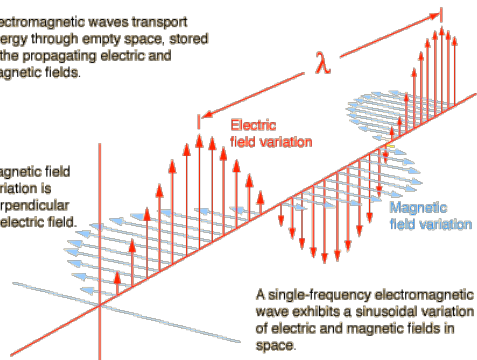


Chapter 24 Notes - EM Waves

Electromagnetic waves transport energy through empty space, stored in the propagating electric and magnetic fields.

Magnetic field variation is perpendicular to electric field.

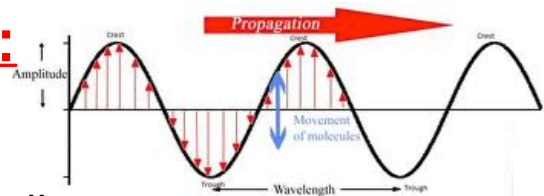


A single-frequency electromagnetic wave exhibits a sinusoidal variation of electric and magnetic fields in space.

EM =
electromagnetic
EM waves are due to
oscillating charged particles creating B
and E fields as it
moves through space

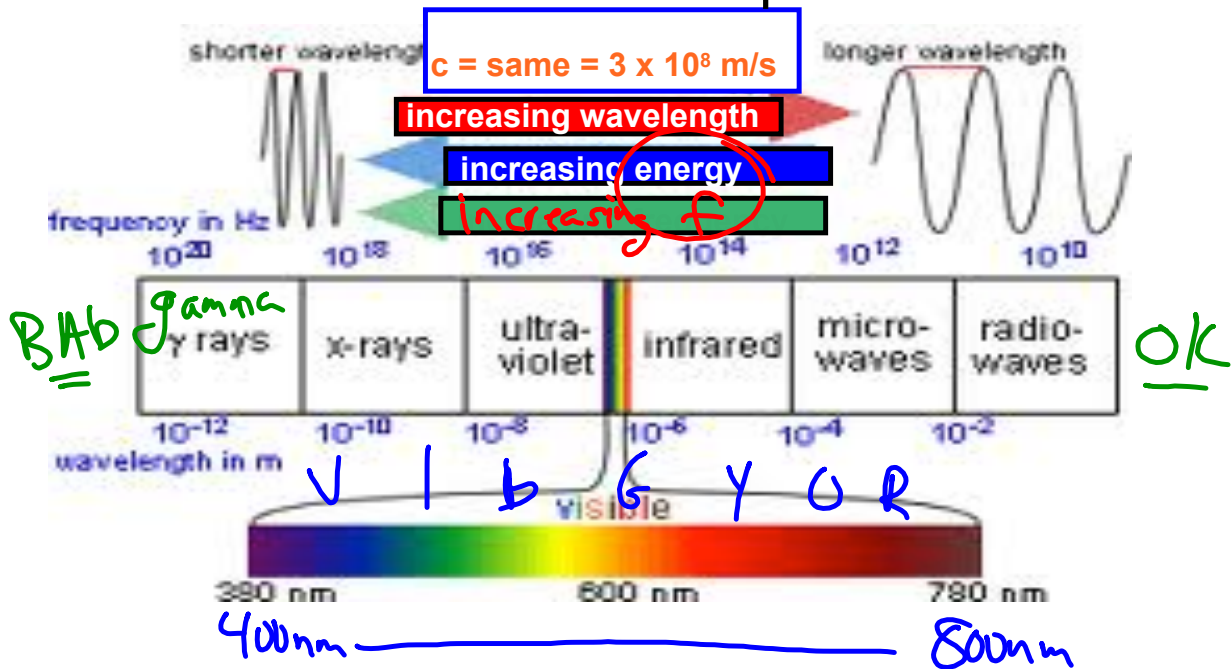
Facts about EM waves:

- 1) EM waves are transverse
- 2) EM wave do NOT need a medium
- 3) EM waves all travel at the same speed in a vacuum and the FASTEST - $c = 3 \times 10^8 \text{ m/s}$
- 4) EM waves travel SLOWEST in solids = MORE DENSITY
- 5) Follows inverse square law



EM Spectra (Demo glasses & Colors & shadows)

- Can be continuous or separate lines



Energy of an EM Wave

- symbol = u = total energy density

- $$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}}$$

- $$u = \left(\frac{1}{2} \epsilon_0 E^2 + \frac{B^2}{2\mu_0} \right)$$

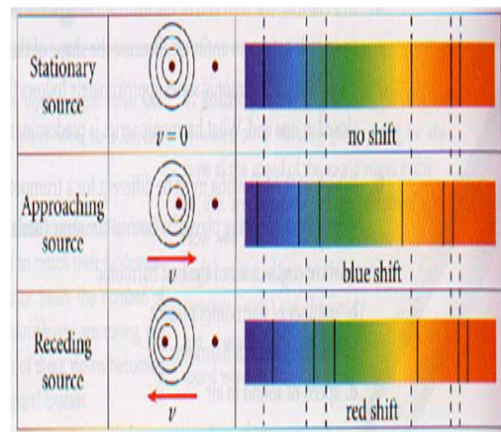
- BUT remember $E = cB$

- so....
$$u = \epsilon_0 E^2 \quad \text{or} \quad u = \frac{B^2}{\mu_0}$$

Doppler and EM Waves

- Still applies
- approaching
 - > higher f = blue shift
- receding
 - > lower f = red shift
- $f' = f(1 \pm (v_{\text{rel}}/c))$
- v_{rel} = relative speed and is $\lll c$

Doppler Effect



Measuring the relative velocities of stars by the Doppler shift.

Polarization of light - demo overhead

Polarization of light

- When light only vibrates in ONE direction
- 50% of light original light intensity if non polarized
- Use Malus' Law of Polarized light

$$> \boxed{S = S_0 \cos^2 \theta}$$

Intensity

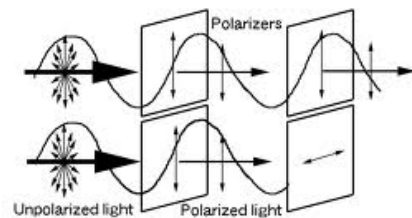
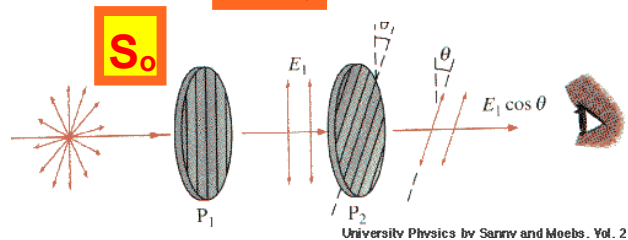


Fig.1 Polarization of light

$$S_1 = \frac{1}{2} S_0$$

$$S_2 = (1/2 S_0) \cos^2 \theta$$



University Physics by Sannv and Meets. Vol. 2

The Picket Fence Analogy



parallel

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



perpendicular

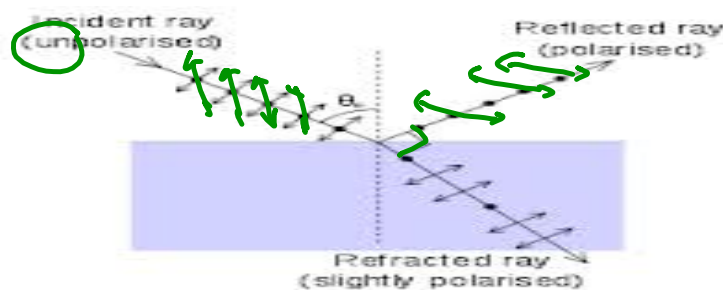
When the pickets of the second fence are horizontal, vertical vibrations which make it through the first fence will be blocked.

If polarizers are parallel S stays at $1/2S_0$

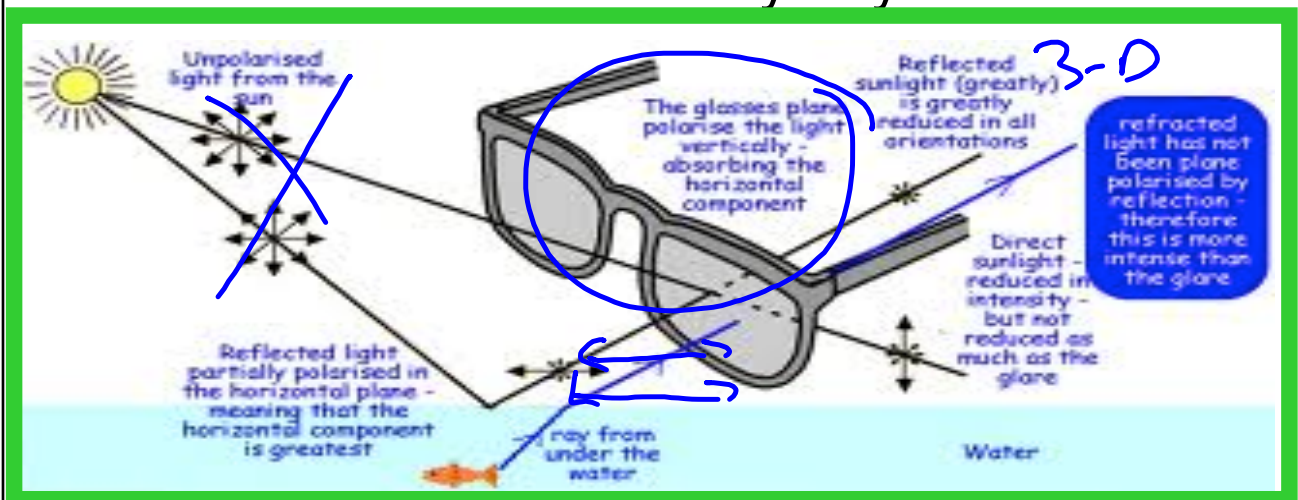
If polarizers are perpendicular $S = 0$

Polarization can occur two ways

1. Filter
 - > Axis of filter determines direction of polarization
2. Reflection
 - > Reflected light is polarized PARALLEL to surface

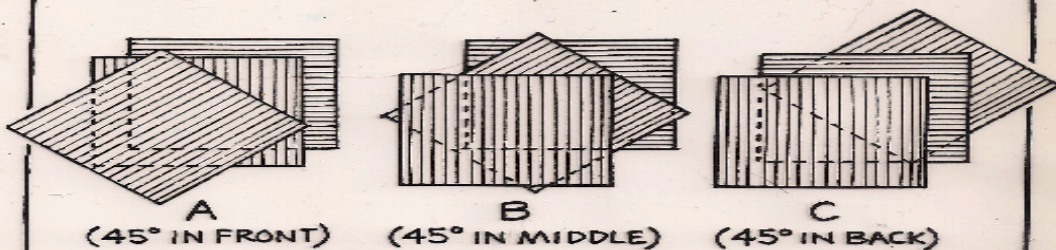


Check Q? - Which pair of glasses would be best at the beach on a sunny day?



Check Q.....

PHYSICS



THREE SETS OF POLARIDS, ONE ATOP THE OTHER, ARE SHOWN ABOVE. IN EACH SET THE POLARIZATION AXES OF TWO POLARIDS ARE AT 90° TO EACH OTHER, AND A THIRD IS AT 45° TO THE TWO. WHICH SET(S) WILL PASS LIGHT WHERE THE THREE OVERLAP?

