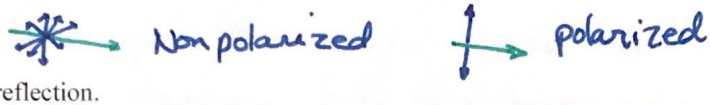
SPH4U1 Task – Polarization Name: Soln

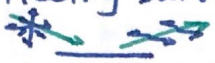
The following questions are about polarization and polarized light.

1. Describe what is meant by polarized light.

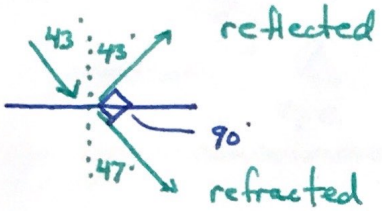
Polarized light is light that has its wave behaviour (E field) aligned.  Non polarized polarized

2. Describe polarization by reflection.

Polarization by reflection is when the reflected light becomes polarized parallel to the reflecting surface. Brester's law represents the ideal case



3. Unpolarized light in air is reflected from a liquid surface in such a way that it is completely polarized. The angle of incidence is 43°. What is the angle of refraction in the liquid?

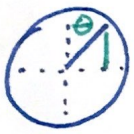


$180 - 43 - 90 = \theta_r$

$\boxed{47^\circ = \theta_r}$

Two disks of Polaroid are aligned so that they polarize light in the same plane.

4. Calculate the angle through which one sheet needs to be turned in order to reduce the amplitude of the observed E-field to one-fifth of its original value.



$E\cos\theta = \frac{1}{5}E$

$\cos\theta = \frac{1}{5}$

$\boxed{\theta = 78.5^\circ}$

∴ the sheet must be rotated 78.5° to reduce the E-field to $\frac{1}{5}$ its original.

5. If the initial intensity was I_0, what will the new intensity be (at the angle you just calculated)?

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

$I = I_0(\cos 78.5)^2$

$I = I_0\left(\frac{1}{5}\right)^2$

$I = \frac{1}{25} I_0$

∴ the intensity is $\frac{1}{25}$ the original.

6. If we want the intensity to be one-fifth of its original value, what must be the angle through which one of the sheets is turned.

$\frac{1}{5}\cancel{I_0} = \cancel{I_0}(\cos\theta)^2$

$\frac{1}{5} = \cos^2\theta$

$\frac{1}{\sqrt{5}} = \cos\theta$

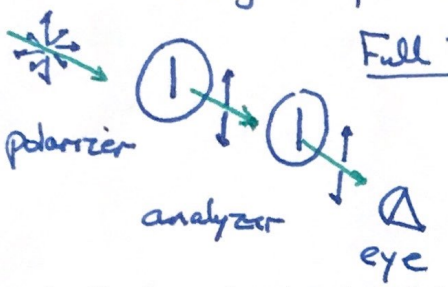
$\theta = 63.4^\circ$

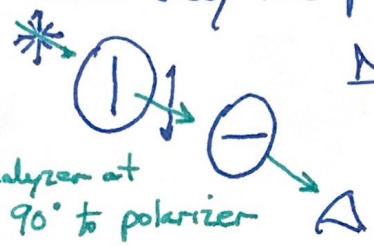
∴ to reduce the intensity, the angle should be 63.4° to $\frac{1}{5}$

Polarized light of intensity I_0 is incident on an analyzer. The transmission axis of the analyzer makes an angle θ with the direction of the electric field of the light waves entering it.

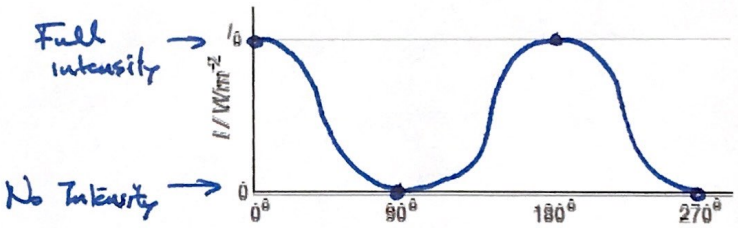
7. Explain the terms polarizer and analyzer, include a diagram of their arrangement and order.

The polarizer acts as a filter for the random E-fields
The analyzer tells you the angle of the "slit" in the polarizer by showing full brightness when they are aligned, to No brightness (intensity) when they are perpendicular.





8. Sketch a graph to show the variation of the intensity of the light transmitted through the analyzer as θ changes from 0° to 270°.



9. A ray of plane-polarized light of intensity 25 Wm^{-2} is normally incident on a polarizing filter. The intensity of the transmitted light is 20 Wm^{-2}. Calculate the angle between the plane of the polarized light and the preferred plane of the filter.

$I_0 = 25\ W/m^2$

$I = 20\ W/m^2$

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

$20 = 25 (\cos\theta)^2$

$\sqrt{\frac{20}{25}} = \cos\theta$

$0.8944 = \cos\theta$

$26.6^\circ = \theta$

∴ the angle between is 26.6°