b) Determine the index of refraction of the plastic.

$$\tan\theta_B = \frac{n_2}{n_1} \leftarrow 1$$

$\uparrow$ 50°

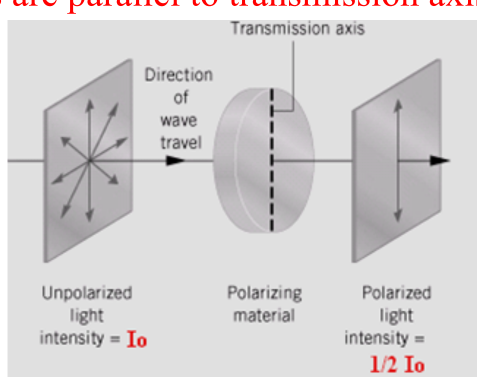
A more sophisticated model of a polarizer using light

I_0 = intensity of incident light

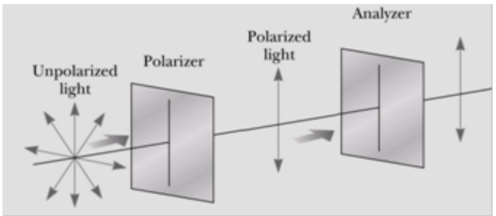
A polarizer allows the parallel component of any wave to pass through and blocks the perpendicular component of any wave.

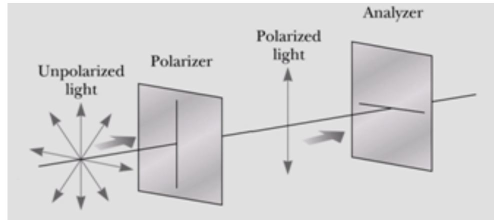
If unpolarized light is incident on a polarizer with intensity I-$_0$, what is the intensity of the transmitted polarized light? ½ I_0

Why? ½ of components of all waves are parallel to transmission axis



Analyzer – polarizer used to detect polarized light





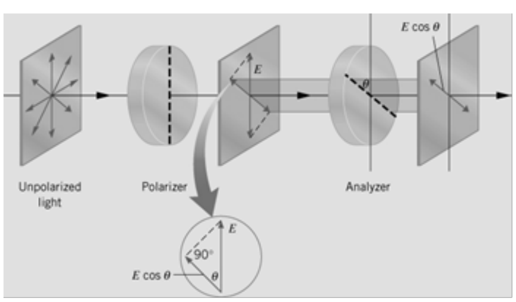
When the transmission axis of the analyzer is parallel to that of the polarizer . . . all polarized light passes through

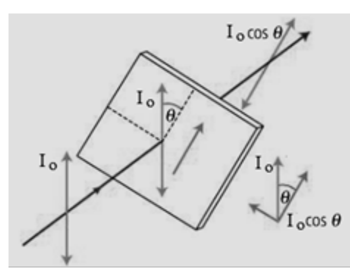
When the transmission axis of the analyzer is perpendicular to that of the polarizer . . . no light passes through

What happens when the analyzer is neither parallel nor perpendicular to the polarizer?

Only the component of the polarized light . . .

parallel to the transmission axis of the analyzer passes through





Malus' Law:

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

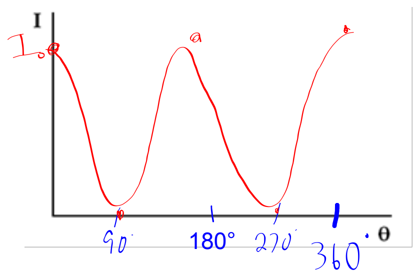
Where:

I = transmitted intensity

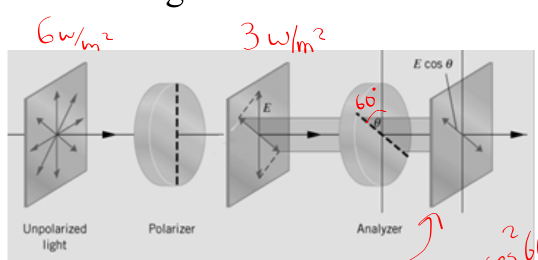
I_0 = intensity of light incident **on the analyzer**

θ = angle between transmission axis of polarizer and analyzer

2. Sketch the relationship between the intensity of the transmitted light and the angle between the two polarizing filters.



3. Natural, unpolarized light of intensity 6.0 W m^{-2} is incident on two polarizing filters oriented at 60^0 to each other.
Find the intensity of the light transmitted through each of them.

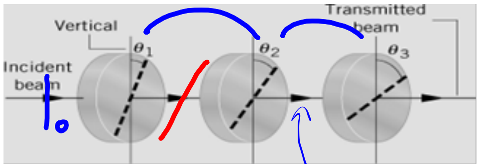


$I = 3 w/m^2 \cdot \cos^2 60°$

$= .75 w/m^2$

4. A beam of unpolarized light, whose intensity is 1551 W/m^2, is incident on the first polarizing filter as shown. The three filters make angles of $\theta_1 = 30^o$, $\theta_2 = 45^o$, and $\theta_3 = 70^o$ with the vertical as shown. What is the final intensity of the beam transmitted through the three filters?

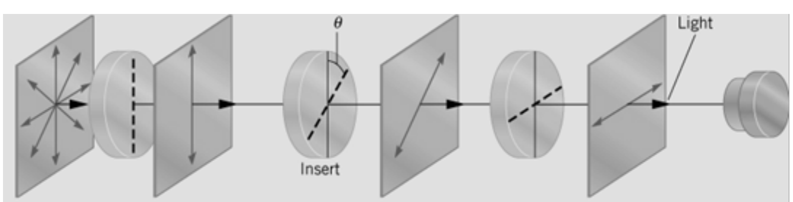
$\theta = 15^\circ$ 25°



$\frac{I_o}{2}$ $\frac{I_o}{2}\cos^2 15^o$

How can light be transmitted through "crossed polarizers?"

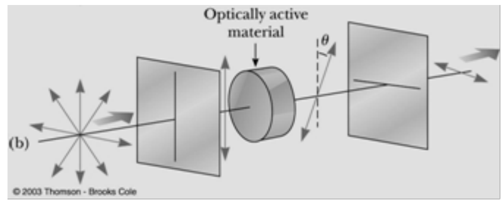
Insert an intermediate polarizer (or an optically active substance) between the original polarizer and the analyzer. Some component of light from the first polarizer will make it through this intermediate polarizer and then some component of this light will make it through the analyzer. The intermediate polarizer "rotates the plane of polarization" at the cost of lost intensity.



Optically Active Substance –

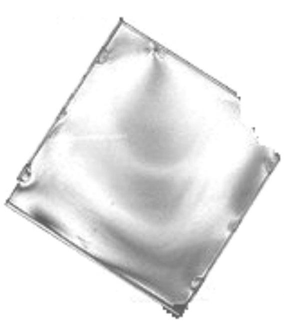
a) one that rotates the plane of polarization of the light that passes through it

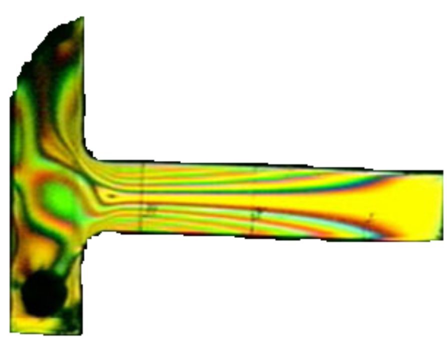
b) one that changes the plane in which the electric field vector of the light vibrates



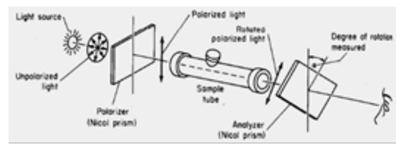
Applications of polarization

1. **Stress analysis**: Some materials are optically active under stress and allow different colors to pass through at different angles.
Engineers can build models out of plastic and subject them to stress. Then when they are placed between a polarizer and an analyzer
and viewed, points of probable mechanical failure due to high stress can be determined.





2. **Determining the concentration of solutions**: Sugar solutions, such as glucose, are optically active. The angle by which polarized light is rotated when passing through the solution is related to the concentration of the solution. Therefore, if a container with a sugar solution is placed between a polarizer and an analyzer and the analyzer is rotated until the intensity of the light passing through it is maximum then from measuring the angle of rotation the concentration of the solution can be calculated.



3. **Liquid crystal displays (LCD):** Calculators, watches, computer screens and televisions have displays that are made up of thousands of small dots called pixels. In an LCD, each pixel is made of a tiny liquid crystal. Liquid crystals have a very useful property; normally they rotate the plane of polarization through 90^0, but when a voltage is applied across them, they don't. So if a liquid crystal is placed between two crossed polarizers the crystal goes dark when the voltage is applied.