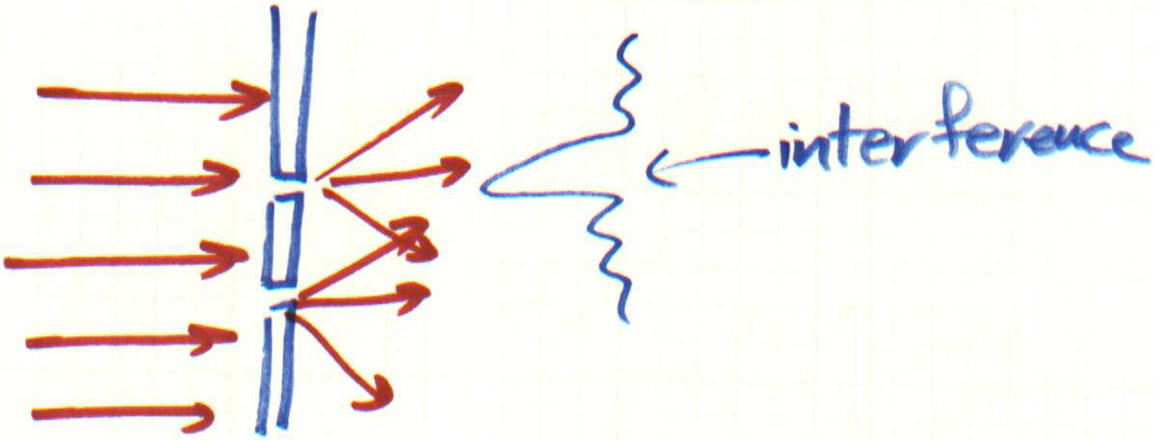
Chapter 25

light → wave? ←

light → particle? ← Newton

Young → showed light rays
interfer ⟹ wave



Photoelectric eff. → particle

Light has a dual nature
wave & particle
(dep. on exp.)

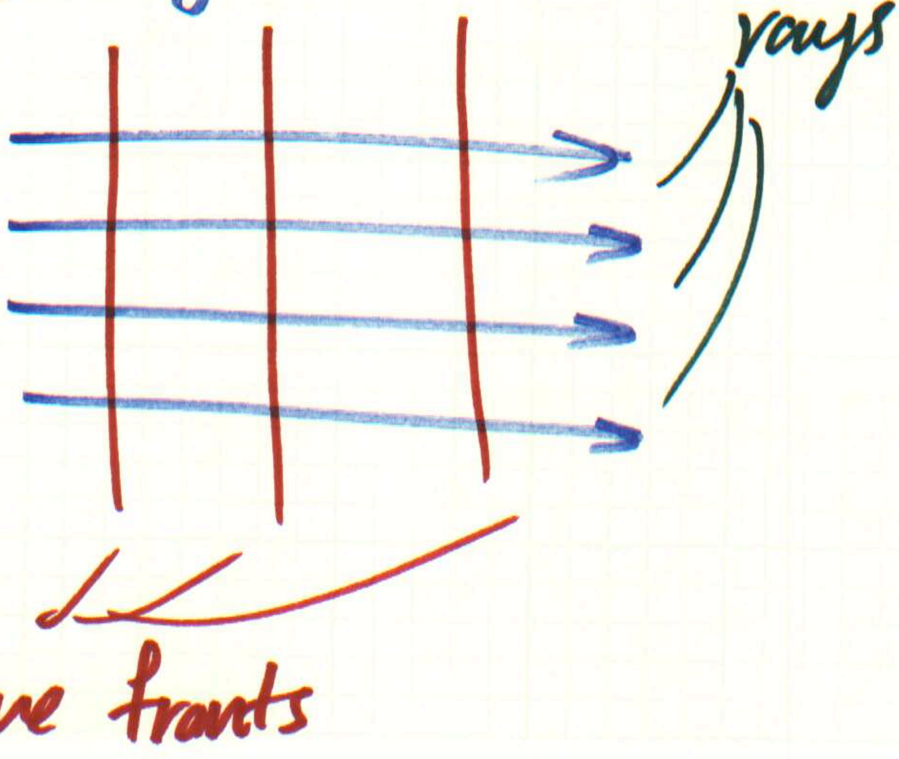
~~Chapter 25~~

Geometric Optics

→ study the propagation of light

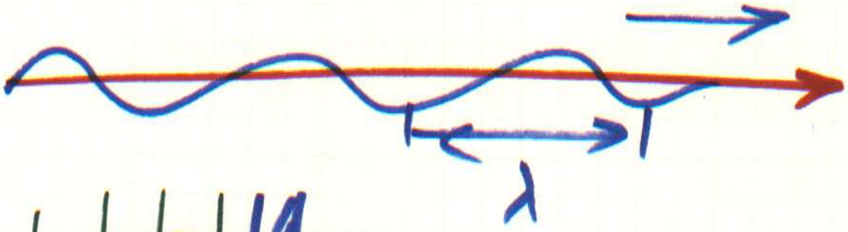
ray: an approx. to represent
a beam of light

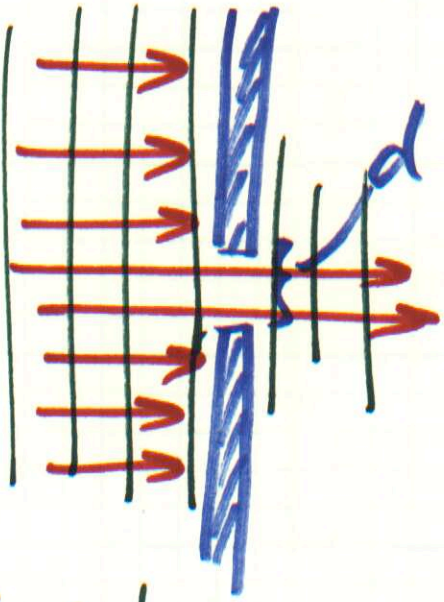
shows the direction & path
of light



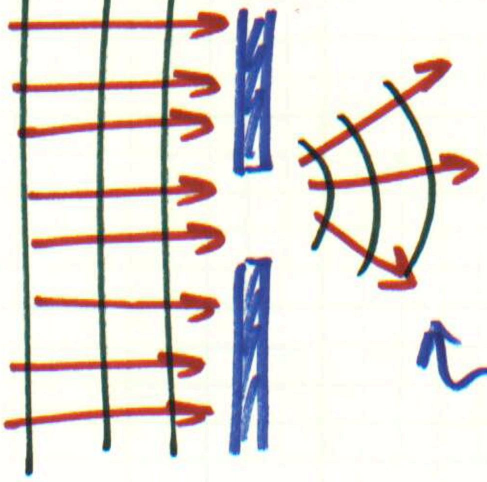
rays: travel in straigh line

rays $\perp$ wave fronts





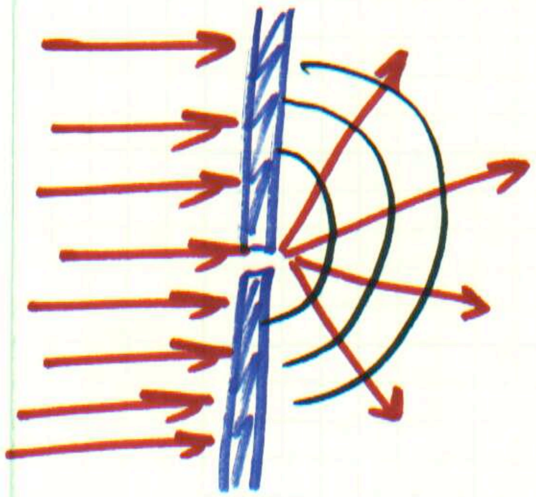
$d \gg \lambda$



$d \approx \lambda$

wave spreads in all direction

$\Longrightarrow$ Diffraction

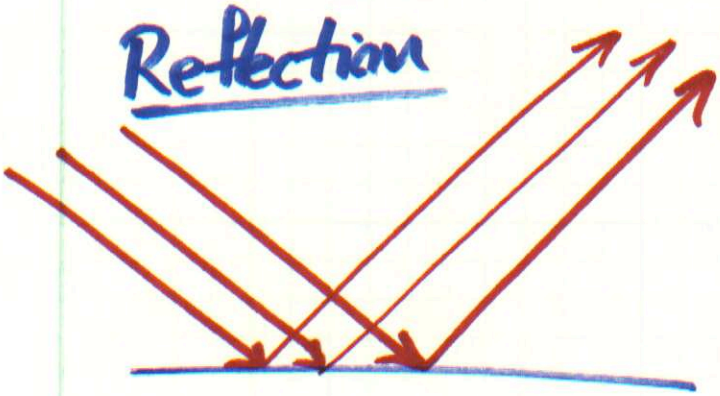


$\lambda \gg d$

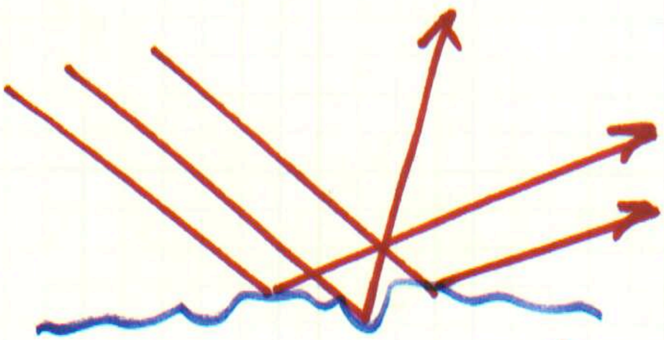
× diffraction

× The slit will look like a point source of light

Reflection

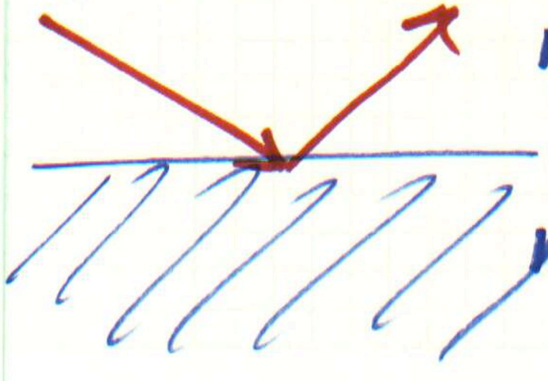


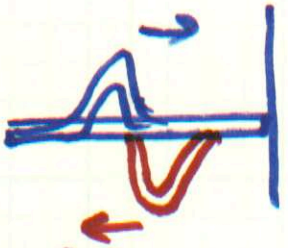
smooth surf.



uneven surf.

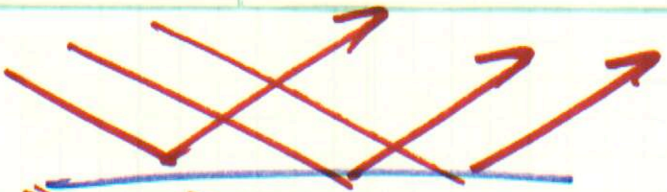
Ref. happens at the boundry of two medium



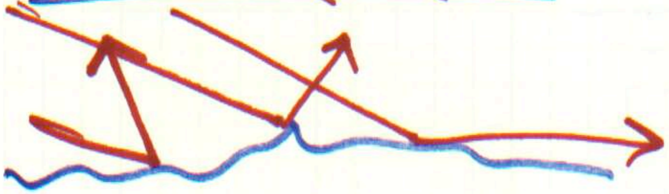


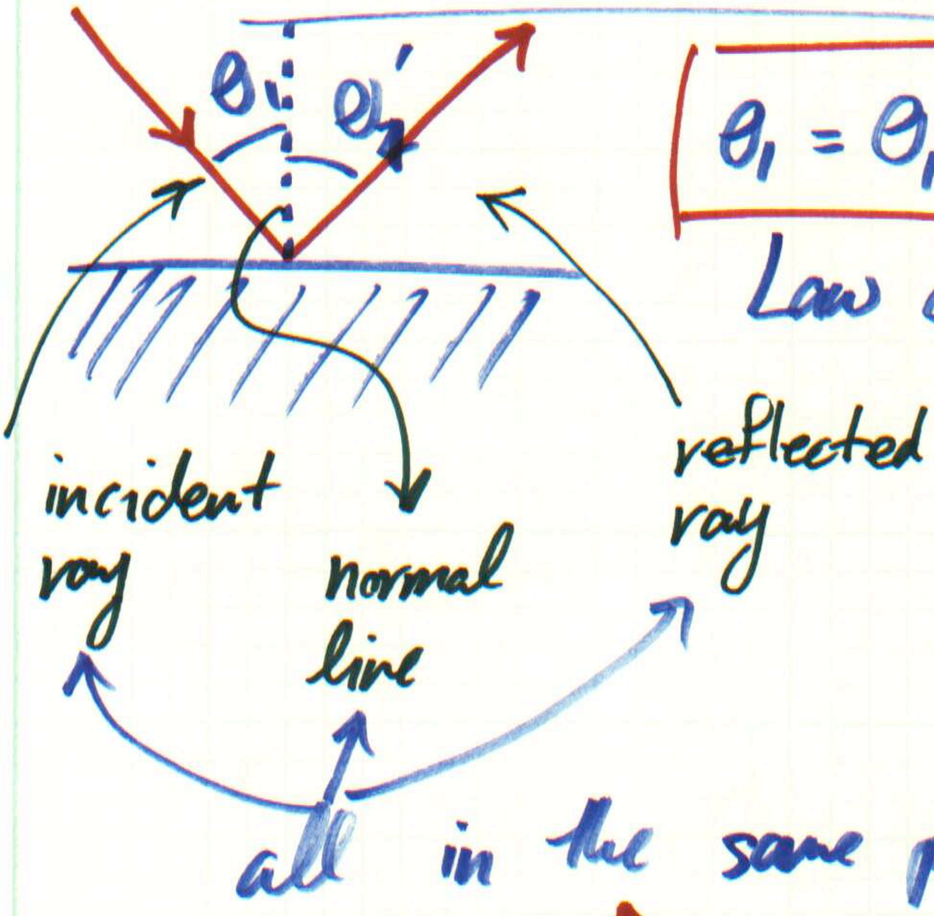
like a reflection in a rope

Specular Ref.:



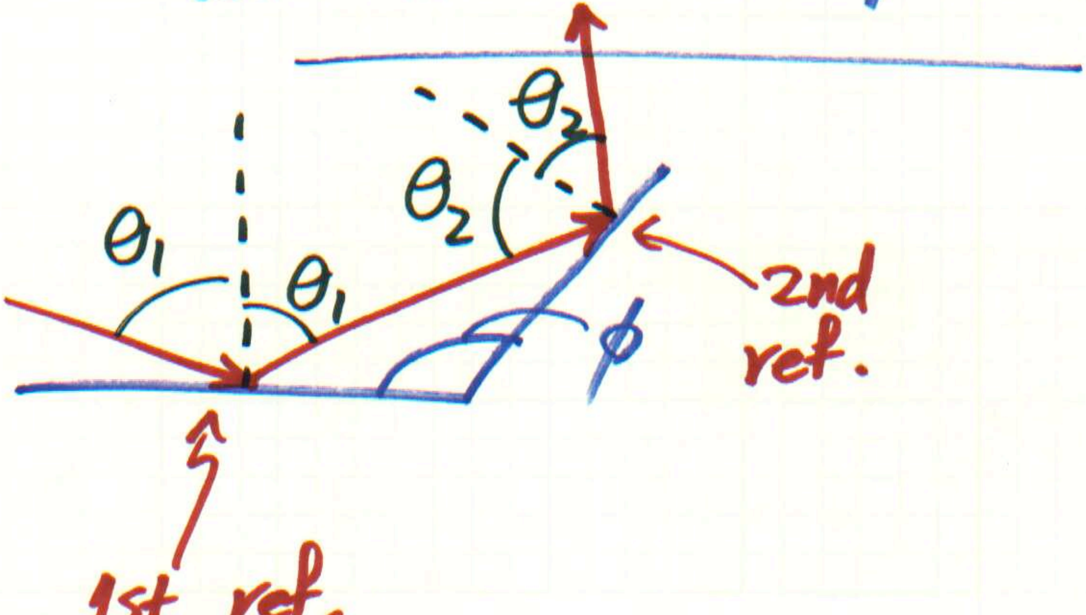
Diffuse Ref.:



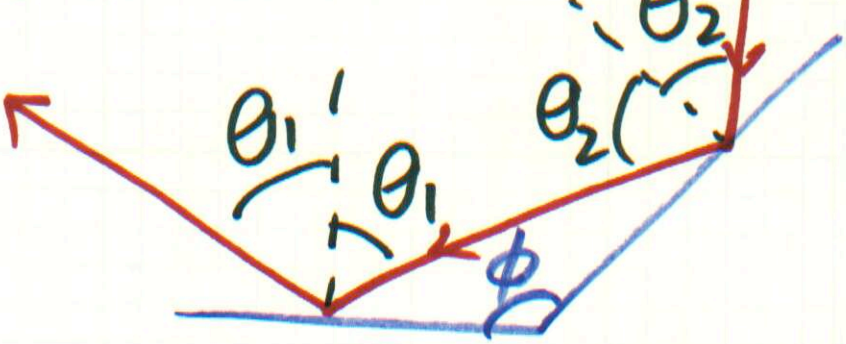


$$\boxed{\theta_1 = \theta_1'}$$

Law of ref.



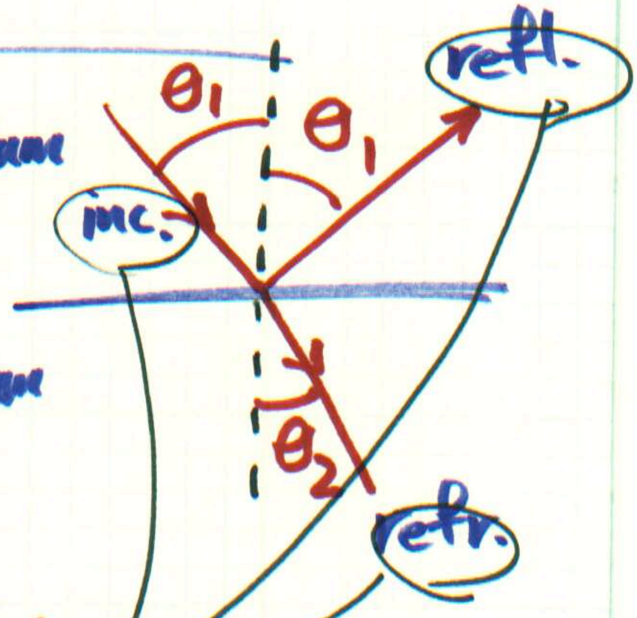
The path of light ray is reversible:



Refraction

transparent media → medium 1

→ medium 2

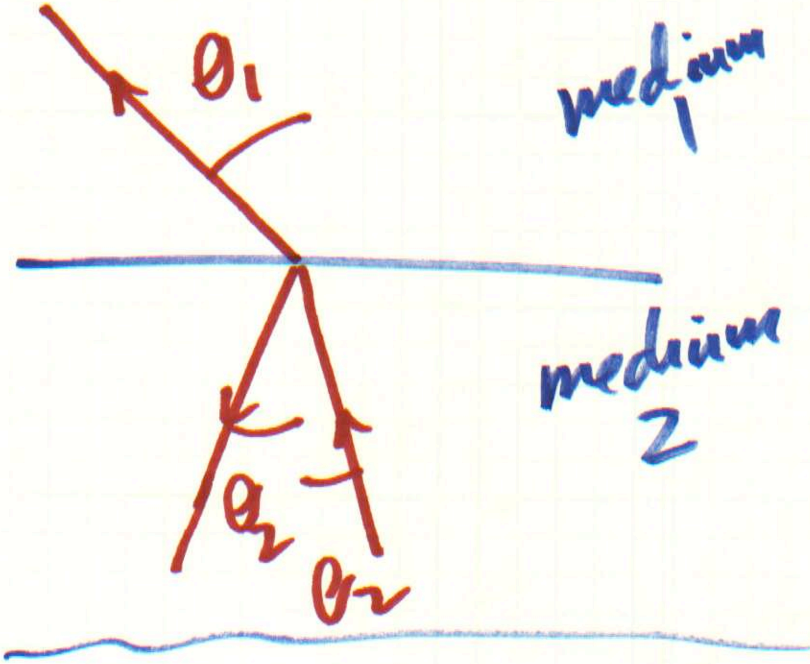


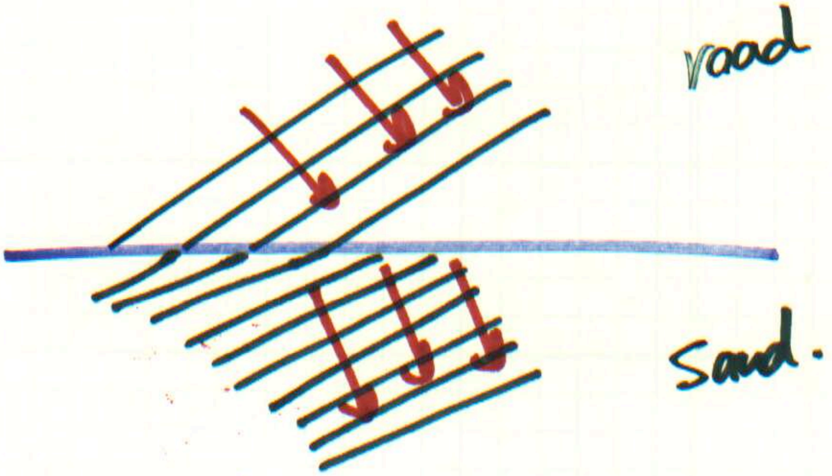
All 3 in the same plane

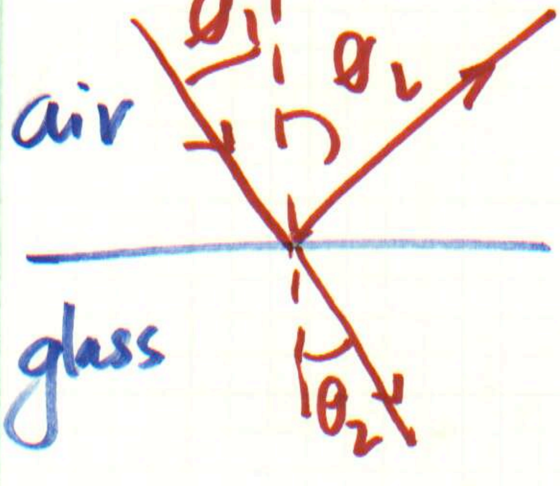
$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \text{const.}$$

depends on the medium

path of light ray → reversible





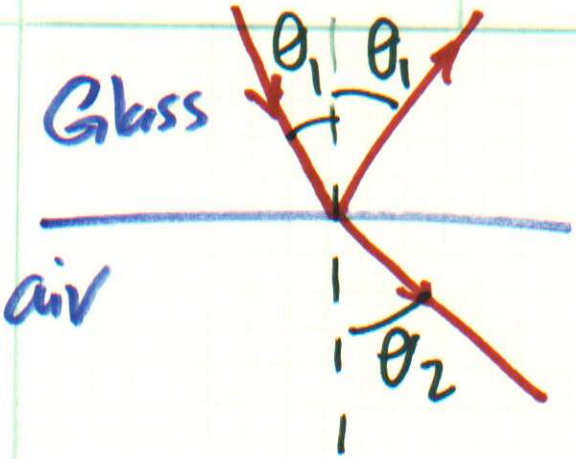


$v_a > v_w$

$\Rightarrow \sin\theta_1 > \sin\theta_2$

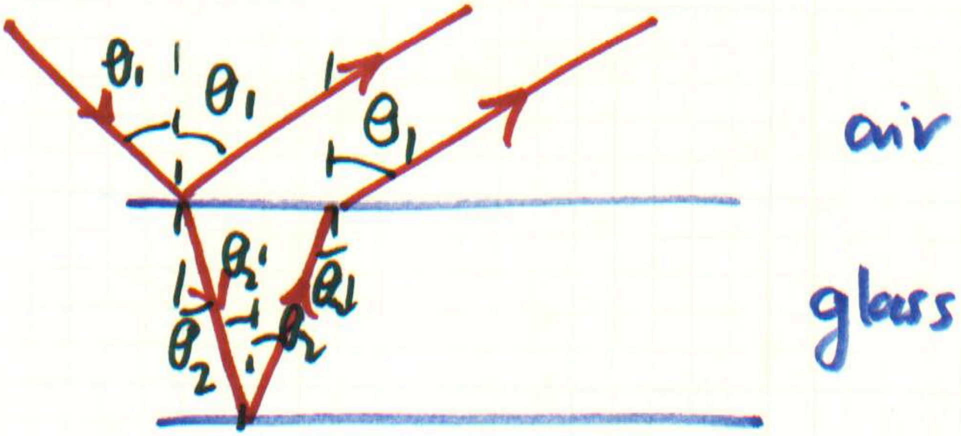
$\Rightarrow \theta_1 > \theta_2$

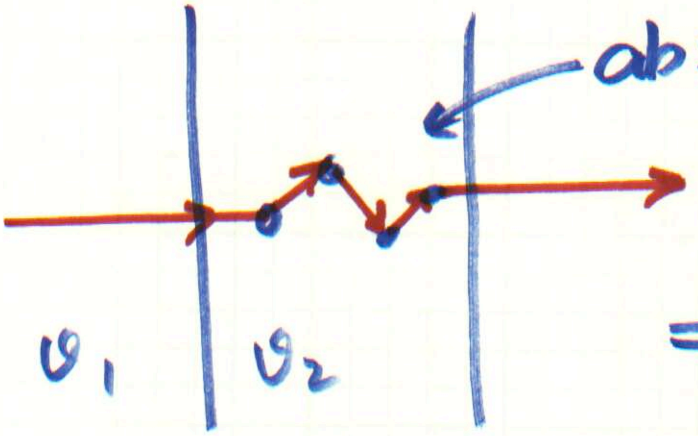
$[0 < \theta_1, \theta_2 < \pi/2]$



$$v_g < v_a$$
$$\downarrow$$
$$\sin\theta_1 < \sin\theta_2$$
$$\downarrow$$
$$\theta_1 < \theta_2$$

Mult. refl. & refr.:





absorption & emission of light

$$\Longrightarrow v_2 < v_1$$

Index of refraction

$$n = \frac{c}{v}$$

c ← speed of light in vaccu

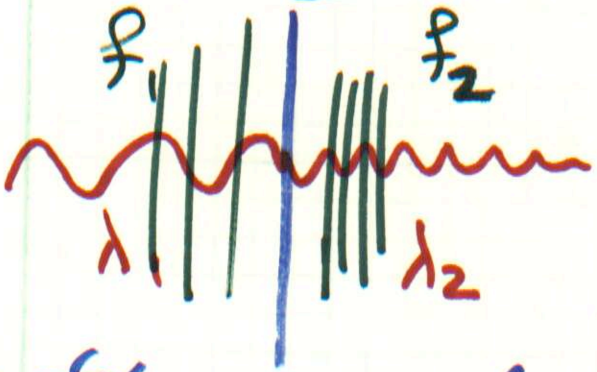
v ← speed of light in material

max. speed = 3.0×10^8 m/s

$n = 1$ ← vaccum

$n > 1$ ← for other media

~~$n < 1$~~ ← light can't travel faster than c



$$f_1 = f_2$$

$$\begin{cases} v_1 \neq v_2 \\ \lambda_1 \neq \lambda_2 \end{cases}$$

$n_1 = c/v_1$ $n_2 = c/v_2$

$$\boxed{\frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2} = \frac{c/n_1}{c/n_2} = \frac{n_2}{n_1}}$$

or [illegible]

$$\boxed{\lambda_1 n_1 = \lambda_2 n_2}$$

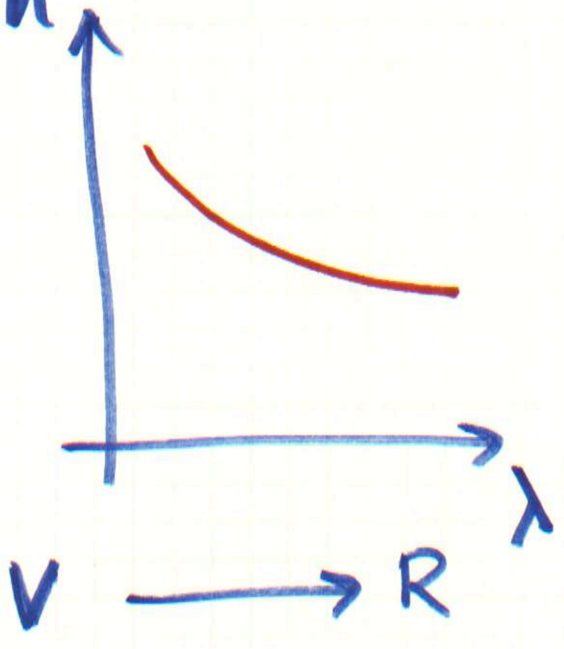
$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2} = \frac{v_1/c}{v_2/c} = \frac{n_1}{n_2}$$

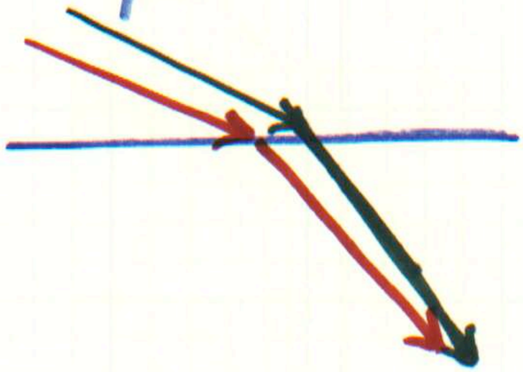
$$\Longrightarrow \boxed{n_1 \sin\theta_1 = n_2 \sin\theta_2}$$ Snell's Law

Dispersion

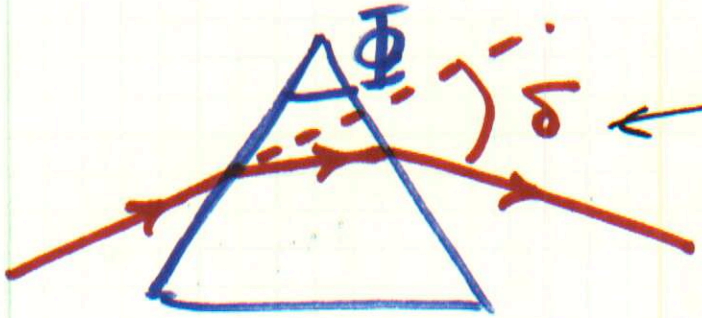
Index of difr. varies w/ λ in different material

this is aka dispersion

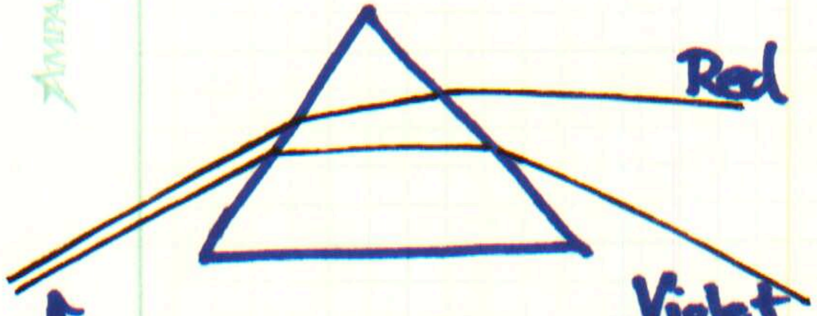




Violet bends more than red



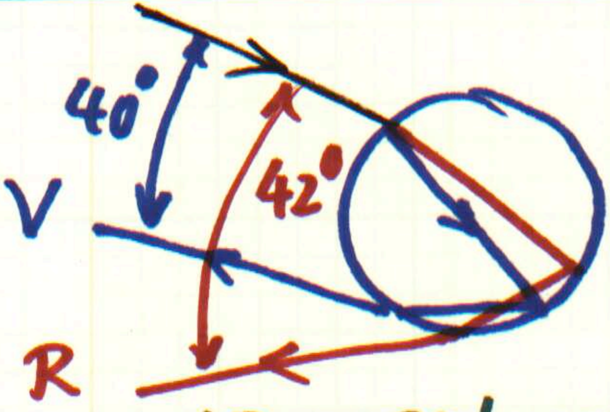
depends on n & Φ



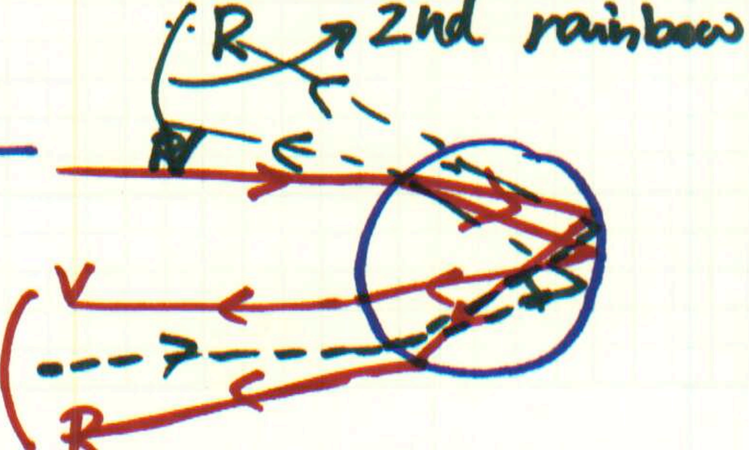
Rainbow of colors

White light
(comb. of diff. wavelengths)

Rainbow



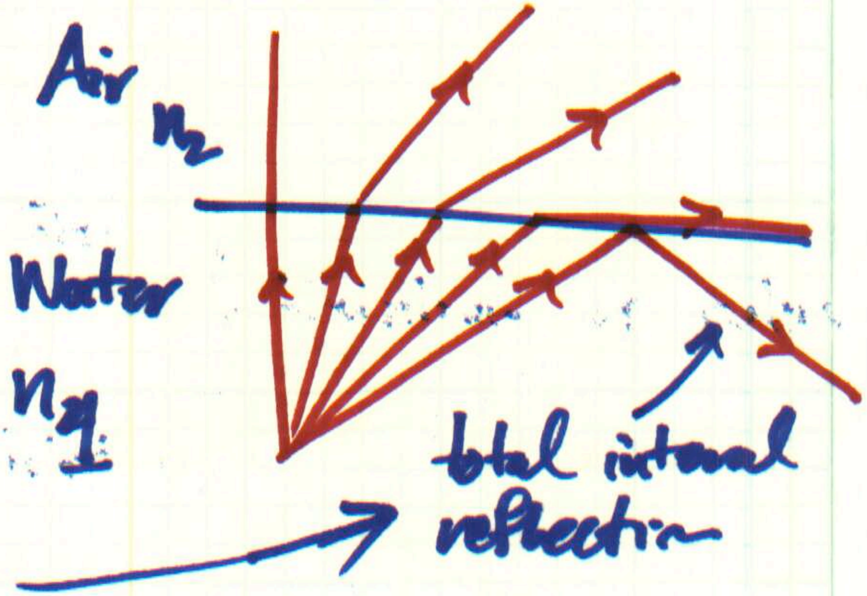
Doble Rainbow



First Rainbow

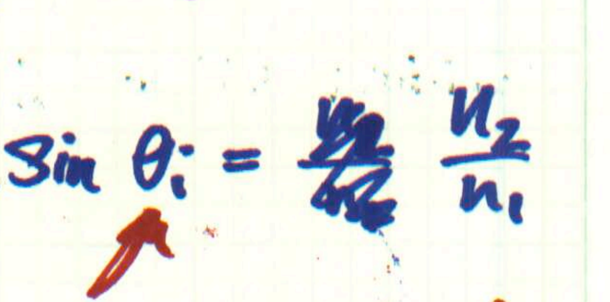
Total Internal Reflection

Happens when light goes from higher n to lower n.



$n_1 > n_2$

θ_c will give an ~~actual~~ angle of refl. of 90°



$$\frac{\sin\theta_i}{\underbrace{\sin\underset{\uparrow\,90^\circ}{\theta_r}}_{1}} = \frac{n_2}{n_1}$$

$$\underset{\uparrow}{\sin\theta_i} = \frac{n_2}{n_1}$$

θ_c or critical angle

When $\theta_{inc.} > \theta_c$ → total internal reflection

Optical Fibers: