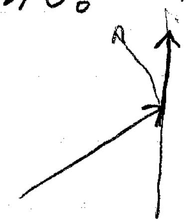
TIR

for $\quad n_1 \sin\theta_0 = n_2 \qquad \theta_2 = \pi/2$



$\sin\theta_{cr} \equiv n_2/n_1$ critical angle for total reflection.

$R = |r|^2 \to 1$

but r is complex for $\theta_0 > \theta_{cr}$.

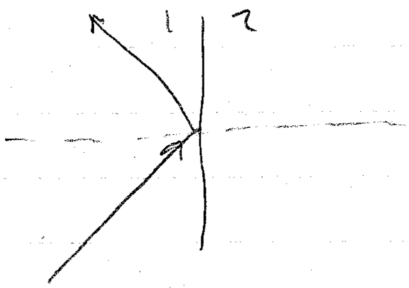
$r = e^{i\phi}$

phase shift is diff't for 'S', 'P' polariz.

from Snell's law, if $\theta_{inc} > \theta_{cr}$ $\quad \sin\theta_t > 1$ and $\theta_t =$ imag.

from wave equation. $E \sim E_0 e^{i(k_x x + k_z z - \omega t)}$

$\rightarrow \quad k_x^2 + k_z^2 = n^2 k_0^2$



in region 1,

$k_x = k_0 n_1 \sin\theta_0$

$k_z = k_0 n_1 \cos\theta_0$

in region 2

$k_x = k_0 n_1 \sin\theta_0$ b/c of phase continuity

$k_z^2 = n_2^2 k_0^2 - k_x^2$

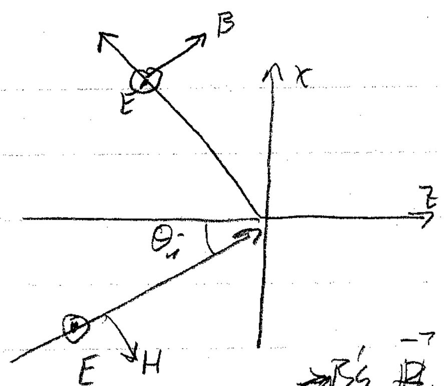
in region 2:

$k_z = \sqrt{n_2^2 k_0^2 - n_1^2 k_0^2 \sin^2\theta_0}$

$= i k_0 \sqrt{n_1^2 \sin^2\theta_0 - n_2^2} \quad \equiv i k_0 \alpha$

now

$E \sim E_0 \left(e^{i k_x x}\right) e^{-k_0 \alpha z}$ evanescent wave for $E_\perp$



$E_i + E_r = E_t$

$\vec{H}_i = H_0(-\cos\theta_i \hat{x} + \sin\theta_i \hat{z}) e^{i()}$

$H_\perp = H_0 \sin\theta_i$

continuity in $B^\perp$

$B_0 \sin\theta_i + B_r \sin\theta_r = B_t \sin\theta_t$

from $\vec{k} \times \vec{E} = \frac{\omega}{c} \vec{B}$

with $\vec{E} = E\hat{y}$ $\quad |\vec{k} \times \vec{E}| = k_0 \tilde{n}_2 E_t = \frac{\omega}{c} B_t$ $\quad$ sim for n_1

$\rightarrow n_1 E_0 \sin\theta_i + n_1 E_r \sin\theta_i = \tilde{n}_2 E_t \sin\theta_t$

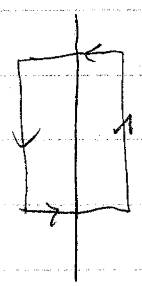
$= \tilde{n}_2 (E_i + E_r) \sin\theta_t$

$E_0(n_1 \sin\theta_i - n_2 \sin\theta_t) = (n_2 \sin\theta_t - n_1 \sin\theta_i) E_r$

$\rightarrow E_0 = -E_r$

use $H^{\parallel}$: $\rightarrow -n_1 E_0 \cos\theta_i + n_1 E_0 \cos\theta_r = n_2 E_t \cos\theta_t$

$+ \sigma E_t$



$\int \nabla \times H \, d\hat{n} \, da$

$\rightarrow \oint H \cdot dl = \frac{\partial}{\partial t} \oint E \cdot \hat{n} \, da + \oint J \cdot \hat{n} \, da$

as $d \to 0$ $da \to 0$

unless w/ $J \propto \delta(z)$

$\Re$ |

Since k_z is pure imaginary, no loss, just reflection
(see homework)

wave picture: vs. z

region 1 $\quad E_0 e^{i(k_x x + k_z z)} + E_0 r e^{i(k_x x - k_z z)}$

for $\vec{E} \perp$ to POI, $r = r_\perp$

$$r_\perp = \frac{n_1 \cos\theta_0 - n_2 \cos\theta_2}{n_1 \cos\theta_0 + n_2 \cos\theta_2}$$

w/ $n_2 \cos\theta_2 = n_2\sqrt{1 - \sin^2\theta_2}$
$= \sqrt{n_2^2 - n_1^2 \sin^2\theta_0}$
$= i\alpha$

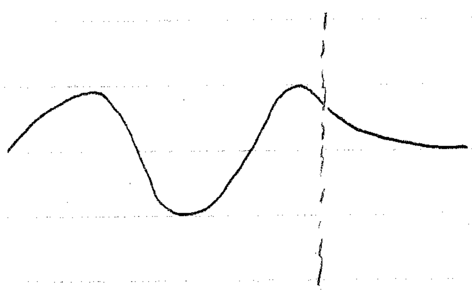
$$r_\perp = \frac{n_1 \cos\theta_0 - i\alpha}{n_1 \cos\theta_0 + i\alpha} = \frac{\eta^*}{\eta}$$

and $|r_\perp|^2 = \frac{\eta^*}{\eta} \cdot \frac{\eta}{\eta^*} = 1$

can write $r_\perp = e^{i\phi}$ with $\phi = \tan^{-1}\left(\frac{-\alpha}{n_1 \cos\theta_0}\right)$

in region 1,

$$E \sim E_0 e^{ik_x x}\left(e^{ik_z z} + e^{-i(k_z z - \phi)}\right)$$
$$= E_0 e^{i(k_x x + \phi/2)} \cdot 2 \underbrace{\cos(k_z z - \phi/2)}_{\text{standing wave in } z, \text{ w/ phase shift}}$$



in region 2 $\quad E \sim E_0 e^{ik_x x - k_0 \alpha z}$

traveling in x, damped in z

wavefronts.