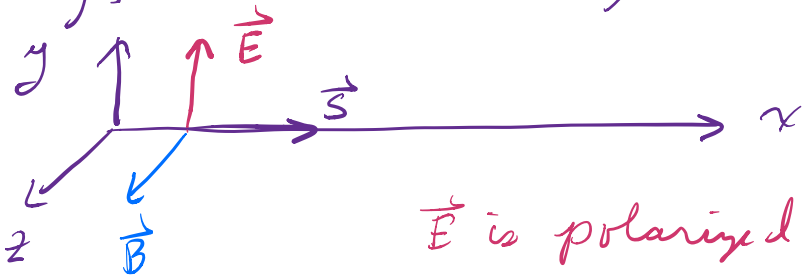
Polarization

(direction of $\vec{E}$)

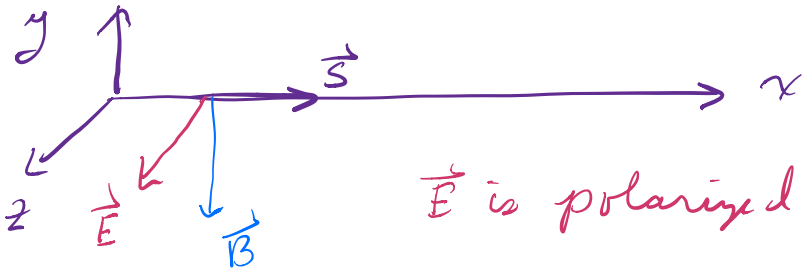
e.g. wave to the right



$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$

$\vec{E}$ is polarized along y-axis.

another possibility:



$\vec{E}$ is polarized along z axis

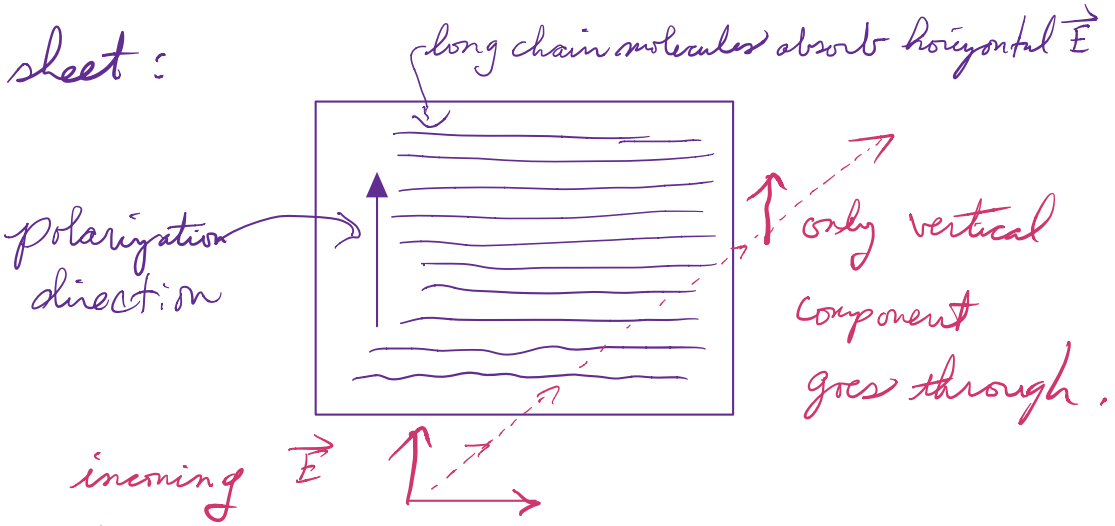
or ... any linear combination of those.

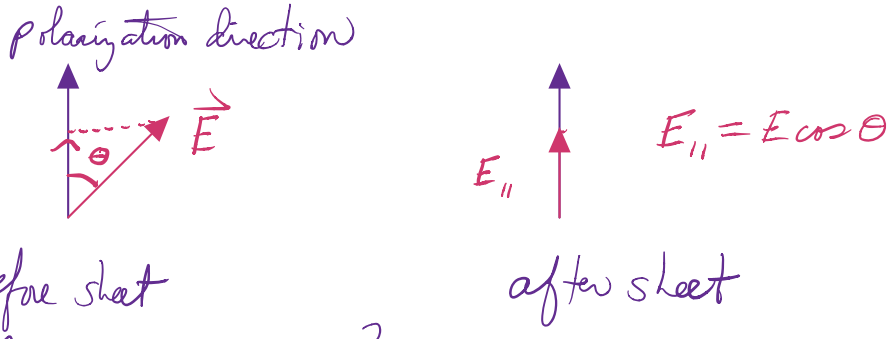
Ordinary light is "unpolarized" — a superposition of EM waves with random polarizations.

Linear polarized light: light with a single direction for $\vec{E}$.

Polarizer: device that passes through the component of $\vec{E}$ parallel to the polarizer axis.

polaroid sheet:





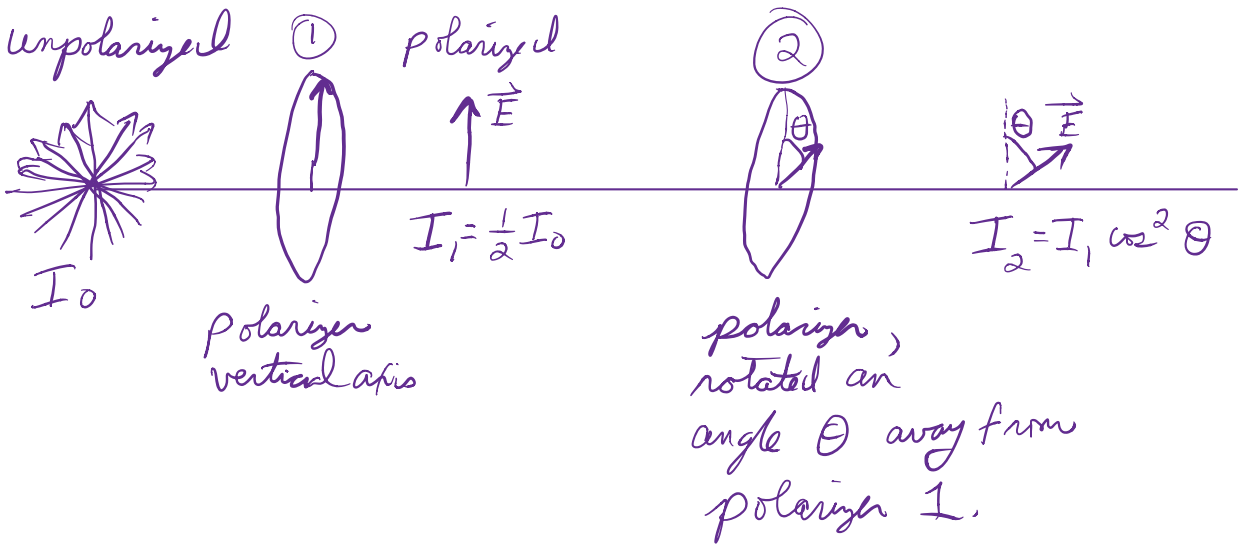
Recall Intensity $\propto E^2$

$\therefore$ $I_{after} = I_{before}\cos^2\theta$ Malus's Law

where θ = angle between polarization direction and $\vec{E}$.

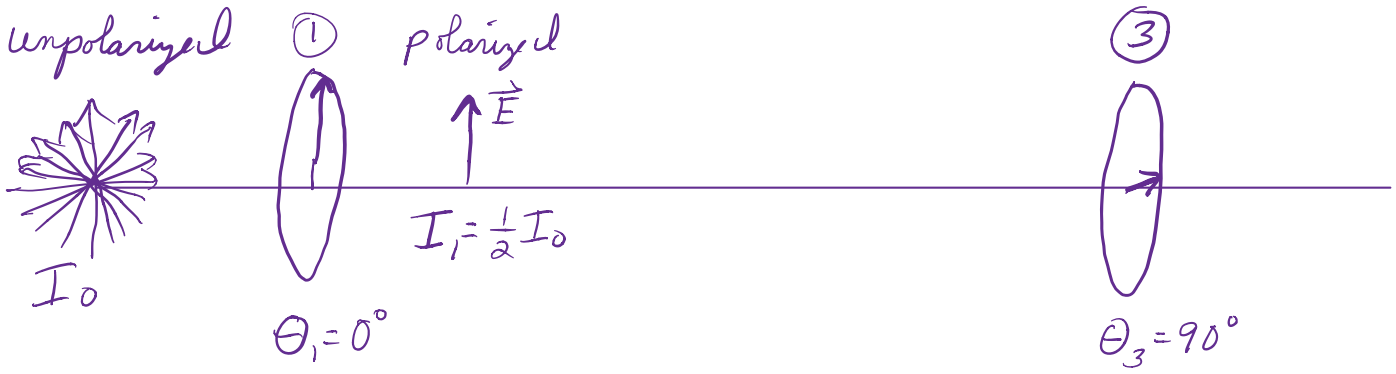
Special case: initially unpolarized light:

$$I_{after} = \frac{1}{2} I_{before}$$



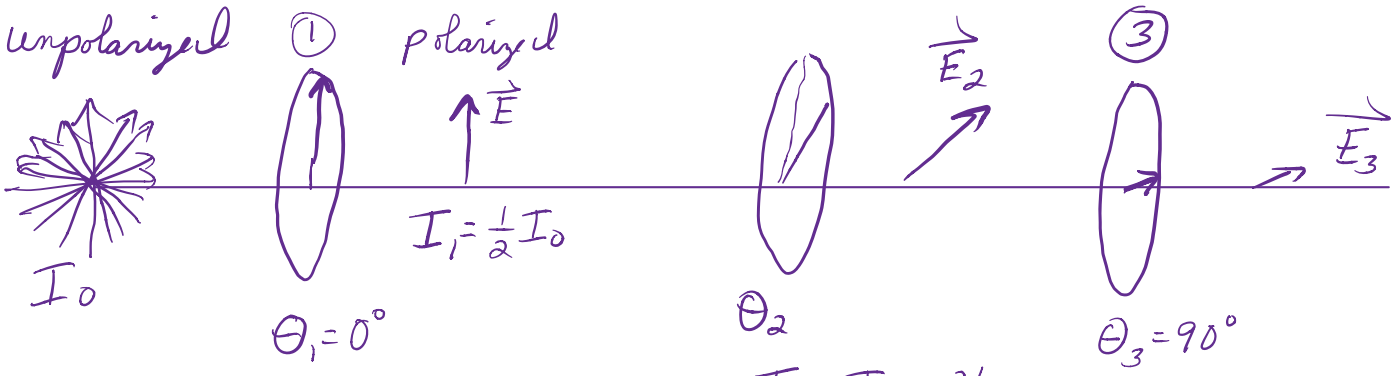
Examples: ch25-polarizer-[1,2].pdf

Crossed polarizers



$$I_3 = I_1 \cos^2 90° = 0$$

Add a polarizing material in between



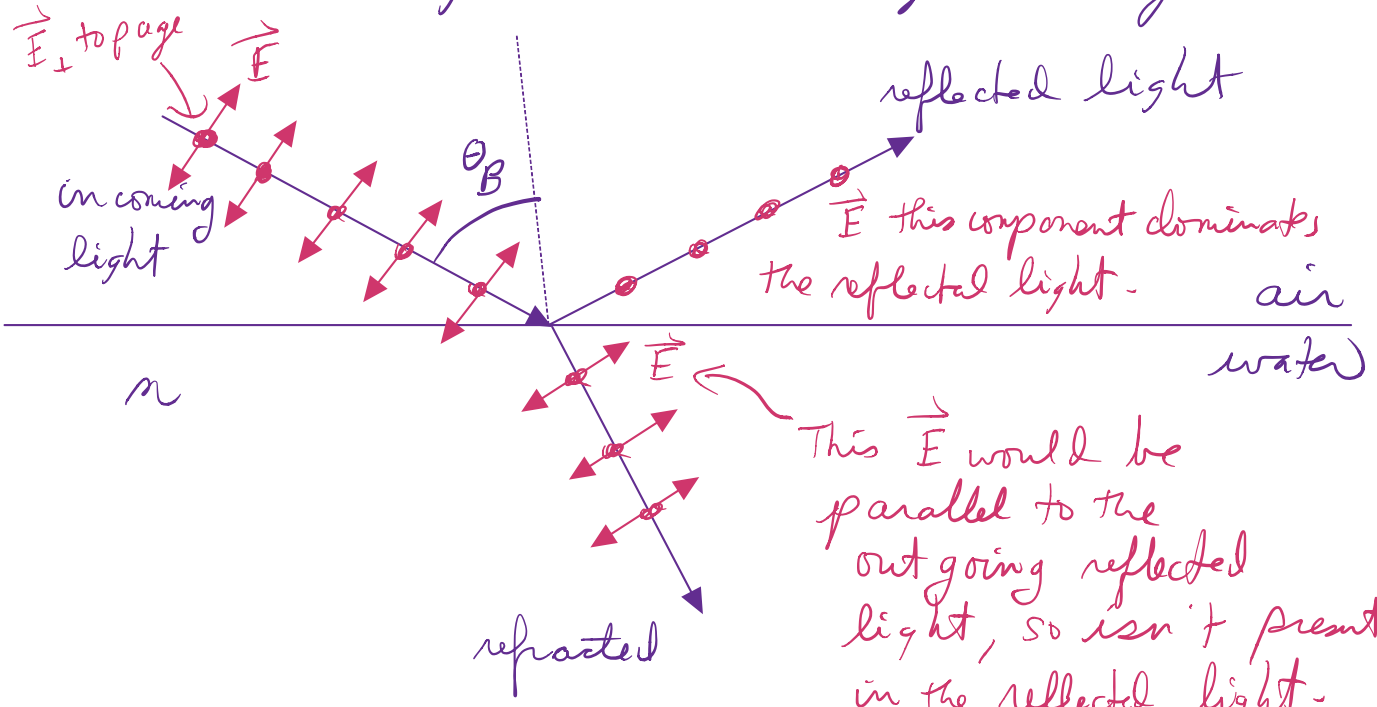
$$I_2 = I_1 \cos^2(\theta_2 - \theta_1)$$

$$I_3 = I_2 \cos^2(\theta_3 - \theta_2)$$

This can be a useful way to highlight materials that change polarization. See examples in text.

Other applications: Many optical phenomena, such as scattering and reflection, are sensitive to polarization.

Brewster's Angle and Polarized Sunglasses



If there would be a 90° angle between the refracted and reflected rays, the reflected ray is polarized.

$$\theta_B = \tan^{-1}(n) = \text{Brewster's angle}$$

e.g. $n = 1.52$ (typical glass) $\theta_B = 56.7°$.

This means reflected light is polarized. This glare can then be blocked by polarized sunglasses.