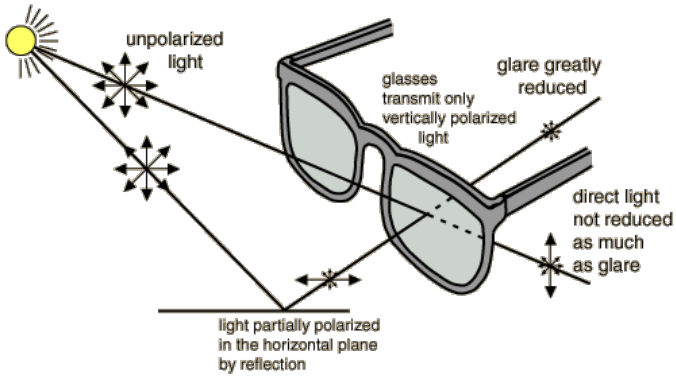
If the distance from the source is decreased by a factor of 5, the intensity is increased by a factor of $5^2 = 25$.

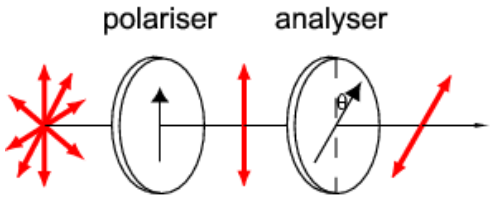


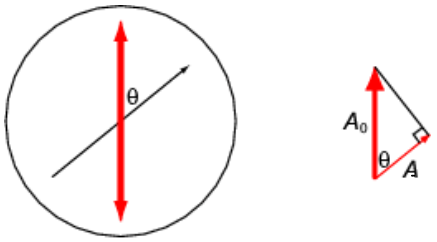
← Inverse Square Law

Polarization of Light









$$A = A_O \cos\theta$$

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

$$A^2 = A_O{}^2 \cos^2\theta$$

$$I \propto A^2$$

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

Malus' Law

(Data Booklet)