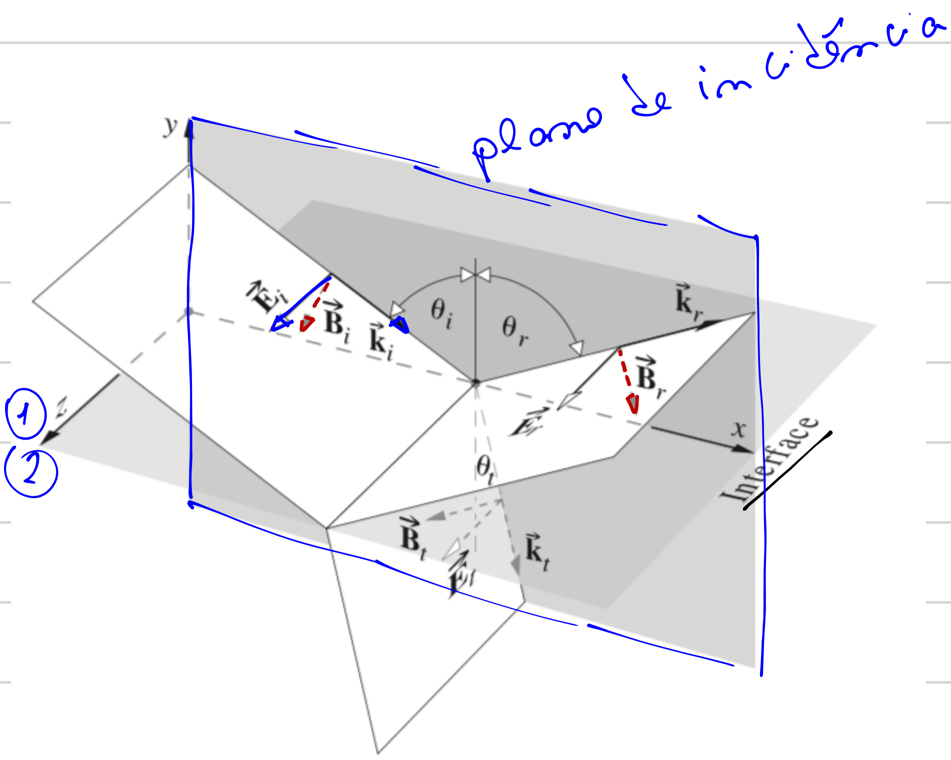
Equações de Fresnel



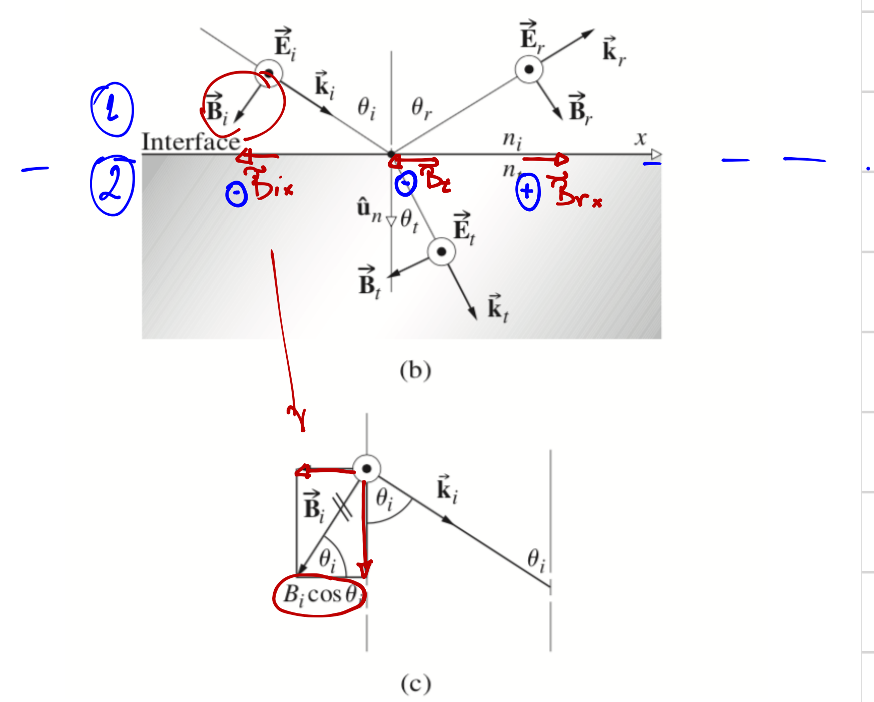


Figure 4.47 An incoming wave whose $\vec{E}$-field is normal to the plane-of-incidence. The fields shown are those at the interface; they have been displaced so the vectors could be drawn without confusion.

→ Campo elétrico $\vec{E}$ perpendicular ao plano de incidência

1º Caso $\vec{E}_{i\perp}$

$$\hat{n} \times (\vec{H}_2 - \vec{H}_1) = 0 \qquad \vec{H} = \frac{B}{\mu}$$

$$\hat{n} \times \frac{\vec{B}_1}{\mu_1} = \hat{n} \times \frac{\vec{B}_2}{\mu_2}$$

meio 1 ← → no meio 2

Somando as amplitudes dos campos $\vec{B}$

$$-\frac{B_{0i}}{\mu_1}\cos\theta_i + \frac{B_{0r}}{\mu_1}\cos\theta_r = -\frac{B_{0t}}{\mu_2}\cos\theta_t$$

Da onda passada $E_{0i} + E_{0r} = E_{0t}$

São válidos na interface entre estes dois meios

$$E_{0i} = v_i B_{0i}$$
$$E_{0r} = v_r B_{0r} = v_i B_{0r}$$
$$E_{0t} = v_t B_{0t}$$

$\theta_i = \theta_r$ reflexão

$$-\frac{E_{0i}}{v_i \mu_1}\cos\theta_i + \frac{E_{0r}}{v_i \mu_1}\cos\theta_i = -\frac{E_{0t}}{v_t \mu_2}\cos\theta_t$$

$$= -\frac{1}{v_t \mu_2}\left[E_{0i} + E_{0r}\right]\cos\theta_t$$

$$E_{0r}\left[\frac{\cos\theta_i}{v_i \mu_1} + \frac{\cos\theta_t}{v_t \mu_2}\right] = E_{0i}\left[\frac{\cos\theta_i}{v_i \mu_1} - \frac{\cos\theta_t}{v_t \mu_2}\right]$$

$$v_i = \frac{c}{n_i} \qquad v_t = \frac{c}{n_t}$$

material 1 e 2 não são magnéticos $\mu_1 = \mu_2 = \mu_0$

$$\frac{E_{0r}}{E_{0i}} = \left[\frac{n_i\cos\theta_i - n_t\cos\theta_t}{n_i\cos\theta_i + n_t\cos\theta_t}\right]$$

p/ $\theta_i = 0$

$$\left(\frac{E_{0r}}{E_{0i}}\right)_\perp = \frac{n_i - n_t}{n_i + n_t}$$

$$r_\perp \equiv \left(\frac{E_{0r}}{E_{0i}}\right)_\perp$$

Coef. de reflexão das amplitudes dos campos elétricos.

$$E_{0r} = E_{0t} - E_{0i} \rightarrow \left(\frac{E_{0t}}{E_{0i}}\right)_\perp \equiv t_\perp$$ Coef. de transmissão

$$\left(\frac{E_{0t}}{E_{0i}}\right)_\perp = \frac{2 n_i \cos\theta_i}{n_i\cos\theta_i + n_t\cos\theta_t}$$

p/ $\theta_i = 0$

$$\left(\frac{E_{0t}}{E_{0i}}\right)_\perp = \frac{2 n_i}{n_i + n_t}$$

2º Caso $\vec{E}_{\parallel}$ paralelo ao plano de incidência

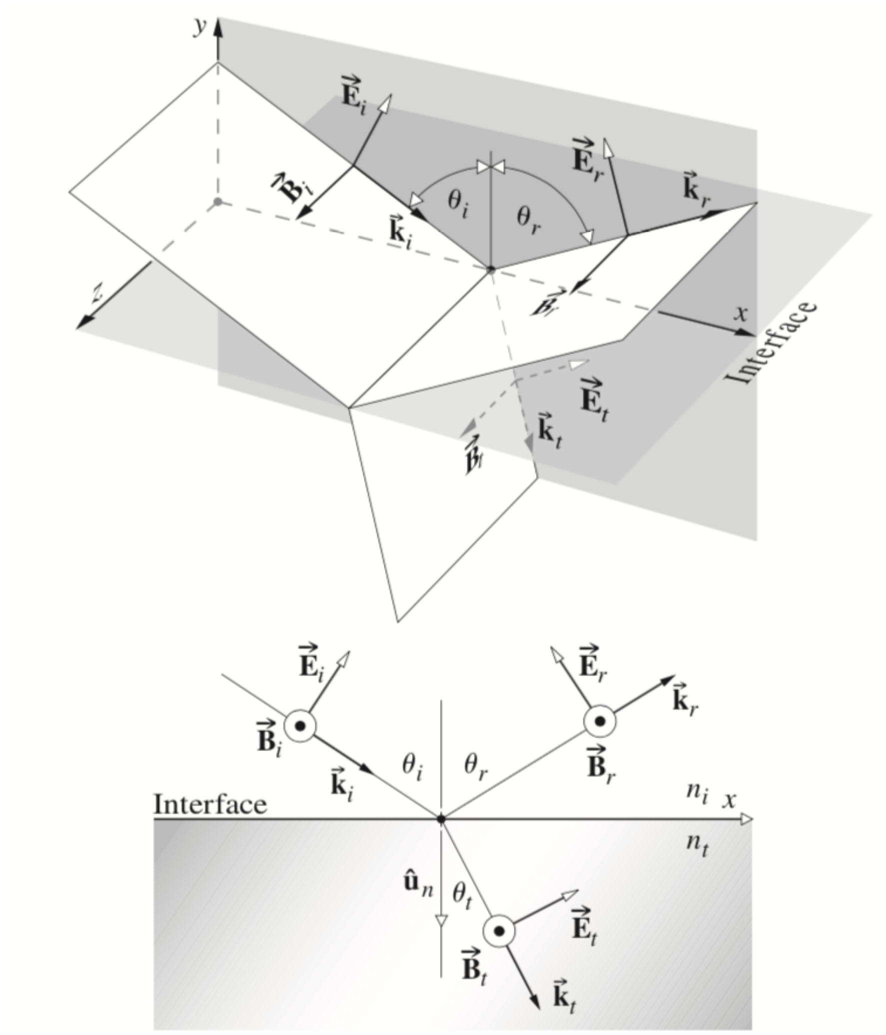


Figure 4.48 An incoming wave whose $\vec{E}$-field is in the plane-of-incidence.

tarefa

$$\left(\frac{E_{0r}}{E_{0i}}\right)_{\parallel} = \frac{n_t \cos\theta_i - n_i \cos\theta_t}{n_i \cos\theta_t + n_t \cos\theta_i}$$

$$\left(\frac{E_{0t}}{E_{0i}}\right)_{\parallel} = \frac{2 n_i \cos\theta_i}{n_i \cos\theta_t + n_t \cos\theta_i}$$

um caso particular, para simplificar
$\theta_i = 0$

$$\boxed{r_{\parallel} = \frac{n_t - n_i}{n_t + n_i}} \qquad \boxed{t_{\parallel} = \frac{2 n_i}{n_i + n_t}} = t_{\perp}$$

$\rightarrow$ $[r_{\parallel}] = -[r_{\perp}]$

$$\boxed{r_{\perp} = \frac{n_i - n_t}{n_t + n_i}}$$

Interpretações das Eq de Fresnel

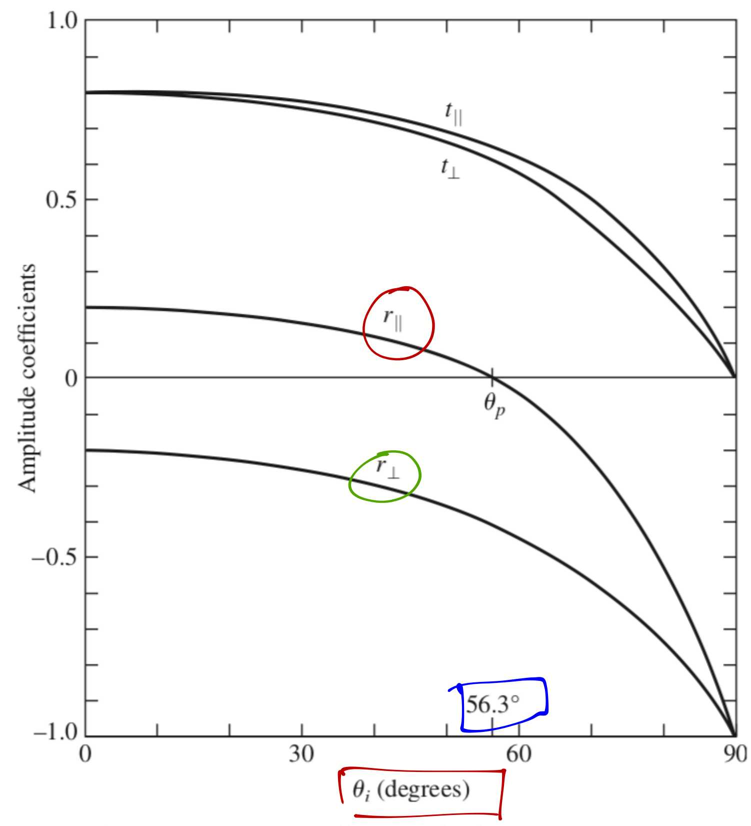
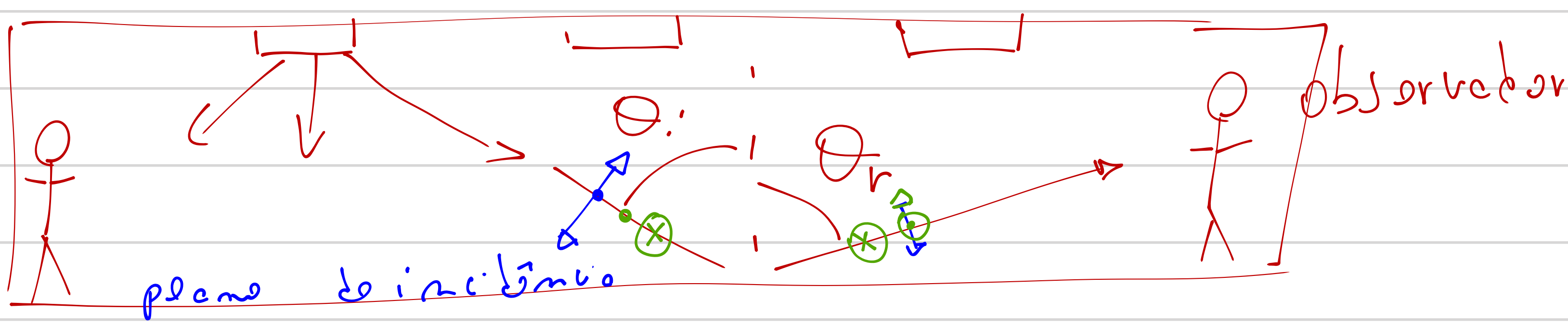


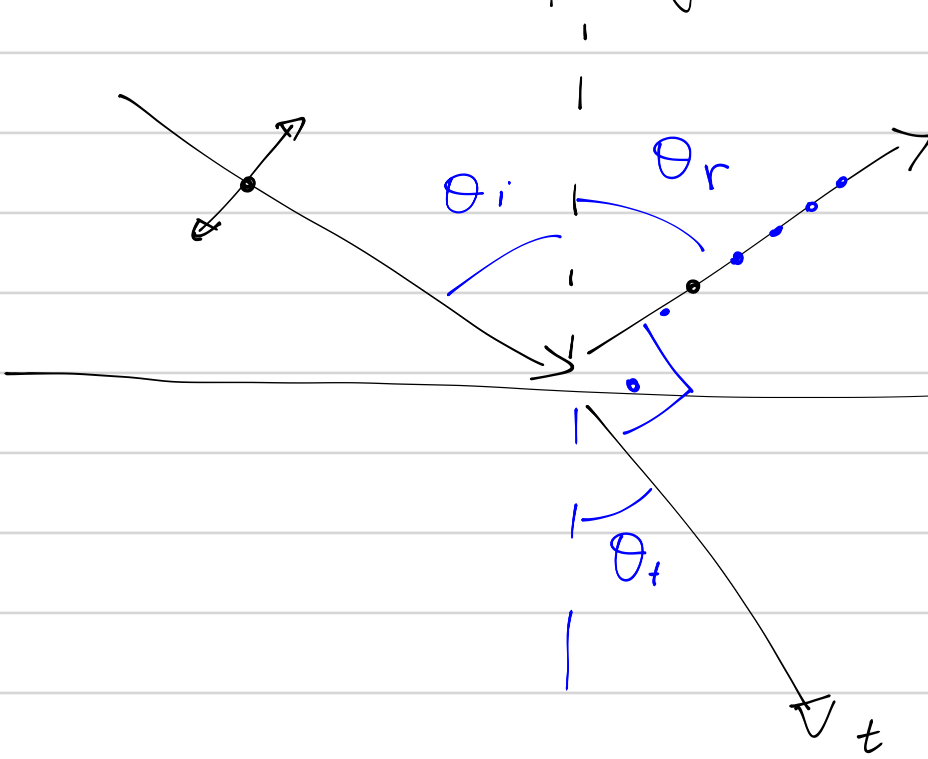
Figure 4.49 The amplitude coefficients of reflection and transmission as a function of incident angle. These correspond to external reflection $n_t > n_i$ at an air–glass interface ($n_{ti} = 1.5$).



1º Exemplo Somente $\vec{E}_\perp$ reflete a um ângulo
→ específico. θ_p = ângulo de polarização
ou
θ_B = ângulo de Brewster

$\vec{E}_{\parallel} = 0$ p/ $\theta = \theta_B$

$$\theta_r + \theta_t = 90°$$



2º exemplo

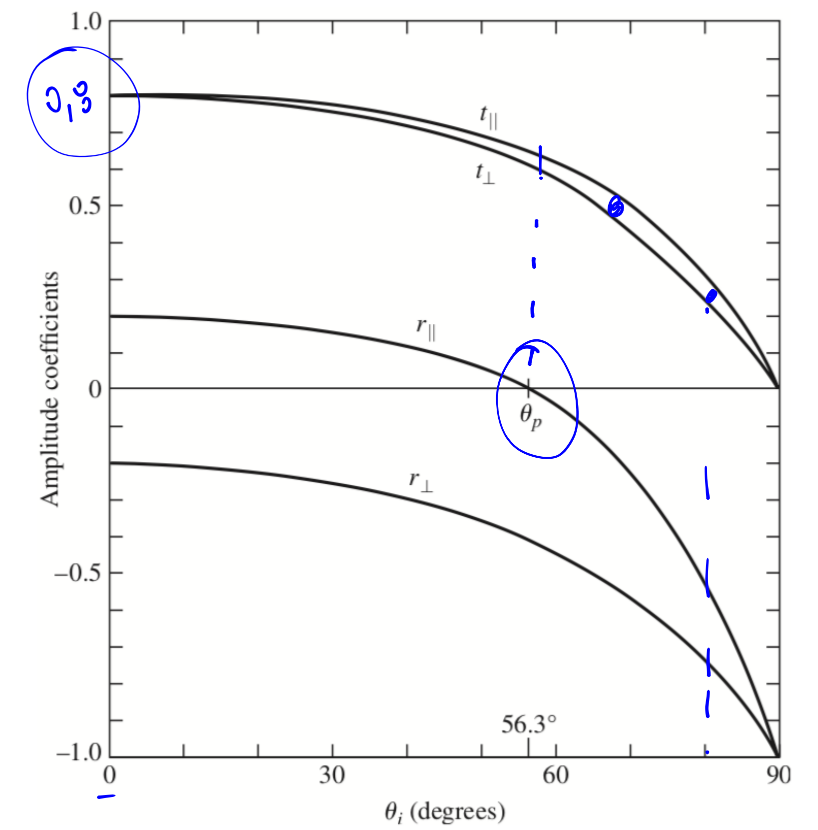
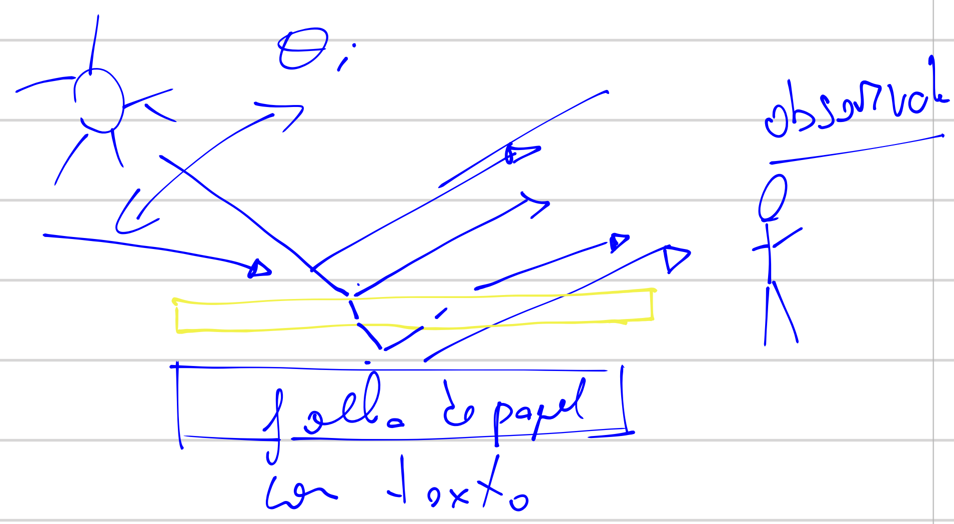
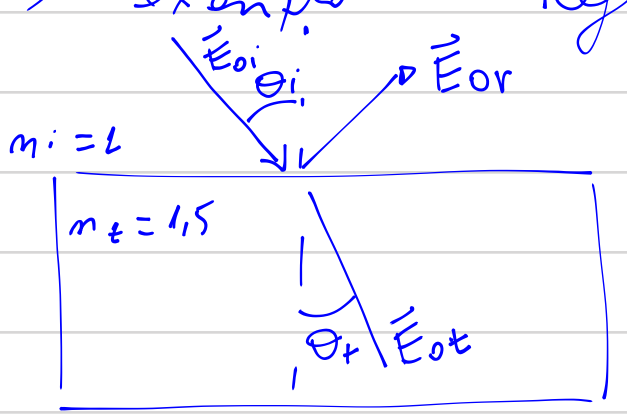
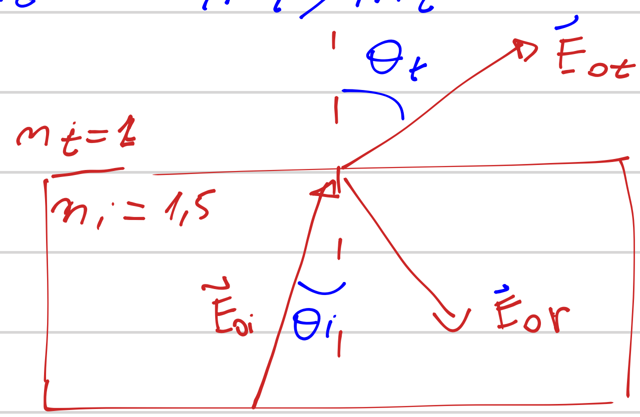


Figure 4.49 The amplitude coefficients of reflection and transmission as a function of incident angle. These correspond to external reflection $n_t > n_i$ at an air–glass interface ($n_{ti} = 1.5$).



3º exemplo Reflexão interna $n_i > n_t$





$n_i \sin\theta_i = n_t \sin\theta_t$ | $n_i \sin\theta_i = n_t \sin\theta_t$

Reflexão externa | Reflexão interna

$\theta_i \to 90°$ antes do θ_t | $\theta_t \to 90°$ antes do θ_i

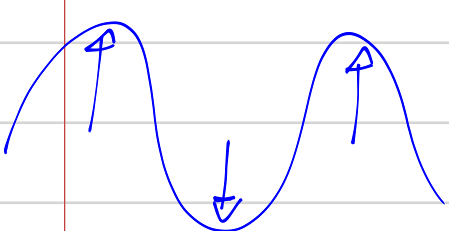
quando isto acontece eu tenho uma reflexão interna total.

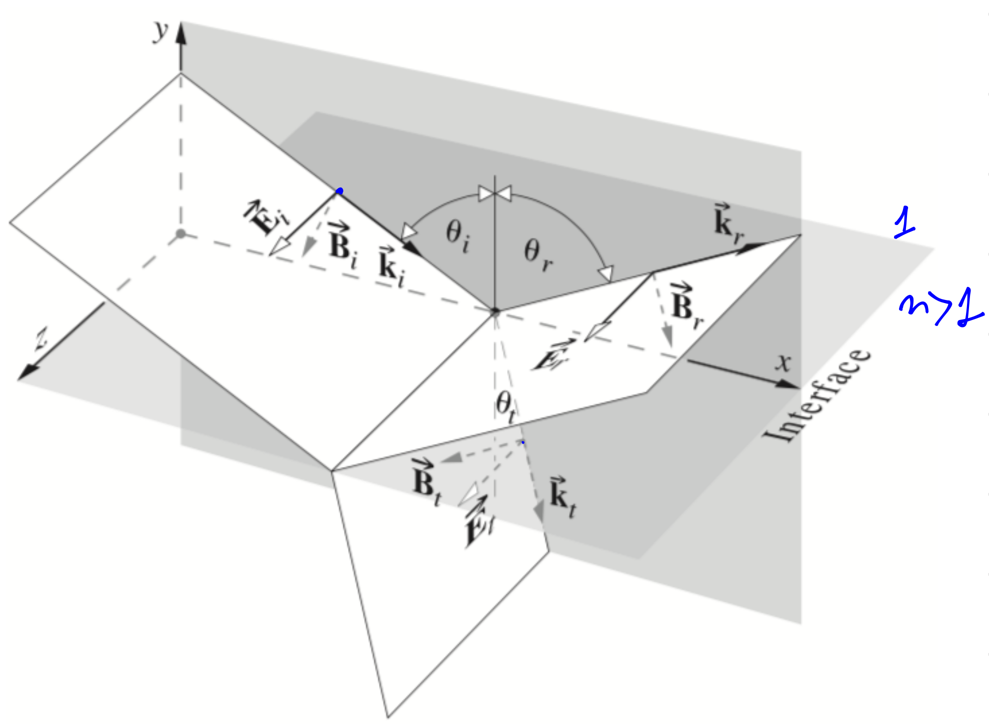
$$n_i \sin\theta_i = n_t \sin 90°$$

$$\sin\theta_i = n_t / n_i$$

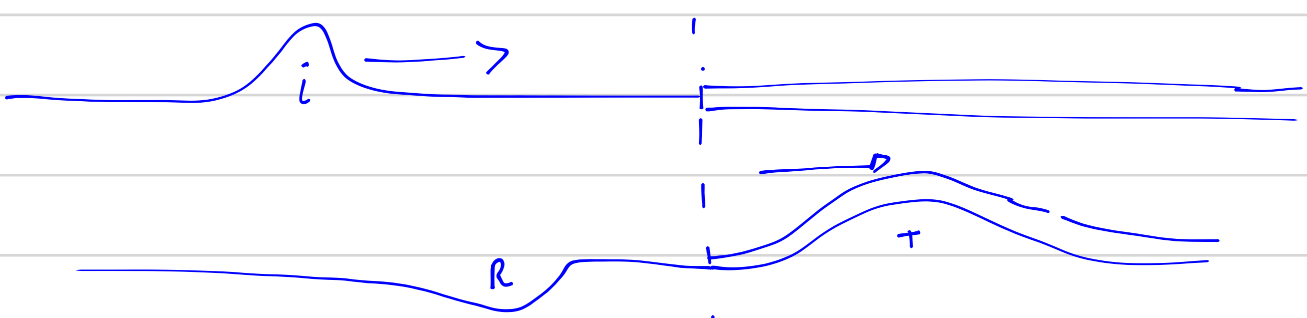
θ_c = ângulo crítico quando ocorre a reflexão interna total.

Fase da Onda





$$r_\perp = \frac{n_i - n_t}{n_i + n_t}$$



$\Delta\phi = \pi$ p/ reflexão

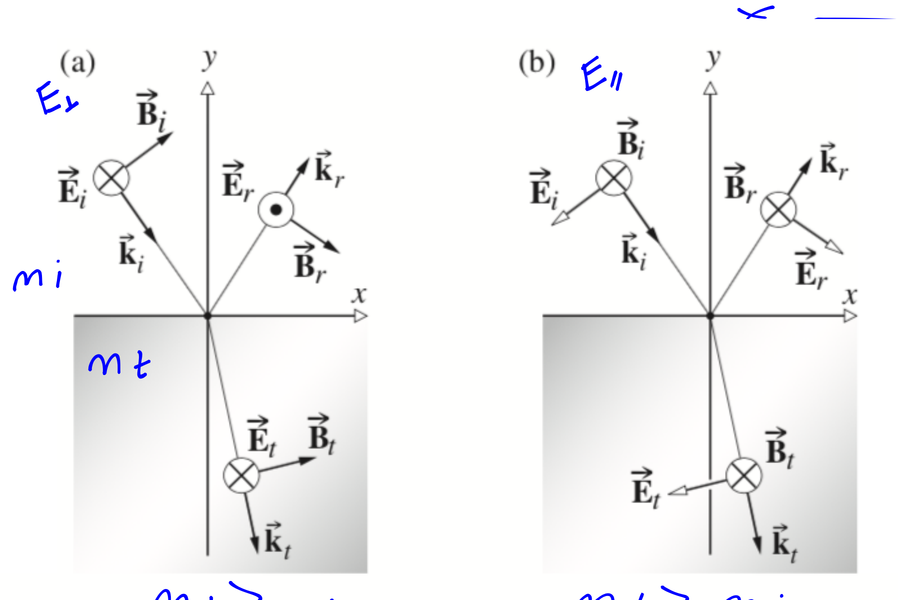
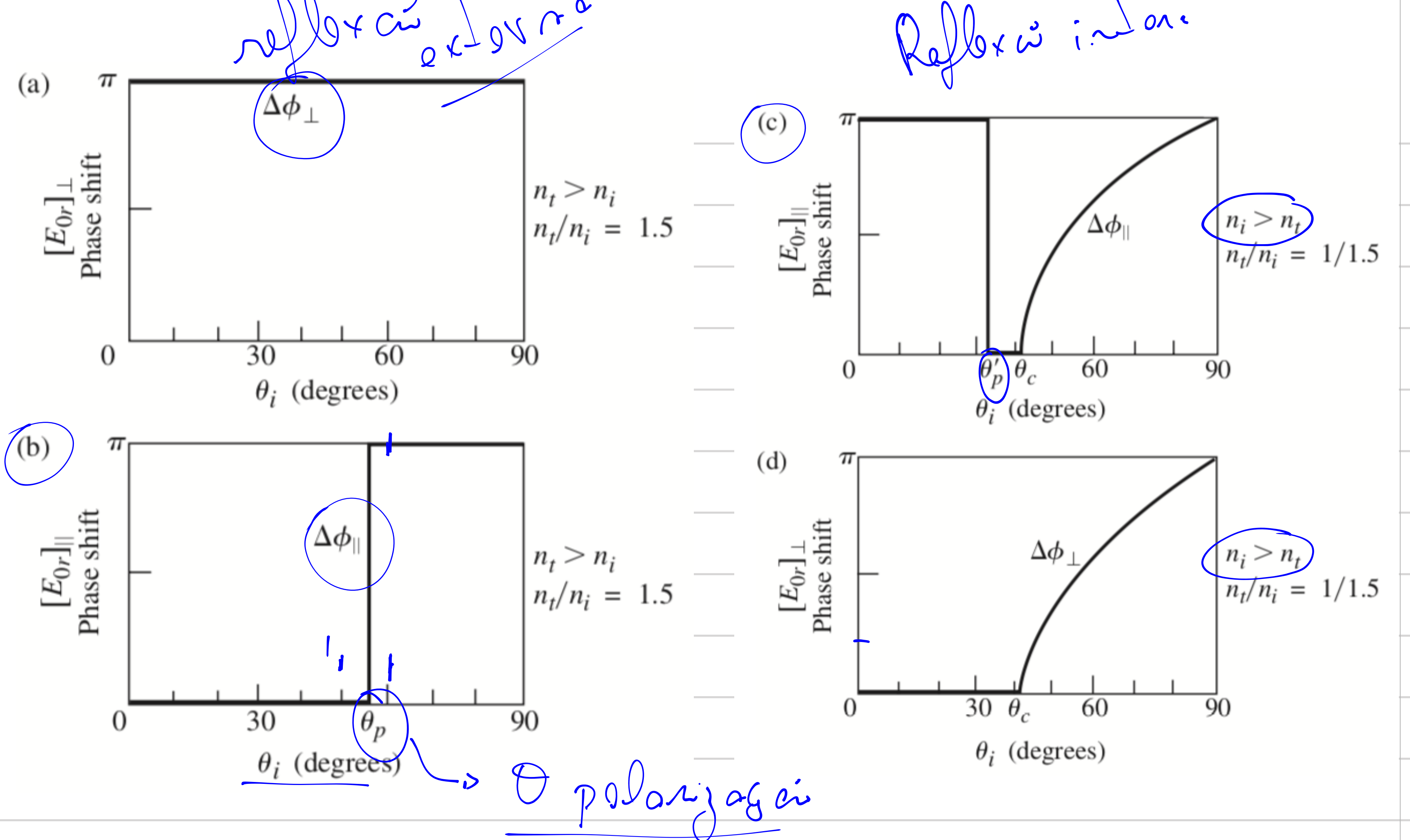
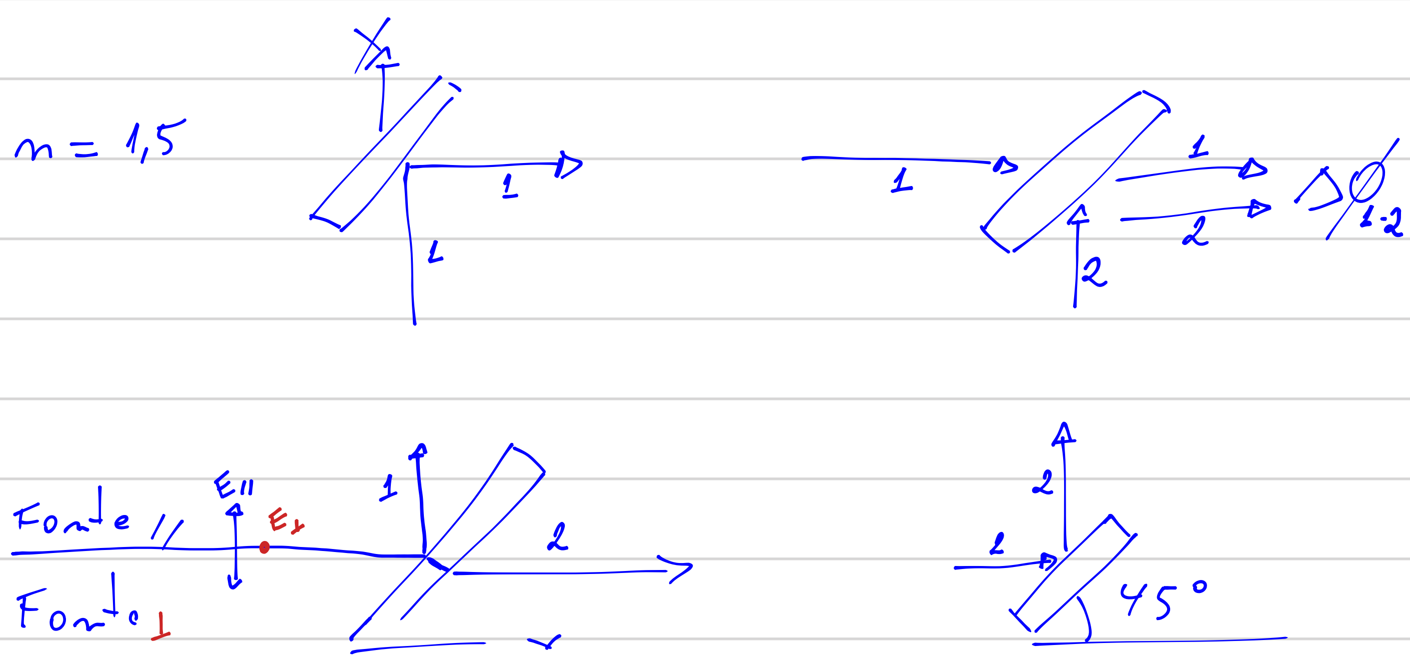


Figure 4.51 Field orientations and phase shifts.





$\Delta\phi_{1\text{-}2}$ = dif. de fase dos feixes 1 e 2

Valendo +1 pt na P1

entrega na P1