Ch 33. The Nature and Propagation of Light

33-1. Nature of Light

Light has both wave and particle properties

Particle-like: emission, absorption…

Wave-like: propagation, interference…

Speed of light $c=2.9979 \times 10^8$ m/s ~ 3.0×10^8m/s

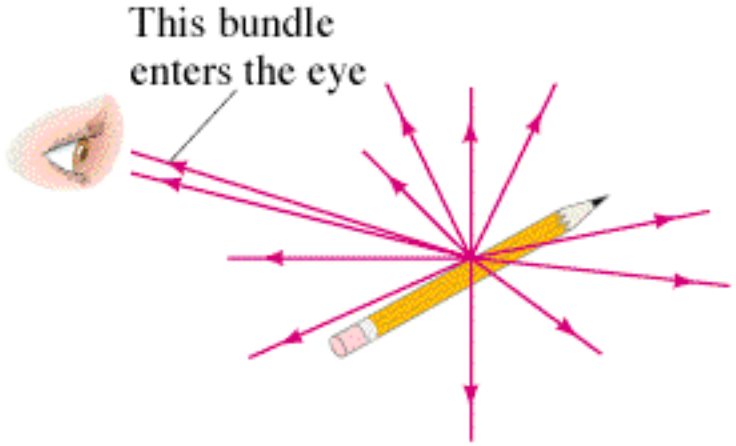
Geometric & Physical Optics

Ray: an imaginary line along the wave traveling direction

In a particle theory of light

Light travels in straight-line paths called light rays

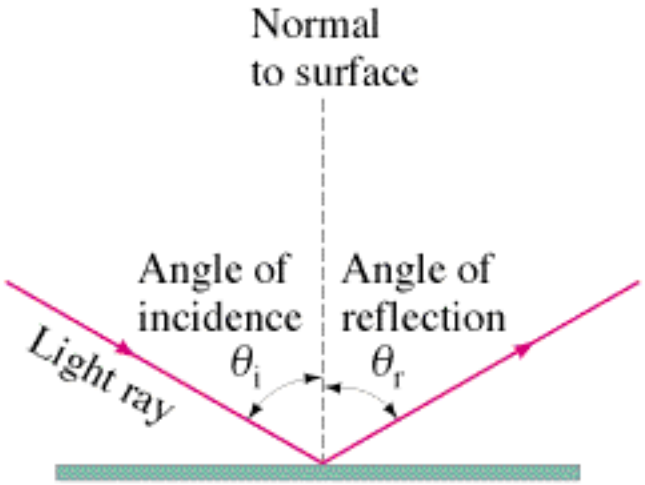
Rays represent the paths of particles



Branch of optics dealing with ray model – geometric optics

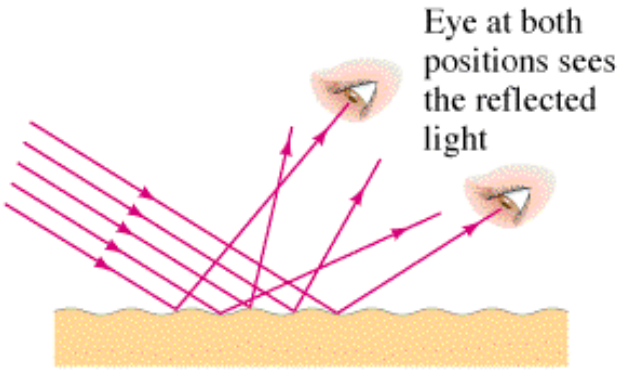
wave behavior – physical optics

33-2. Reflection & Refraction

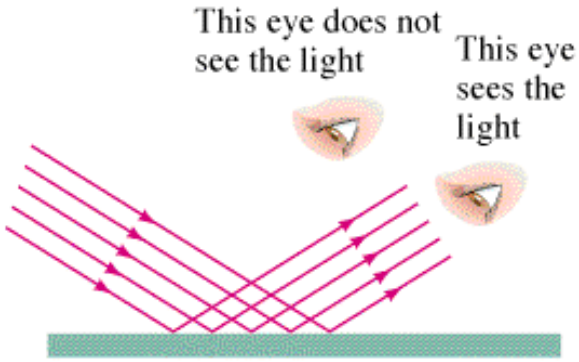


Angle of incidence θ_i
Angle of reflection θ_r

Law of reflection:
$\theta_i = \theta_r$



Diffusive reflection



Specular reflection

Refraction

Index of refraction of a material:

$n=c/v \geq 1$

$c=3.0\times10^8$ m/s — speed of light in vacuum

v: — speed of light in the medium

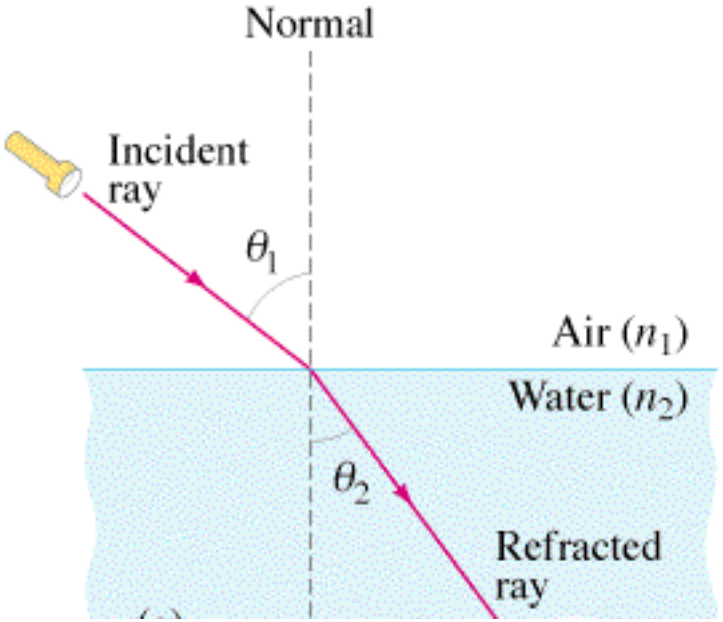
Light frequency doesn't change going from one material to another

$\lambda = \lambda_o/n$

Higher n
- slower v
- smaller λ

Vacuum & air:	n=1.00
Water	n=1.33
Glass	n=~1.4-1.6

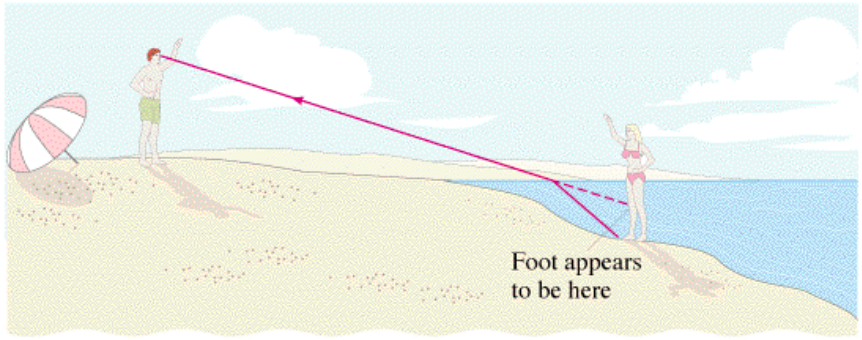
Law of Refraction

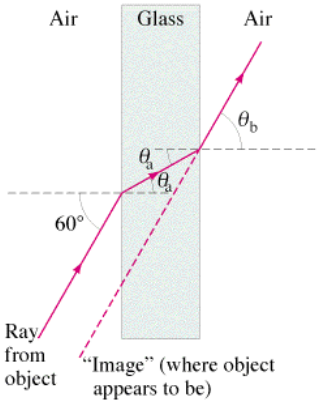


Snell's Law

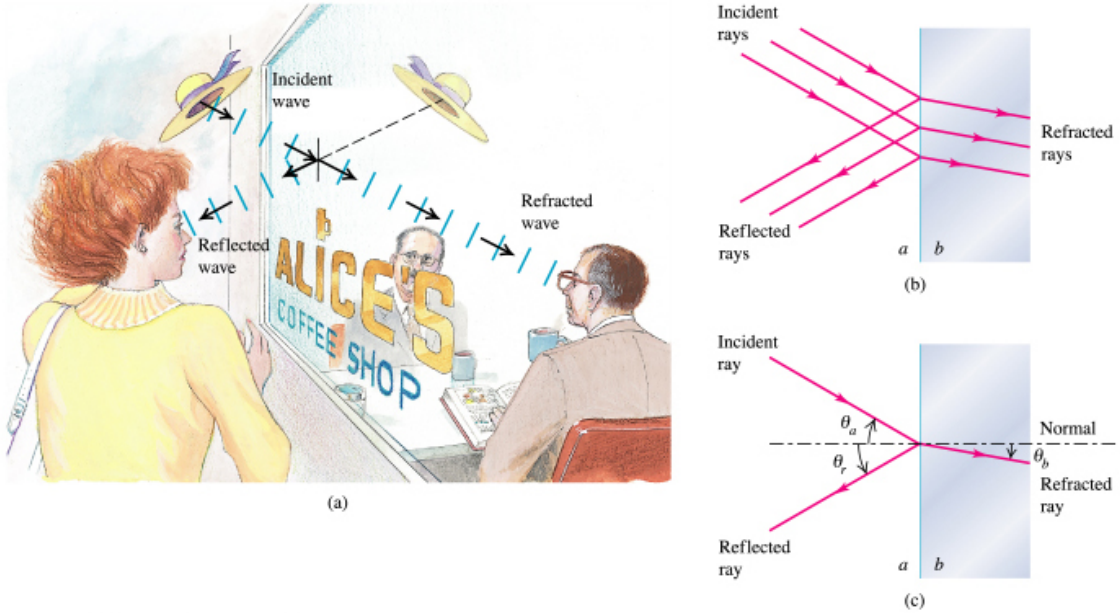
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

If $n_1 > n_2$, then $\theta_1 < \theta_2$



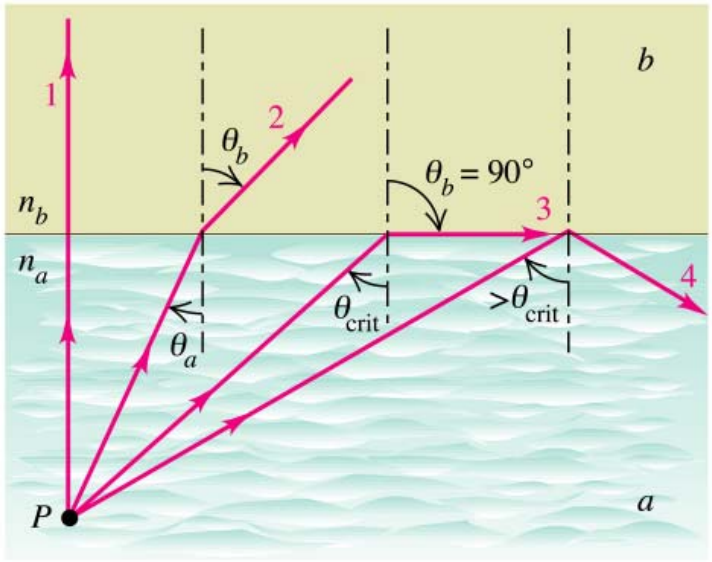


General Case: Across Interface of Two Transparent Materials



Incident, reflected, refracted rays and the normal to the surface all lie in the same plane.

33-3. Total Internal Reflection



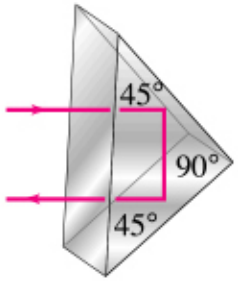
$n_b < n_a$

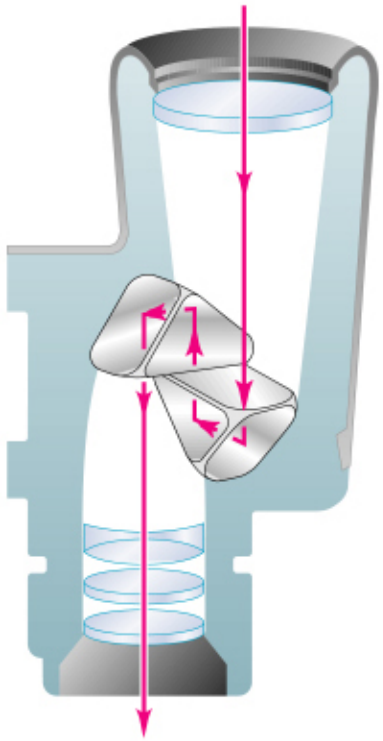
$$\sin\theta_C = \frac{n_b}{n_a}\sin 90° = \frac{n_b}{n_a}$$

When $\theta > \theta_C$, all lights are reflected, no refraction

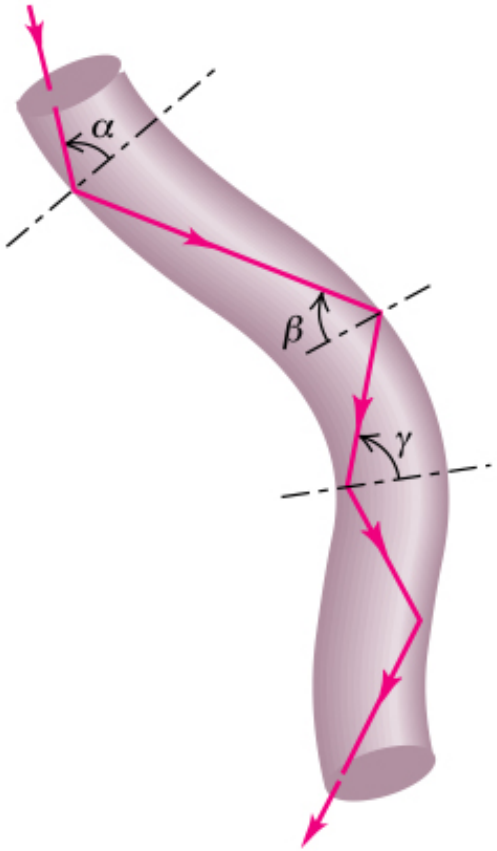
Only happens when light goes from high *n* to low *n* material

Applications of Total Internal Reflection





Porro Prism



Fiber Optics

33-4. Dispersion

$n=c/v$, depends on wavelength λ