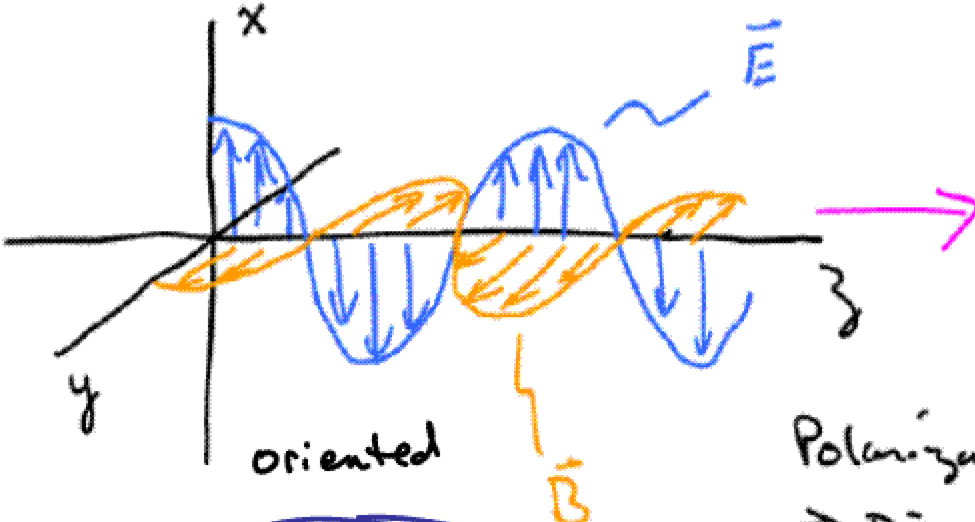
Physics 142 – December 4, 2008

Polarization of Electromagnetic waves

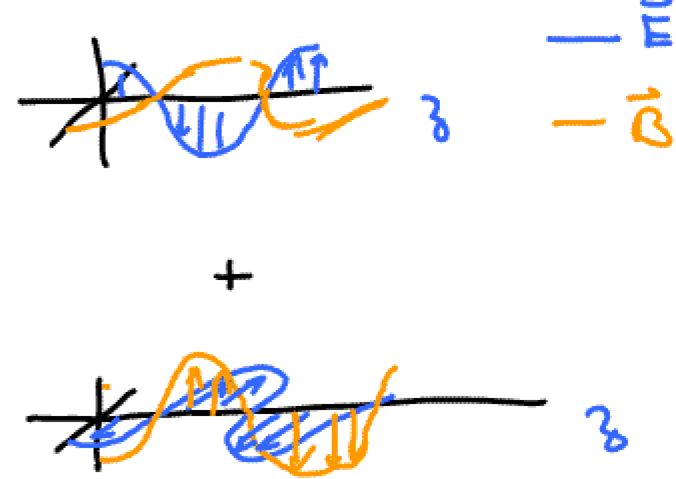


Polarization → Dir. of $\vec{E}$ vector

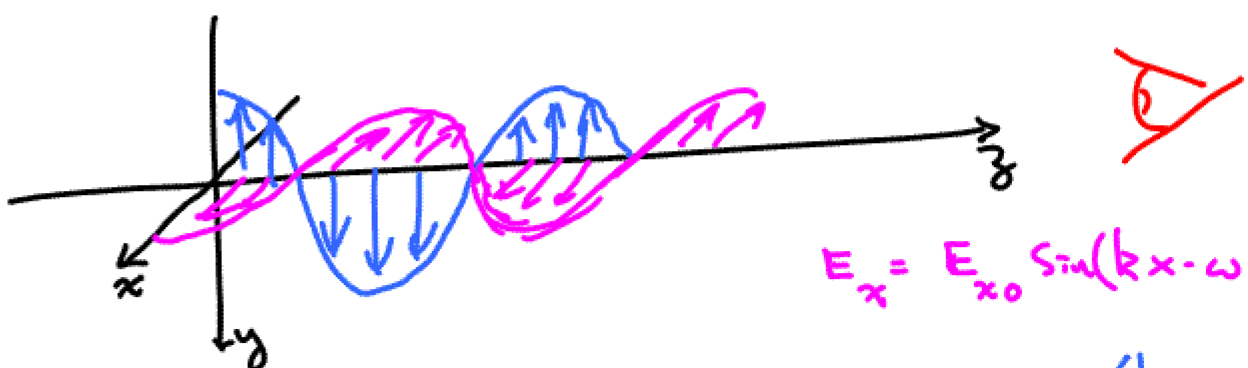
$\vec{E}$ oriented along x axis

wave is polarized along x-axis

General Soln =



go to Basis where we draw just $\vec{E}$ for each of the possible orthogonal solns

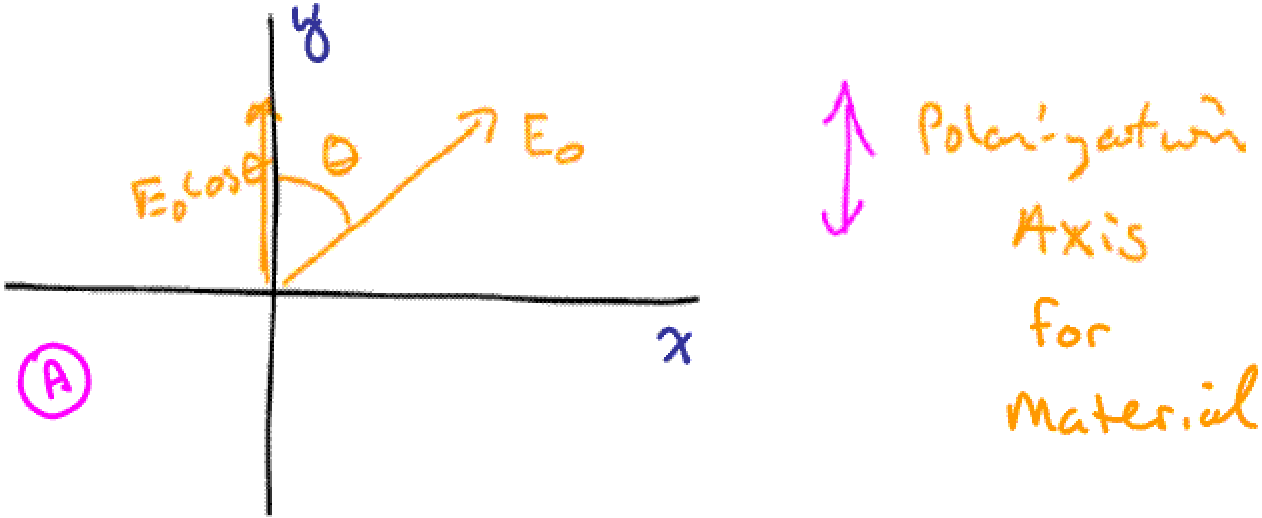


$$E_x = E_{x0} \sin(kx - \omega t)$$

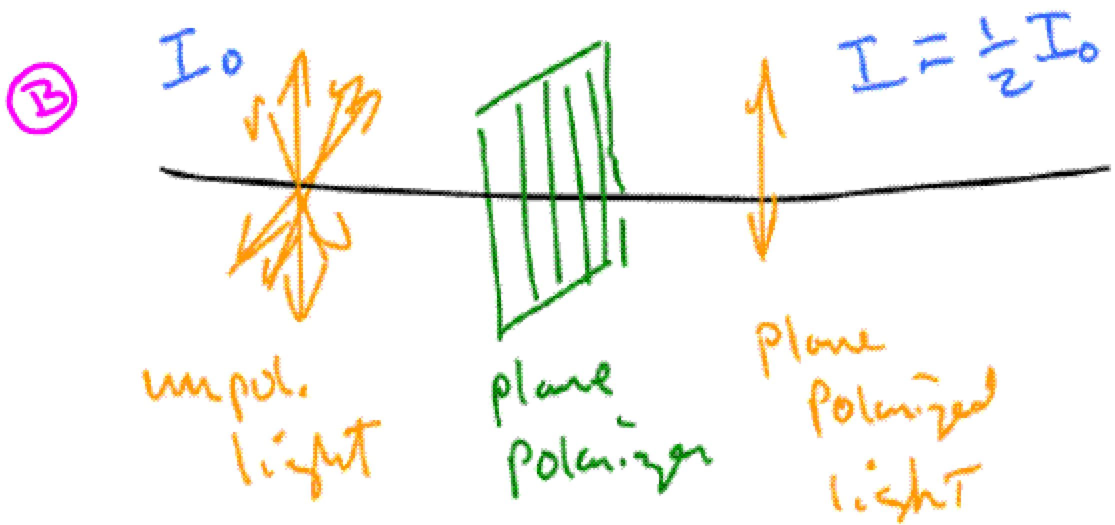
$$E_y = E_{y0} \sin(kx - \omega t + \varphi)$$

See java applet on class website

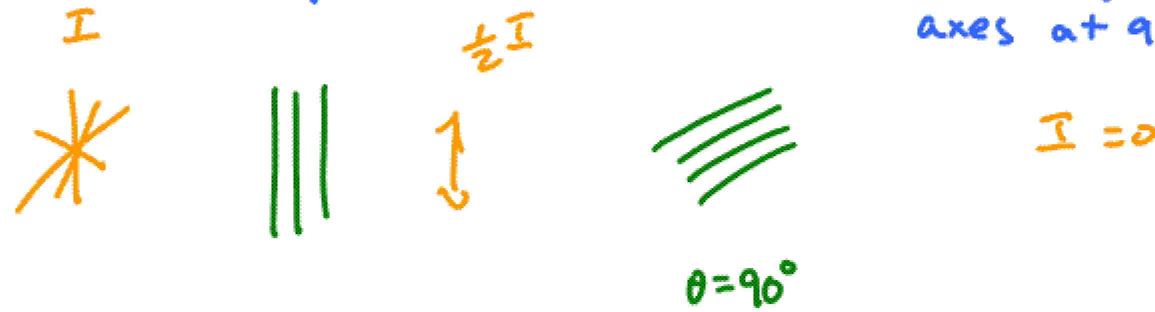
Amplitudes + phases may differ to give different types of Polarization



$$I_{New} \sim E_0^2 \cos^2\theta \sim I_{init} \cos^2\theta$$



Send initially unpolarized light thru 2 polarizers w/ polarizing axes at 90° to each other

Ⓐ


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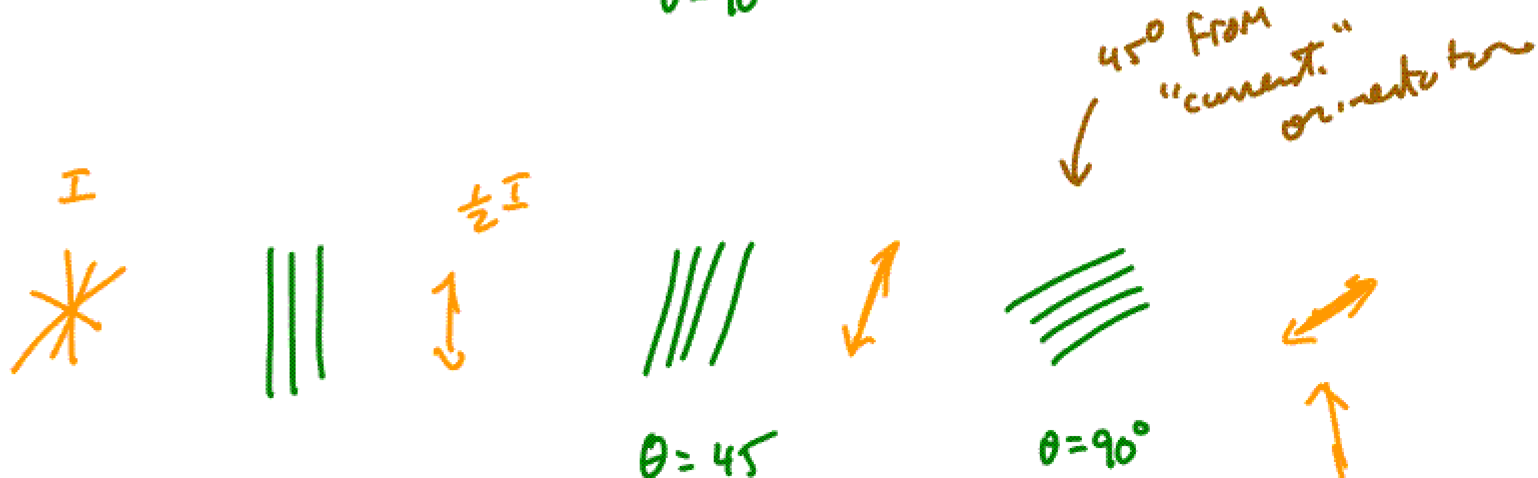
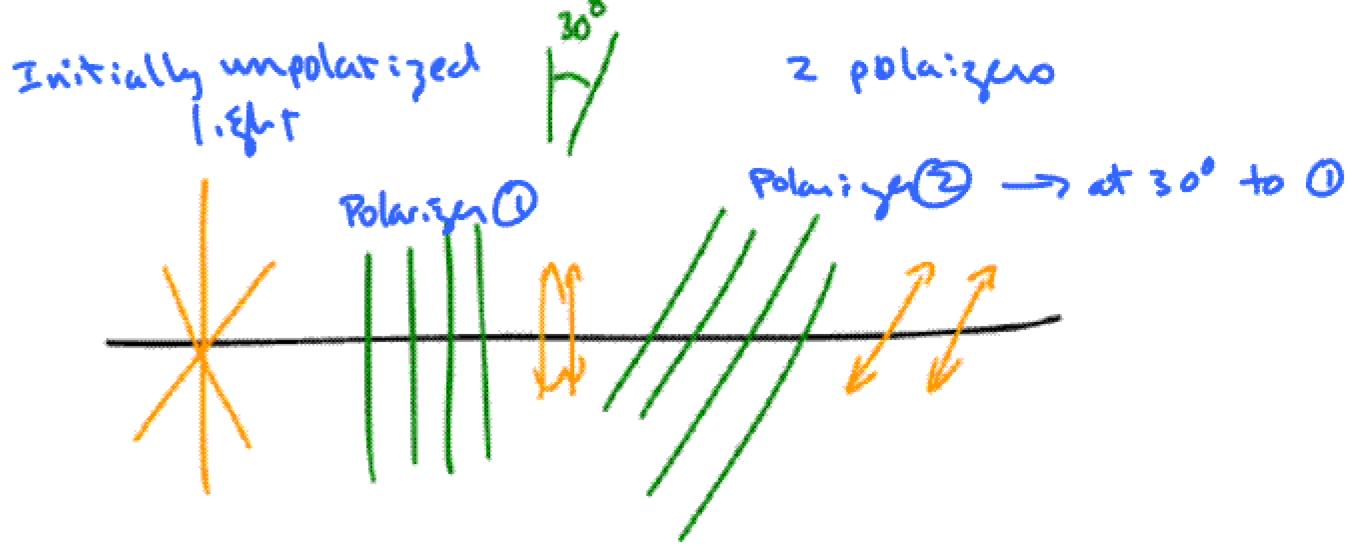


Now put a 3rd polarizer between the other two at 45°

$I = (\frac{1}{2}I)\cos^2 45$

$I = \left[(\frac{1}{2}I)\cos^2 45\right]\cos^2 45$

NOT zero !



I_0 $\frac{1}{2} I_0$ $I = \frac{1}{2} I_0 \cos^2 30$

EM waves + laws of optics

Light in a Material

$$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} \Rightarrow v = \frac{1}{\sqrt{\epsilon \mu}}$$

$$v < c$$

$$\frac{c}{v} \equiv n \equiv \text{index of refraction}$$

vacuum

$n \geq 1$

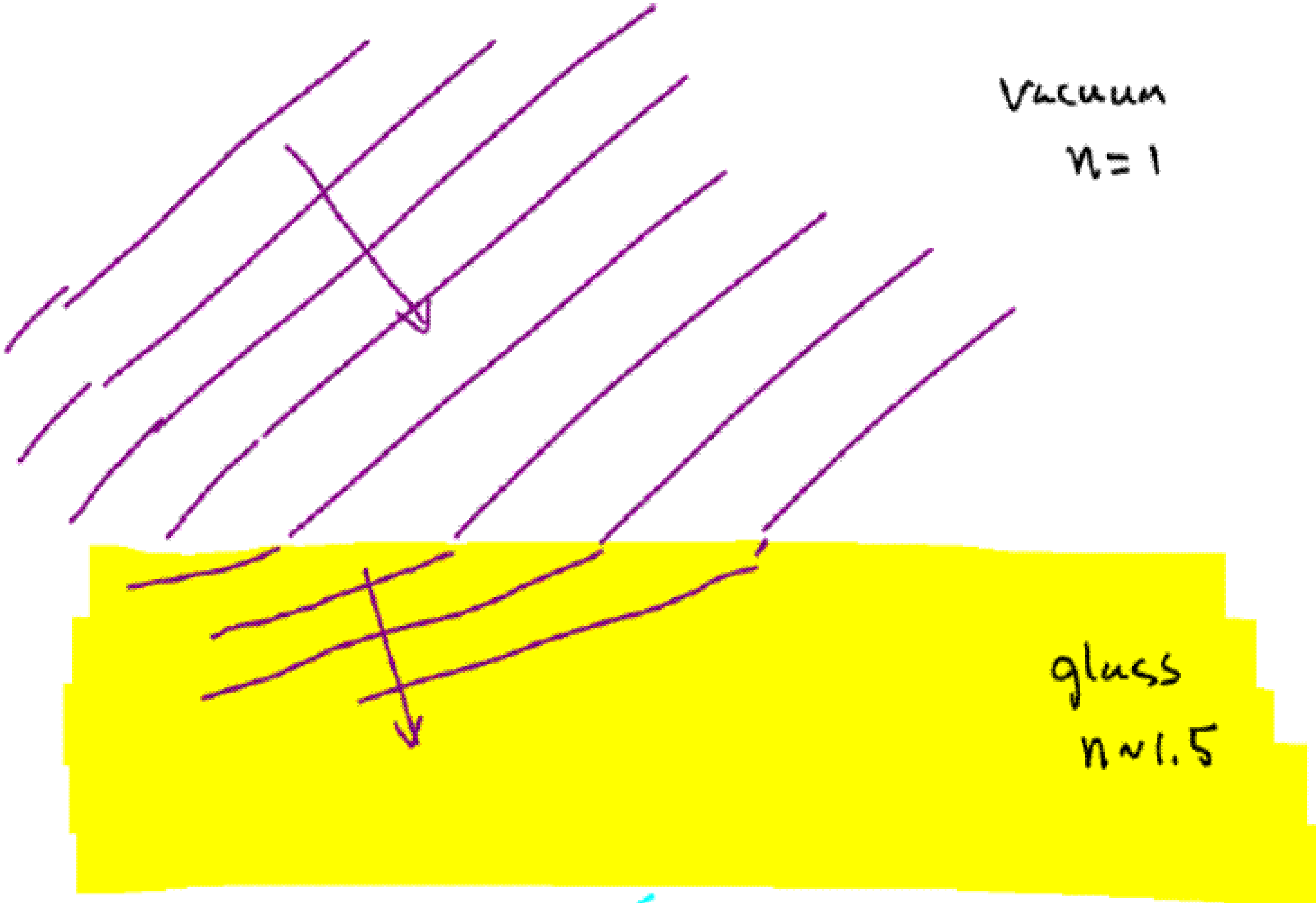
$$\lambda_0 \nu = c \qquad \lambda \nu = v$$

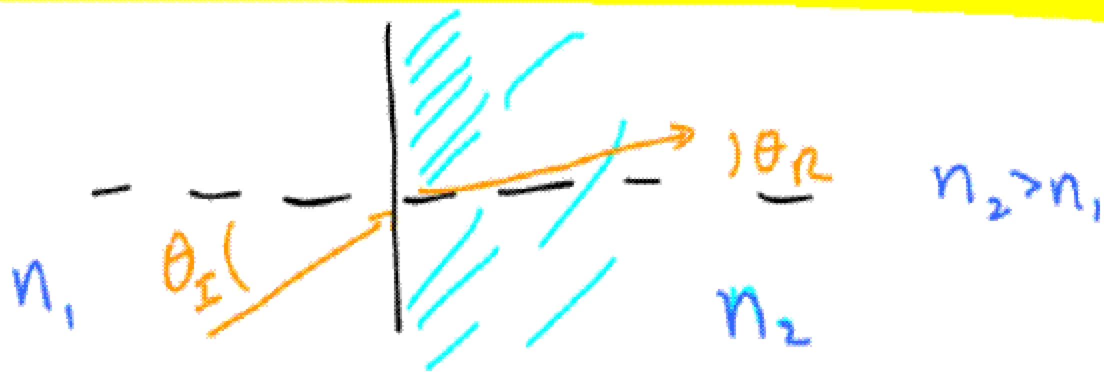
$$\lambda \nu = \frac{c}{n}$$

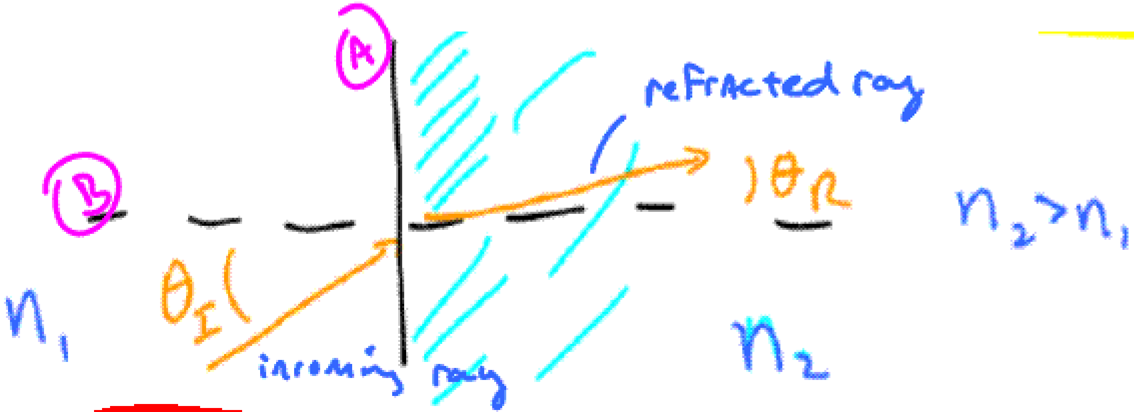
$$\lambda n = \frac{c}{\nu} = \lambda_0$$

in material — in vacuum

λ in material is shorter than in vacuum

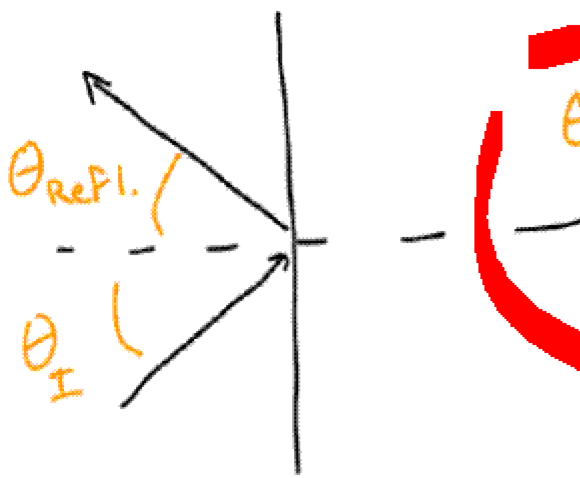

vacuum
n=1
glass
n~1.5


θ_R
$n_2 > n_1$
n_1
θ_I
n_2



Snell's law $n_1 \sin\theta_I = n_2 \sin\theta_R$

Refraction



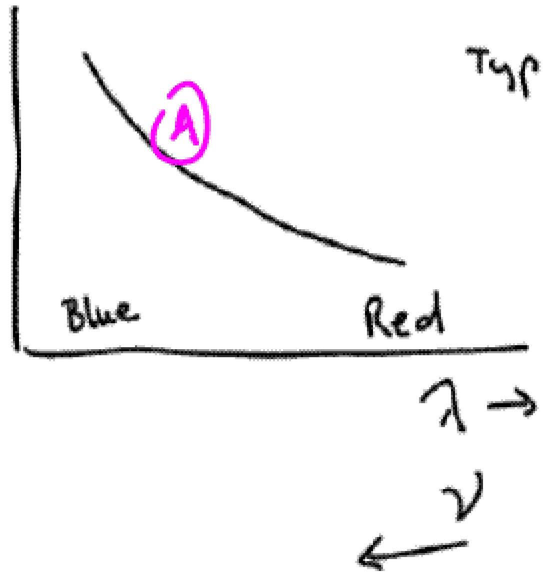
$\theta_I = \theta_{Refl}$

Law of Reflection

Dispersion

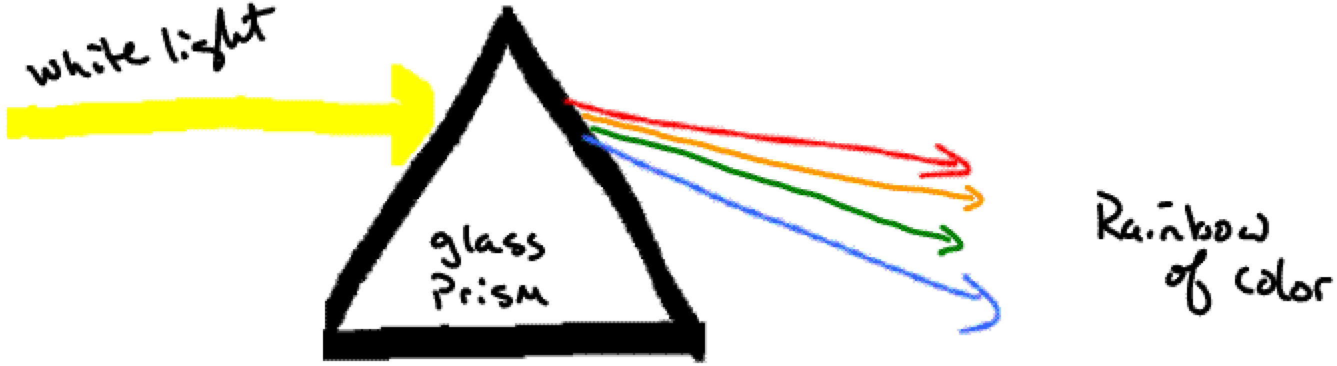
n depends on λ (ν)

$\frac{c}{v} = n$



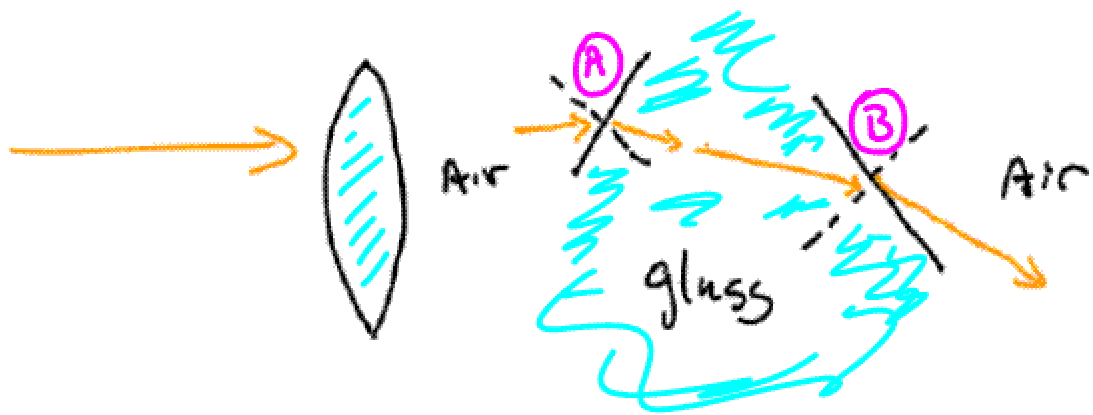
Typically $n(\text{red}) < n(\text{blue})$

red light typically faster

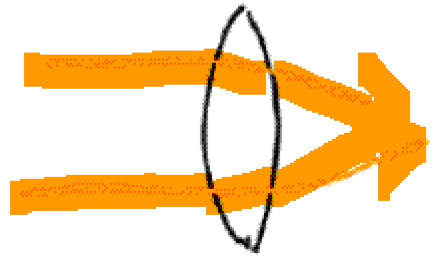


because $n_{red} < n_{blue}$
red bent less

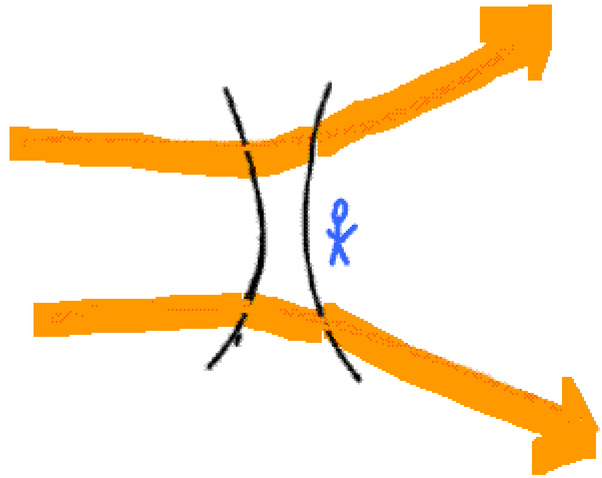
operation of a thin convex lens



Converging lens (convex)

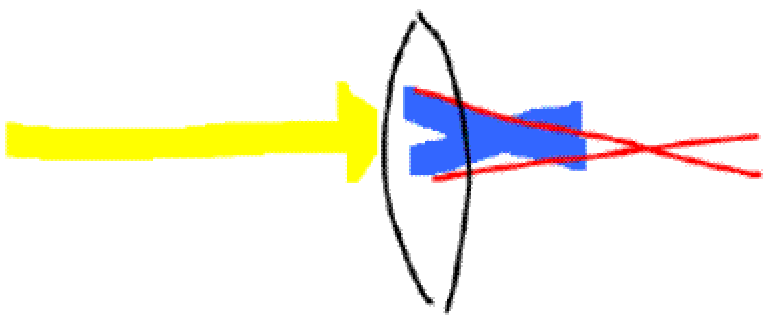


Diverging lens (concave)

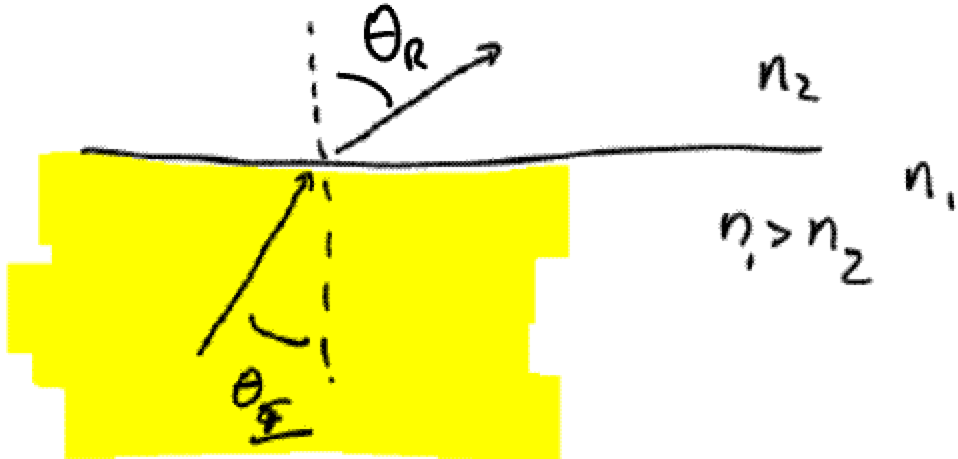


common abberation

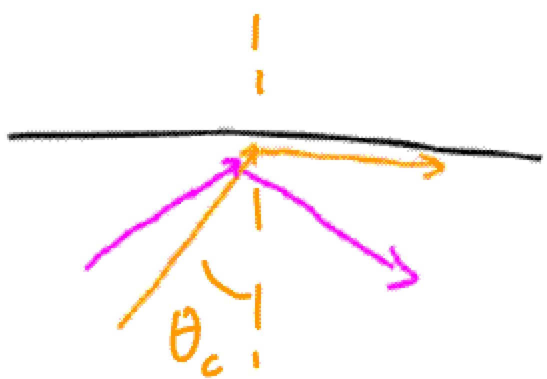
Chromatic dispersion



Pulse broadening in optical fibers



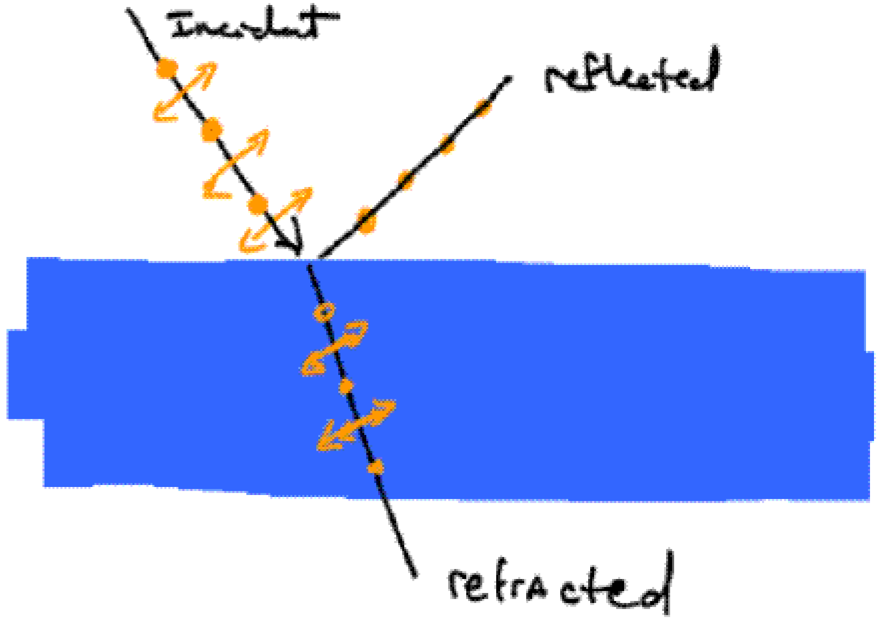
$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$



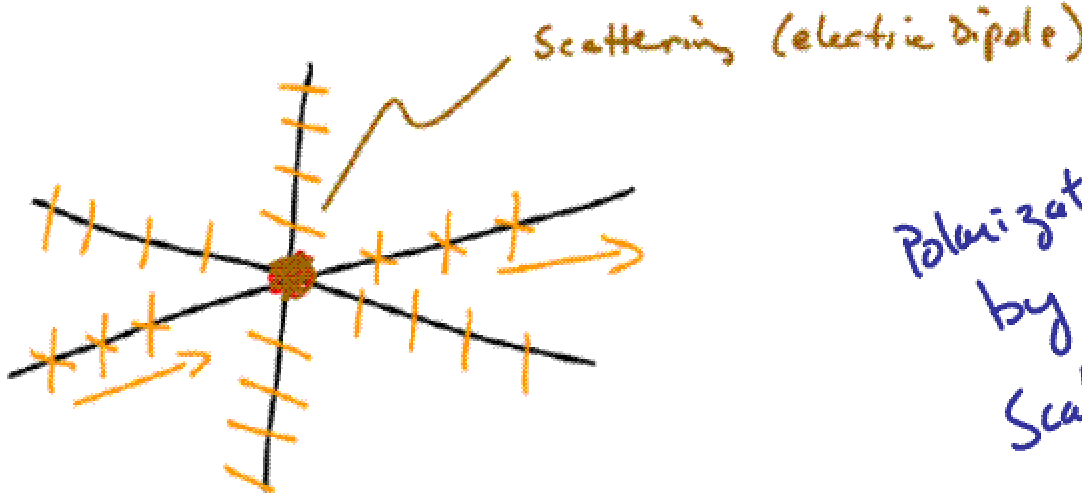
$$n_1 \sin \theta_c = n_2 \sin 90$$

θ_c = critical Angle

If $\theta_I > \theta_c$ Total internal reflection



Polarización by Reflection



Polarización by Scattering