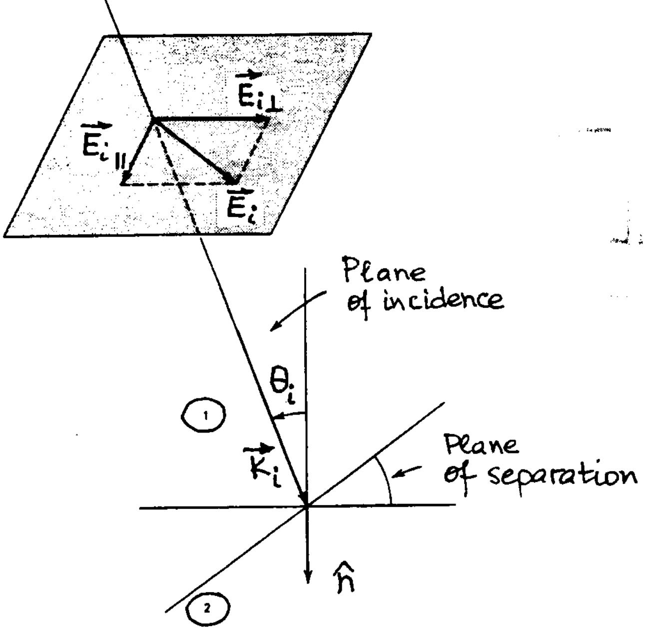
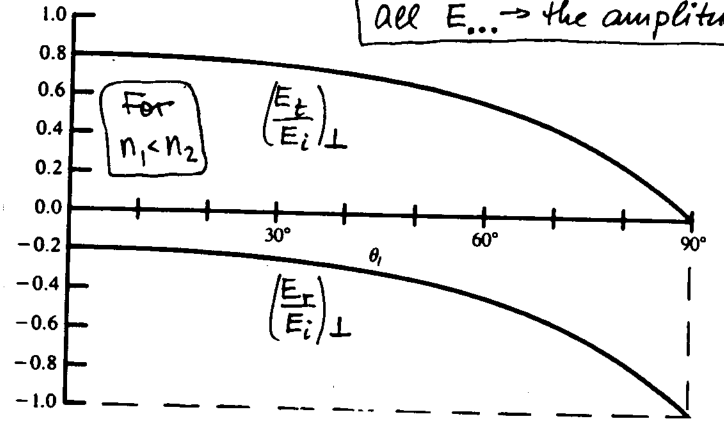


all E... → the amplitudes!



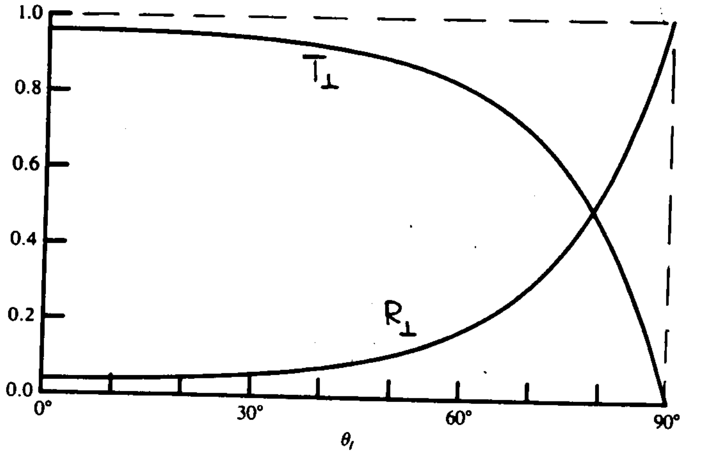
Reflection and refraction when $n_1/n_2 = 1/1.5$, for example, when light falls on a glass of $n = 1.5$. The $\boldsymbol{E}$ field is *normal* to the plane of incidence.

$$\left(\frac{E_r}{E_i}\right)_\perp = \frac{\frac{n_1}{n_2}\cos\theta_i - \cos\theta_t}{\frac{n_1}{n_2}\cos\theta_i + \cos\theta_t} = -\frac{\sin(\theta_i - \theta_t)}{\sin(\theta_i + \theta_t)}$$

$$\left(\frac{E_t}{E_i}\right)_\perp = \frac{2\frac{n_1}{n_2}\cos\theta_i}{\frac{n_1}{n_2}\cos\theta_i + \cos\theta_t} = \frac{2\cos\theta_i \sin\theta_t}{\sin(\theta_i + \theta_t)}$$

$$R_\perp = \left|\frac{\langle\vec{S}_r\rangle\cdot\vec{n}}{\langle\vec{S}_i\rangle\cdot\vec{n}}\right| = \left(\frac{E_r}{E_i}\right)_\perp^2$$

$$T_\perp = \left|\frac{\langle\vec{S}_t\rangle\cdot\hat{n}}{\langle\vec{S}_i\rangle\cdot\hat{n}}\right| = \frac{n_2}{n_1}\left(\frac{E_t}{E_i}\right)_\perp^2 \frac{\cos\theta_t}{\cos\theta_i}$$

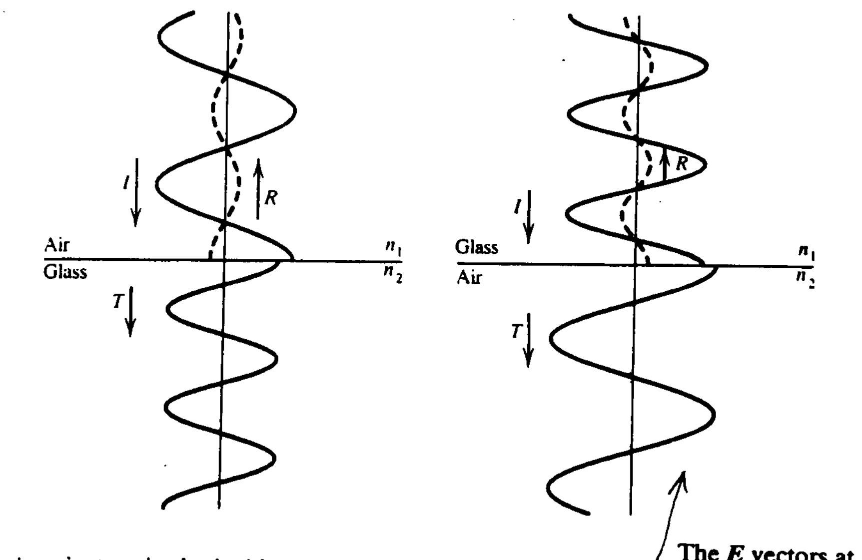


The coefficients of reflection $R_\perp$ and of transmission $T_\perp$ as functions of the angle of incidence θ_i for $n_1/n_2 = 1/1.5$.

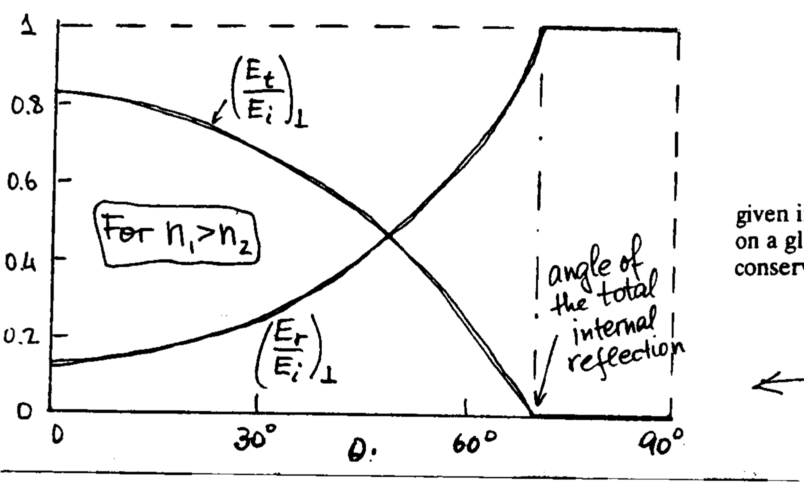
For normal incidence:

$$\left(\frac{E_r}{E_i}\right)_\perp = -\left(\frac{n_2 - n_1}{n_2 + n_1}\right) \qquad \left(\frac{E_t}{E_i}\right)_\perp = \frac{2n_1}{n_2 + n_1}$$

$$R_\perp = \left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2 \qquad T_\perp = \frac{4n_1 n_2}{(n_2 + n_1)^2}$$



The $\boldsymbol{E}$ vectors at given instant in the incident, reflected, and transmitted waves at normal inciden on a glass-air interface. On the right, E_{Tm} is larger than E_{Im}. However, conservation of energy still applies.



Note the phase relation between the incident and reflected waves

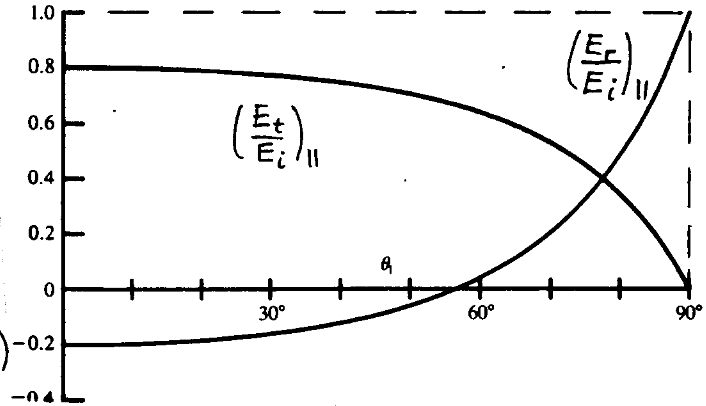
$\left(E_{\parallel}\right)$

$$\left(\frac{E_r}{E_i}\right)_{\parallel} = \frac{\frac{n_1}{n_2}\cos\theta_t - \cos\theta_i}{\frac{n_1}{n_2}\cos\theta_t + \cos\theta_i} = \frac{\tan(\theta_i - \theta_t)}{\tan(\theta_i + \theta_t)}$$

$$\left(\frac{E_t}{E_i}\right)_{\parallel} = \frac{2\frac{n_1}{n_2}\cos\theta_t}{\frac{n_1}{n_2}\cos\theta_t + \cos\theta_i} = \frac{2\cos\theta_i \sin\theta_i}{\sin(\theta_i+\theta_t)\cos(\theta_i-\theta_t)}$$

$$R_{\parallel} = \left[\frac{\tan(\theta_i - \theta_t)}{\tan(\theta_i + \theta_t)}\right]^2$$

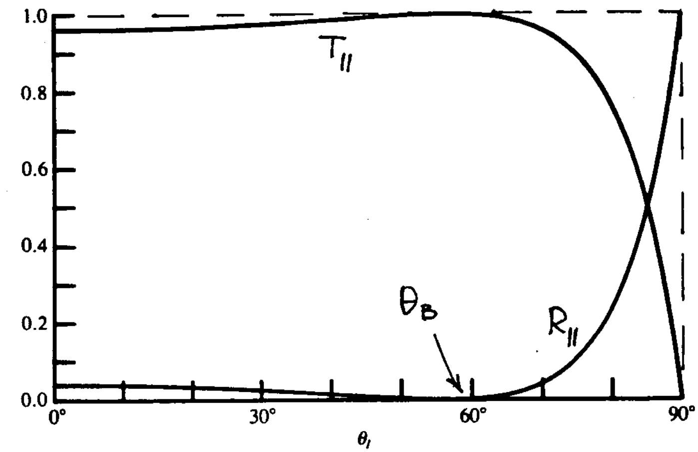
$$T_{\parallel} = \frac{4\frac{n_1}{n_2}\cos\theta_i\cos\theta_t}{\left[\frac{n_1}{n_2}\cos\theta_t + \cos\theta_i\right]^2}$$



Reflection and refraction when $n_1/n_2 = 1/1.5$, but with ***E parallel*** to the plane of incidence.

The Brewster angle: $\theta_t + \theta_i = \frac{\pi}{2}$

$$\boxed{\tan\theta_{iB} = \frac{n_2}{n_1}} \longrightarrow \text{only for } E_{\parallel}!$$



The coefficients of reflection $R_{\parallel}$ and of transmission $T_{\parallel}$ as functions of the angle of incidence θ_i for $n_1/n_2 = 1/1.5$. Note the Brewster angle at 56

The total internal reflection:

$$\boxed{\sin\theta_{ic} = \frac{n_2}{n_1}}$$

(the e. m. wave goes from a material with a greater n_1 toward another material with smaller n_2)

— for both $E_{\parallel}$ and $E_{\perp}$: