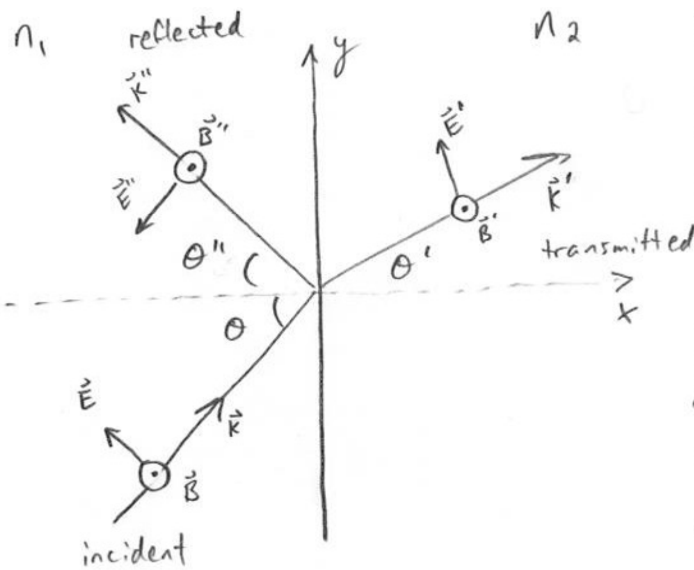
Recitation 2 – Dielectric interfaces

Let's suppose we have TM-polarized light incident on the boundary between two dielectrics with indices n_1 and n_2. The incident light makes some nonzero angle θ with the optical axis. Sketch that situation, including the directions of the k vector, E-field, and B-field for each of the three waves involved.



I'm not yet making any assumptions about θ, θ', and θ'', but we have shown in the past that $\theta = \theta''$ and $n_1 \sin\theta = n_2 \sin\theta'$

Note that I'm fixing the relative directions of $\vec{k}$, $\bar{E}$, and $\bar{B}$ by using the Poynting vector. We know $\vec{k}$ is in the $\bar{E} \times \bar{B}$ direction.

Given an incident electric field of the form

$$\vec{E}_I(\vec{x}, t) = \vec{E}_0 e^{i(\vec{k}\cdot\vec{x} - \omega t + \delta)}$$

What phase angle δ could we choose to represent an incident E-field that has zero magnitude when $\vec{x}$ and t are zero?

Well, when $\vec{x}$ and t are zero, we get

$$\vec{E}_I = \vec{E}_0 e^{i\delta} \qquad \text{And} \quad e^{i(0)} = 1,$$

$$e^{i(\pi/2)} = i$$

$e^{i\delta}$ is never zero by itself for any real δ, but since we take the real part of these expressions to get the physical fields, and $\mathrm{Re}\{e^{i\pi/2}\} = 0$, a phase angle of $\delta = \pi/2$ would do it.