Assignment 1

1. When going from a more dense to less dense medium (i.e. $n_1 > n_2$) light bends away from the normal. At a so called critical incident angle θ_c, the refracted angle is 90^o. If $\theta_I > \theta_c$ the wave is totally reflected. Evaluate θ_c for a beam reflecting at a glass (n=1.5) air interface.

2. Show that for a s polarized wave, the reflection and transmission coefficients are given by: (Take $\mu_1 = \mu_2 = 1$)

$$R = \left(\frac{1 - \beta\alpha}{1 + \beta\alpha}\right)^2 \qquad \beta \equiv \frac{n_2}{n_1}$$

$$T = \frac{4\alpha\beta}{(1 + \beta\alpha)^2} \qquad \alpha \equiv \frac{\cos\theta_T}{\cos\theta_I}$$

3. Explain how Polaroid sunglasses cut down on glare (Hint: Think of Brewster's angle.)

4. Circular Polarization: Instead of taking x & y as the two orthogonal polarization vectors for a wave propagating in the z direction, one can use the following.

$$\vec{\epsilon}_{\pm} = \hat{x}\cos\omega t \pm \hat{y}\sin\omega t$$

a) Show

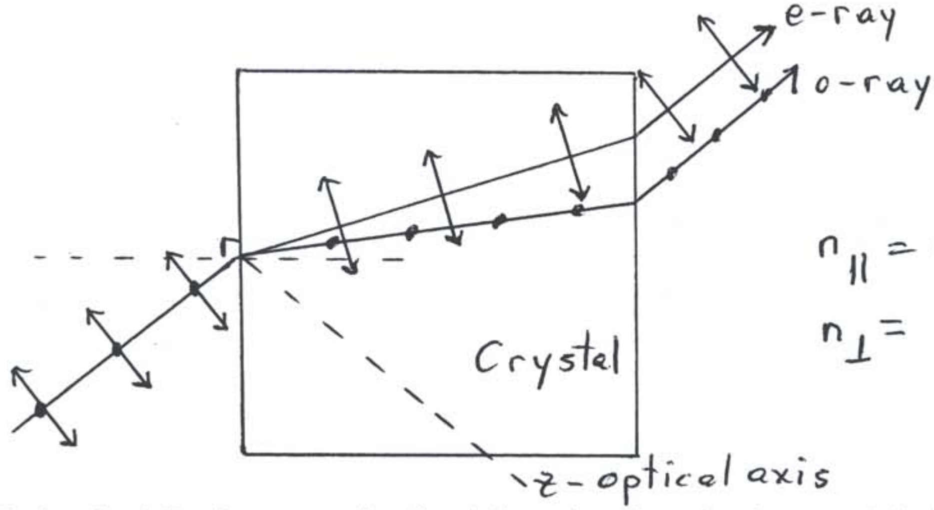
$$\langle \vec{\epsilon}_a \cdot \vec{\epsilon}_b \rangle = \delta_{ab} \qquad a, b = +, -$$

b) Show $\vec{\epsilon}_+$ rotates counterclockwise in the xy plane. Which direction does $\vec{\epsilon}_-$ rotate in?

c) Consider $\vec{E} = \hat{x} E_0 \cos\omega t.$

What fraction of this wave is polarized along $\vec{\epsilon}_+$?

5. Consider light incident on a calcite crystal as shown below, where the angle between the ordinary ray and the optical axis is close to 45°.



$n_{\parallel} = 1.486$

$n_{\perp} = 1.658$

Derive the following expression for alpha and evaluate it. Assume alpha is small.

$$\alpha \simeq \frac{n_{\perp}^2 - n_{\parallel}^2}{\sqrt{2}\left(n_{\perp}^4 + n_{\parallel}^4\right)^{1/2}}$$

$\parallel$ = parallel z

$\perp$ = perpendicular z