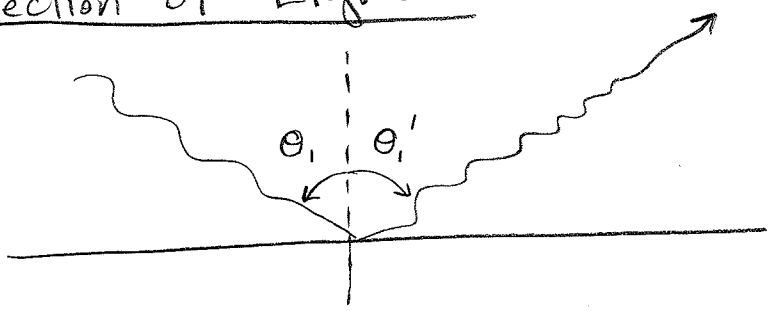
Reflection of Light

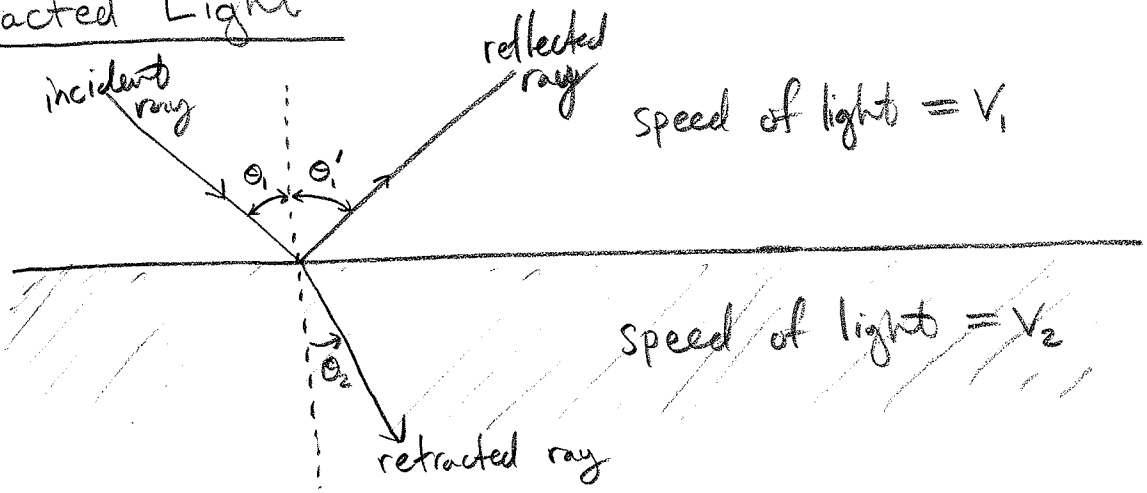


specular reflection off a smooth surface.

$$\theta_1 = \theta_1'$$

angle of incidence = angle of reflection

Refracted Light



$$\frac{\sin\theta_2}{\sin\theta_1} = \frac{V_2}{V_1} = \text{constant}$$

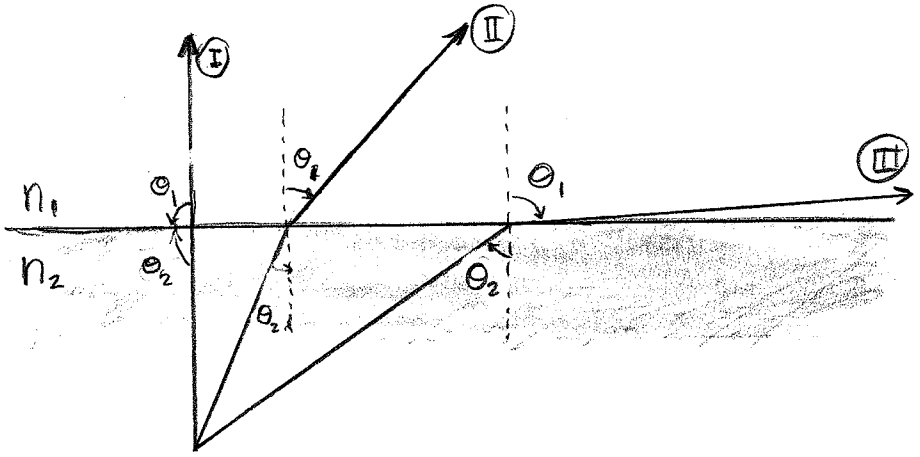
Def^n/ $n = c/v$ = index of refraction for media.

Then, $$\frac{\sin\theta_2}{\sin\theta_1} = \frac{V_2}{V_1} = \frac{c/n_2}{c/n_1} = \frac{n_1}{n_2}$$

$$\therefore \quad \boxed{n_1 \sin\theta_1 = n_2 \sin\theta_2}$$ Snell's Law

WHY? Because $f_1 = f_2 \Rightarrow \frac{V_1}{\lambda_1} = \frac{V_2}{\lambda_2}$ ... work out in lecture.

Critical Angle and total internal reflection



$n_1 < n_2$

(I): CASE ONE : $\theta_1 = \theta_2 = 90°$, no retraction, direct transmission.

(II): CASE TWO : $\theta_1 \neq \theta_2$, but $\theta_1 < 90°$

(III): CASE THREE : $\theta_1 \neq \theta_2$ but θ_1 almost 90° ..... when we approach $\theta_1 = 90°$ the refracted ray does not escape the lower region.

$$n_2 \sin\theta_2 = n_1 \sin\theta_1$$

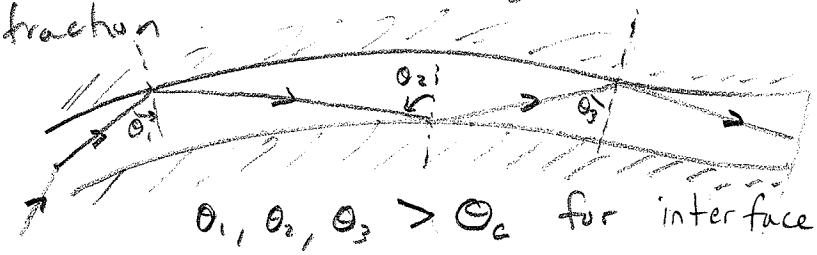
$\sin(90°)$ for critical case,

$$\Rightarrow \boxed{\theta_c = \sin^{-1}\left[\frac{n_1}{n_2}\right]}$$

Examples:

- diver underwater, we worked in lecture. also, see Prob. Set IV, Sol'n

- fiber optic cable, always internal reflection, uses the idea of the critical angle as limiting case for refraction



$\theta_1, \theta_2, \theta_3 > \theta_c$ for interface of cable.

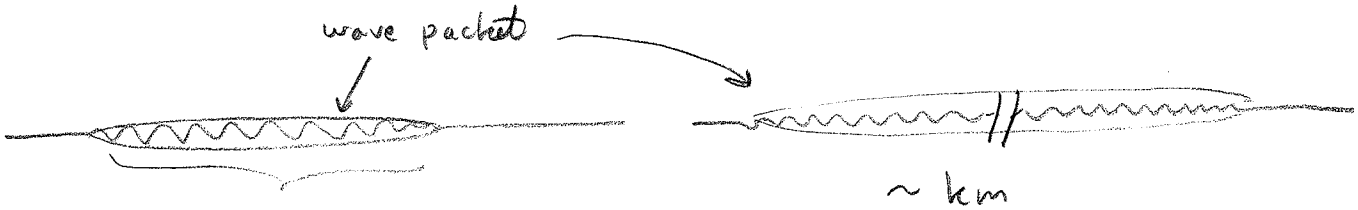
Dispersion:

Because the index of refraction n is actually a function of wavelength λ it follows the process of refraction will pull different angles for different $\lambda \Rightarrow$ colors separate.

$\Rightarrow$ rainbows, moon bows etc...

Coherence:

The length of a wave packet gives some measure of coherence. Sine waves do not go to $\pm\infty$ in practice. Instead



~mm
(gas discharge tube)
(old light bulb for physics labs)

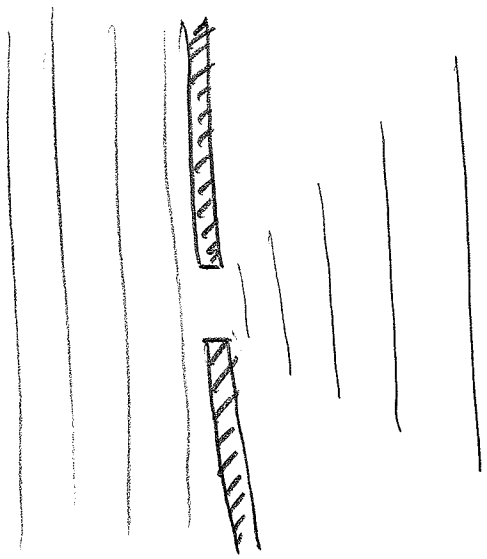
~ km
(lasers have much longer coherence length ... new optics experiements possible since laser's invention)

Interference in Thin Films:

- See notes from lecture. Essential idea is simply that we compare phases for two paths which begin from coherent source. Phase differences stem from wave-length differences and 180° bumps from certain reflections.
  (see pages 905 – 908 of Serway)

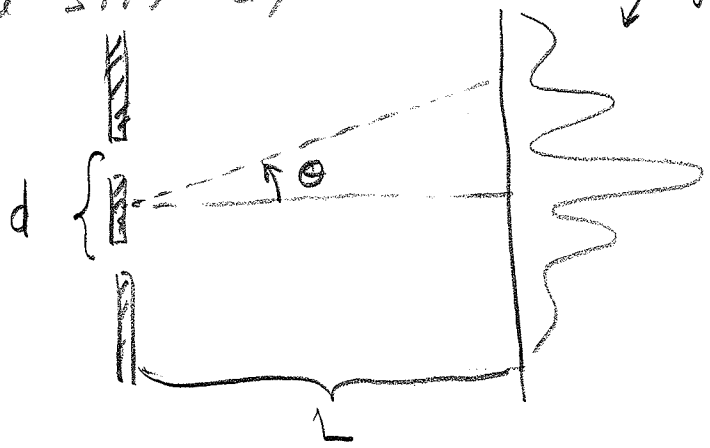
DIFFRACTION:

As light travels through small opening it spreads out on the other side,



We discussed in lecture the

- double slit experiment



We showed that $d \sin\theta_m = m\lambda$ (maximums, $m = 0, 1, 2, \ldots$)

$d \sin\theta_m = (m - \frac{1}{2})\lambda$ (mins, $m = 1, 2, 3 \ldots$)

- diffraction also occurs for single slit because waves from top and bottom of opening interfere. We briefly discussed how this limits optical precision of telescopes (see 9/2 - 9/5 for added comments)