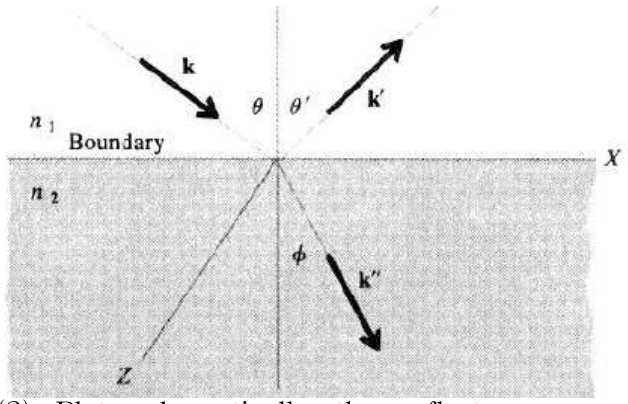
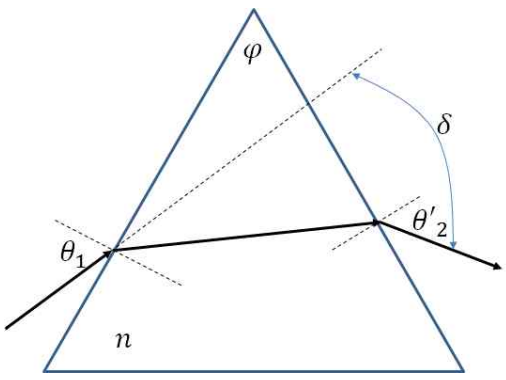
1. (10 point) (1) Derive the Maxwell wave equations for the electric field $\vec{E}$ and magnetic field $\vec{H}$ in the vacuum. And express the speed of light in terms of the permittivity of the vacuum ϵ_o and the permeability of the vacuum μ_o.

2. (20 point)
(1) Derive the Fresnel's equations for the TM polarized wave (p-polarized wave).



(2) Plot schematically the reflectance as a function of the incidence angle θ for the relative index of refraction $n=\frac{n_2}{n_1}>1$. And mark the Brewster angle θ_B. in the plot.

3. (20 point)
(1) Find the deflection angle δ in terms of the angle of incidence θ_1, angle of transmission θ'_2, and the apex angle of the prism ϕ.
(2) Show that $\sin\theta_1=\sqrt{n^2-1}\,\sin\phi-\cos\phi$ when $\theta'_2=90^o$. The index of refraction n of the prism can be obtained using the above relation.



4. (20 point) The Jones matrix for a quarter-wave plate ($\lambda/4$-plate) with a fast axis horizontal is $\begin{pmatrix}1 & 0\\ 0 & i\end{pmatrix}$.
(1) Find the eigenvalues and eigenvectors of the Jones matrix for a $\lambda/4$-plate.
(2) Calculate the polarization of the emerging beam when the $\lambda/4$-plate is inserted into a beam of linearly polarized light polarized at angle θ with respect to the x-axis? What is the polarization of the emerging beam if $\theta=45^o$?

5. (30 point) In Lloyd's single-mirror interference experiment shown below, the angle of incidence is $90^o-\alpha$, where α is very small. Assume that the mirror is halfway between the aperture and the screen.
(1) At a point P in the screen, find the difference in phase between the two waves, one directly arriving at P and the other reflected from the mirror before arriving at P.
(2) Is the first fringe at the point $y=0$ bright or dark? And explain your answer.
(3) Calculate the fringe spacing in terms of α, the wavelength λ, the slit separation h, and the aperture-to-screen distance x.