Polarization of Light

IB 12

Nature of EM Waves:

1.

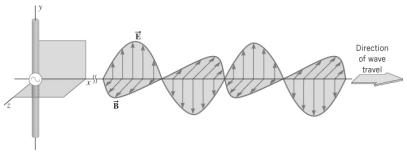
2.

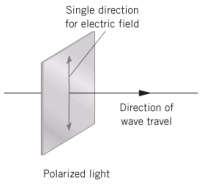
3.

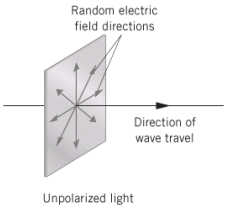
4.

Polarized Light –

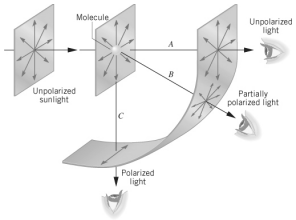
Unpolarized Light –





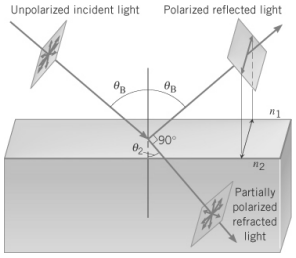


Polarization of sunlight:



1. **from scattering by molecules in atmosphere**: Sunlight is polarized in a direction perpendicular to direction of wave velocity.

2. **by reflection from non-metallic surface:** Incident sunlight is unpolarized. Reflected and refracted rays are partially polarized by the surface. The plane of polarization of the reflected light is horizontal (parallel to surface). If the reflected and refracted rays are perpendicular, the reflected light is completely polarized. The angle of incidence for this complete polarization depends on relative indices of refraction of the two substances and is known as Brewster's angle (ϕ).



Brewster's Law – When light is incident on a surface at such an angle that the reflected and transmitted rays are perpendicular and the reflected ray is totally plane polarized, then the index of refraction of the substance is equal to the tangent of the angle of incidence. ($n = tan\ \phi$)

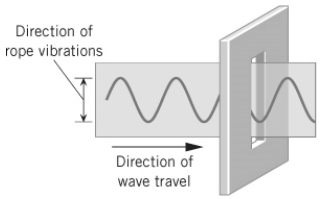
Derivation:

Example: What is Brewster's angle for sunlight reflected off a lake?

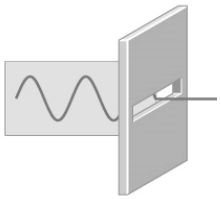
Polarizer –

Transmission axis –

A simple model of a polarizer using a wave on a rope



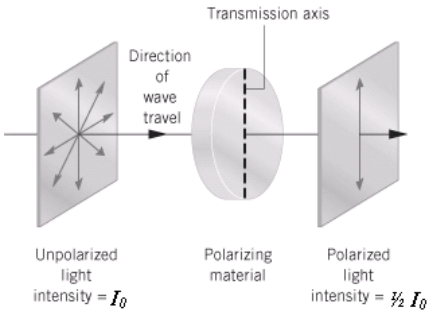
Transmission axis of polarizer is parallel to the plane of polarization of the wave.



Transmission axis of polarizer is perpendicular to the plane of polarization of the wave.

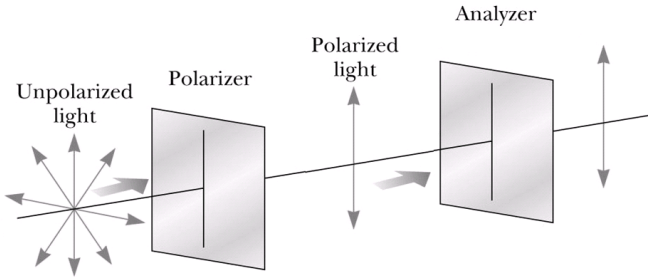
NOTE:

A more sophisticated model of a polarizer using light



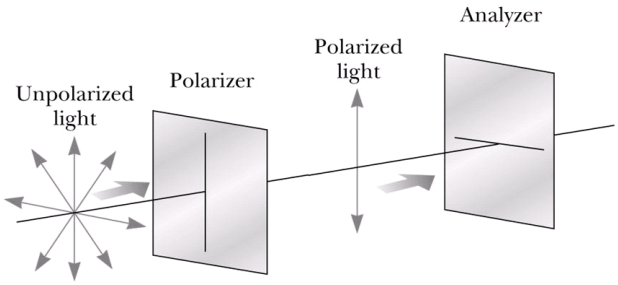
How do polarized sunglasses reduce glare?

Analyzer –



When the transmission axis of the analyzer is parallel to that of the polarizer . . . _____

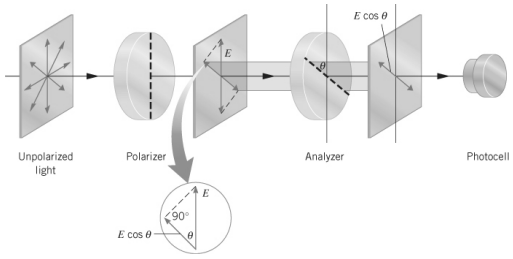
_____



When the transmission axis of the analyzer is perpendicular to that of the polarizer . . . _____

_____

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



Derivation:

Malus' Law – the transmitted intensity of polarized light is equal to the product of the incident intensity times the square of the cosine of the angle between the direction of the analyzer and the direction of the electric field vibration of the polarized light ($I = I_o \cos^2 \theta$)

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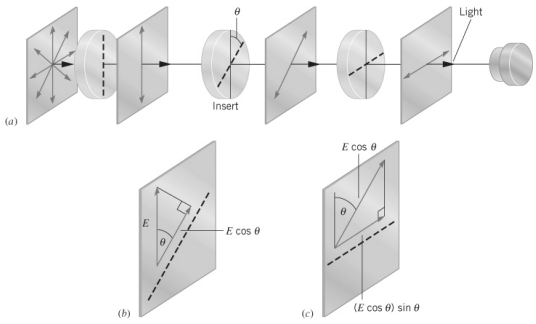
1. Natural, unpolarized light of intensity 6.0 W m^{-2} is incident on two polaroids oriented at 600 to each other. Find the intensity of the light transmitted through both of them.

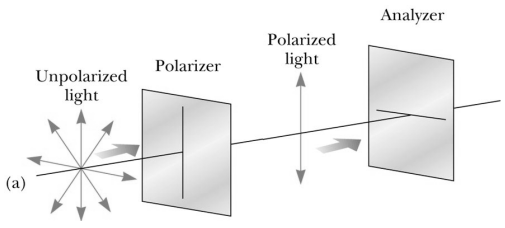
How can light be transmitted through "crossed polarizers?"

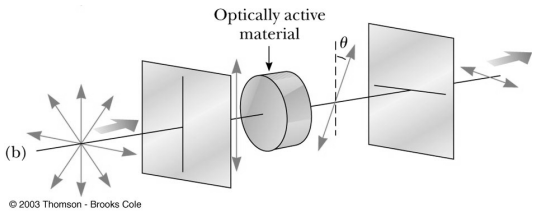


Optically Active Substance –

1)

2)





Applications:

1. Determining the concentration of solutions

2. Stress analysis

3. Liquid crystal displays (LCD)