Homework #9 (solutions)

Problem 10.8

Calcite : $n_o = 1.658$, $n_e = 1.486$

$\lambda_o = \lambda_0 / n_o = 355\ nm$

$\lambda_e = \lambda_0 / n_e = 396\ nm$

We must use Fresnel's equations to see how much energy is transmitted and reflected

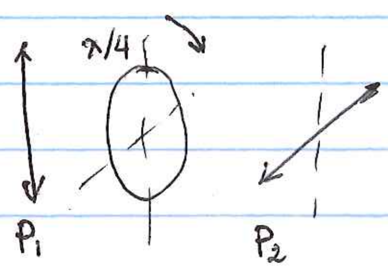
Reflection for intensity $R = \frac{(n-1)^2}{(n+1)^2}$ b/w calcite and the air $n = n_o$, or n_e

$R_o = \left(\frac{n_o - 1}{n_o + 1}\right)^2 = 0.061$ $\qquad$ $R_e = \left(\frac{n_e - 1}{n_e + 1}\right)^2 = 0.038$

Fraction of energy entering the crystal

$T_o = 1 - R_o = 0.939$ $\qquad$ $T_e = 1 - R_e = 0.962$

A1.



~~Quater waveplate, depending on its orientation can~~

The thickness of a ~~wa~~ quater wave plate is such that ~~on~~ a polarization component aligned with its ~~or~~ slow axis is delayed by quater-period with respect of its fast axis.

So if ~~light~~ P1 is aligned with one of the waveplate axes, there is no change in light polarization, ~~P~~ and the polarizer P_2 blocks it, so the minimum transmission is 0.

However, if the waveplate is rotated by 45°, the original linear polarization after P_1 is transformed into circular, so half of its intensity passes through the polarizer.
More accurately, the intensity of light after P_1 is $\frac{1}{2} I_0$, and the intensity after P_2 is a half of this, or $\frac{1}{4} I_0$. This is max. possible transmission.

A2. If the light is sent through the polarizer backward, 100% of it may go through the "output" polarizer (if its polarization is correct), then get rotated by 45° in a magnetic crystal, and then it arrives to the "input" polarization 90° away from its axis. Then the light polarization is determined by the extinction ratio of the input polarizer, so max 10^{-3} fraction of the light is transmitted.

10.7

Verdet constant $V = 90 \ \text{rad}/\text{T}\cdot\text{m}$

$$\varphi = V \cdot l \cdot B \quad \Rightarrow B = \varphi / V \cdot l = 0.707\,\text{rad} \Big/ 90\,\frac{\text{rad}}{\text{T}\cdot\text{m}} \cdot 0.02\,\text{m}$$

$$B = 0.44\,T \quad (\approx 1000 \times \text{Earth magnetic field})$$

The Verdet constant is inversely proportional to the light wavelength, so $\frac{\varphi_{533nm}}{\varphi_{633nm}} = \frac{\lambda_{633nm}}{\lambda_{533nm}}$

Thus $\varphi_{583nm} = 53.4°$, which is 8.4° more that [illegible] the input poralizer axis.

Thus, the 533 nm light transmission will be $\cos^2(8.4°) = 0.022$

A3 Smaller wavelength means one can focus the light into a smaller spot, and thus it allows reducing the size of pits ⇒ more storage capacity on the same size disc.