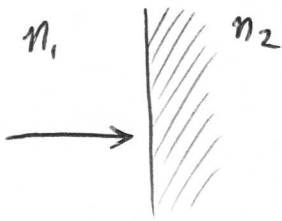


Last time



$$\frac{E_{0,R}}{E_{0,I}} = \frac{n_1 - n_2}{n_1 + n_2}$$

$$\frac{E_{0,T}}{E_{0,I}} = \frac{2n_1}{n_1 + n_2}$$

The intensity of incident, reflected and transmitted waves is

$$I_I = \frac{1}{2} n_1 \epsilon_0 c E_I^2$$

$$I_R = \frac{1}{2} n_1 \epsilon_0 c E_R^2$$

$$I_T = \frac{1}{2} n_2 \epsilon_0 c E_T^2$$

$n_1 = \frac{n_1^2}{n_1}$

← accounts for the higher energy density in a material  
 ← accounts for the slower speed of light in a material

↑  
 Transmitted wave is in a different material.

The fraction of photons reflected is

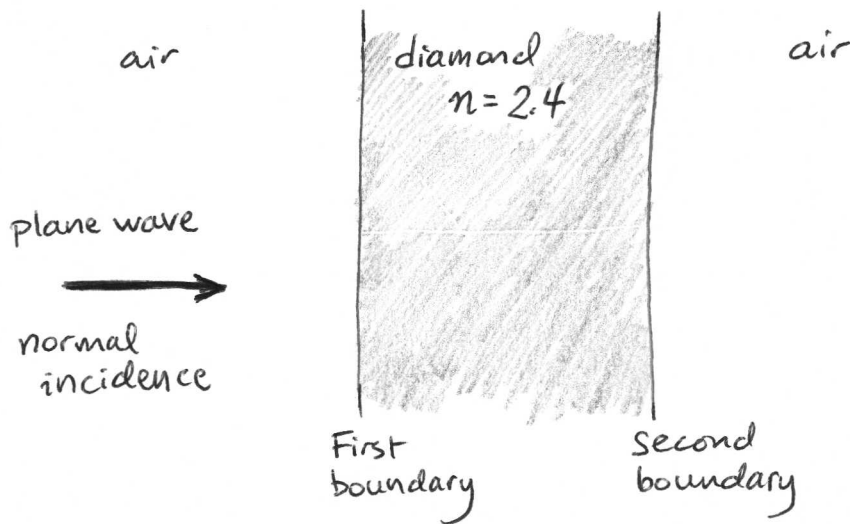
$$R = \frac{I_R}{I_I} = \left| \frac{n_1 - n_2}{n_1 + n_2} \right|^2$$

Known as "reflectance" or "reflectivity"

The fraction of photons transmitted is

$$T = \frac{I_T}{I_I} = \frac{n_2}{n_1} \left| \frac{2n_1}{n_1 + n_2} \right|^2$$

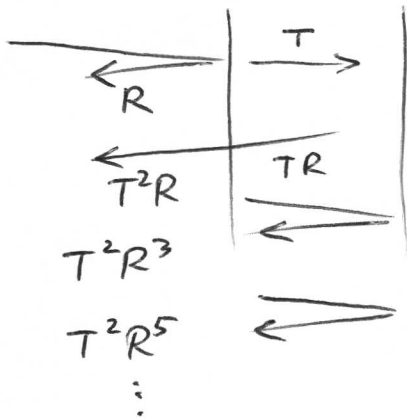
Note  $R + T = 1$



- Find  $R$  for the first boundary
- Find  $R$  for the second boundary
- Find the combined reflectance from the thick slab of diamond assuming that the coherence length of light is short enough that you can neglect interference effects.

(3)

Answer to pop quiz, part c).



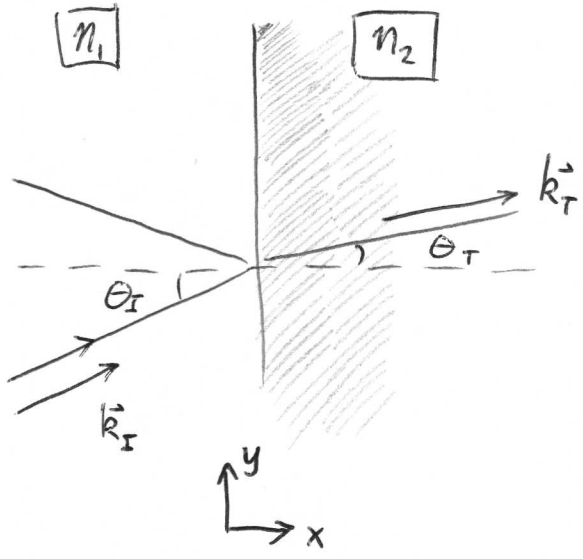
$$\begin{aligned} & R + T^2R + T^2R^3 + T^2R^5 + \dots \\ &= R + T^2R(1 + R^2 + R^4 + R^6 + \dots) \\ &= R + T^2R\left(\frac{1}{1-R^2}\right) \\ &= R\left(1 + \frac{(1-R)^2}{(1-R^2)(1+R)}\right) \\ &= R\left(1 + \frac{1-R}{1+R}\right) \\ &= R\left(\frac{1+R+1-R}{1+R}\right) \\ &= \frac{2R}{1+R} \end{aligned}$$

(4)

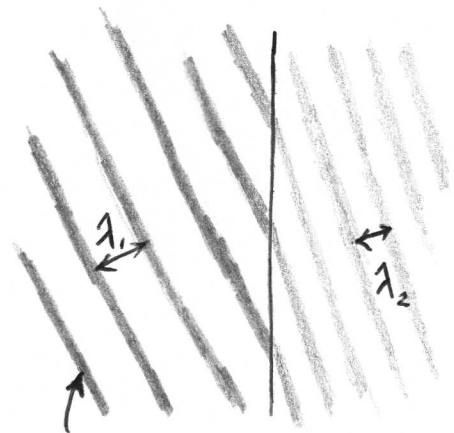
# SNELL'S LAW

$$n_1 \sin \theta_I = n_2 \sin \theta_T$$

We need this rule when analyzing problems with  $\theta_I \neq 0$ .



The derivation is based on the concept of "phase matching" at the interface.



$\lambda$  must change as we cross the interface from  $n_1$  into  $n_2$

$$\frac{2\pi}{\lambda_1} = k_1 = \frac{n_1 \omega}{c}$$

$$\frac{2\pi}{\lambda_2} = k_2 = \frac{n_2 \omega}{c}$$

lines of constant phase,  
 $\vec{r} \cdot \vec{k}_I = \text{const}$

The lines of constant phase must match at the interface.

$\Rightarrow$  Propagation direction must change.

The interface is located at  $\vec{r} = y \hat{y}$ .

$$y \hat{y} \cdot \vec{k}_I = y \hat{y} \cdot \vec{k}_T \quad \text{phase matching condition.}$$