Phys 1402 2014-11-20

Geometric Optics - controlling the speed of light.

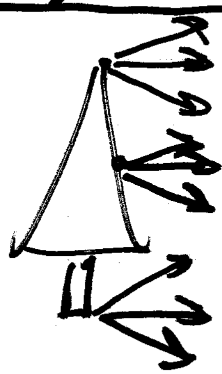
Speed of Light $v = c = 3 \times 10^8$ m/s

In a material: $v = \frac{c}{n}$

n = index of refraction

vacuum	$n = 1$
air	$n = 1.003$
water	$n = 1.33$
glass	$n = 1.5$

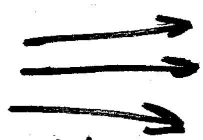
Image Formation



Tons of rays crossing each other. Too much to handle.

Strongly Diverging Rays Near obj.

Point Source

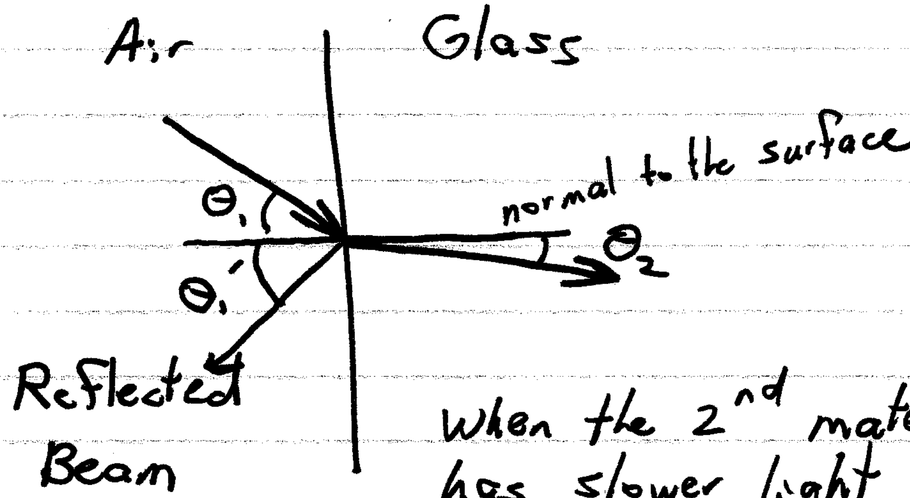


Weakly Div. Far

(2)

Everything we see sends diverging rays toward our eyes.

Reflection & Refraction



When the 2[nd] material has slower light, the beam bends toward the normal.

Reflection $\theta_1 = \theta_1'$

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

If n increases, θ decreases.

Ex: $n_1 = 1$ $\theta_1 = 40°$

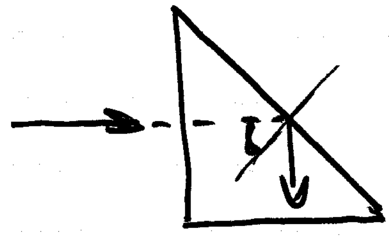
$n_2 = 1.5$

$$\sin\theta_2 = \frac{n_1}{n_2}\sin\theta_1 = 0.429$$

$$\theta_2 = 25.4°$$

(3)

Ex: Light in glass @ 45°.



$n_1 = 1.5 \quad \theta_1 = 45°$

$n_2 = 1$

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

$$\sin\theta_2 = \frac{n_1}{n_2} \sin\theta_1 = 1.06$$

$\theta_2 = n/a$

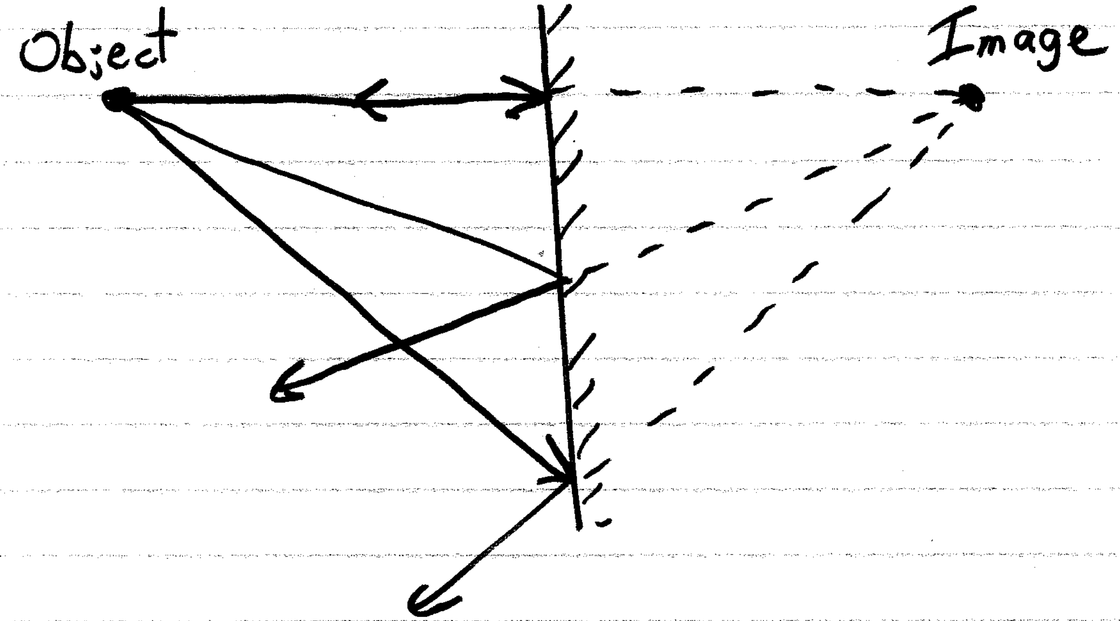
no refraction

Total Internal Reflection.

Critical angle: θ_1 so that $\sin\theta_2 = 1$

(4)

Object in front of a mirror



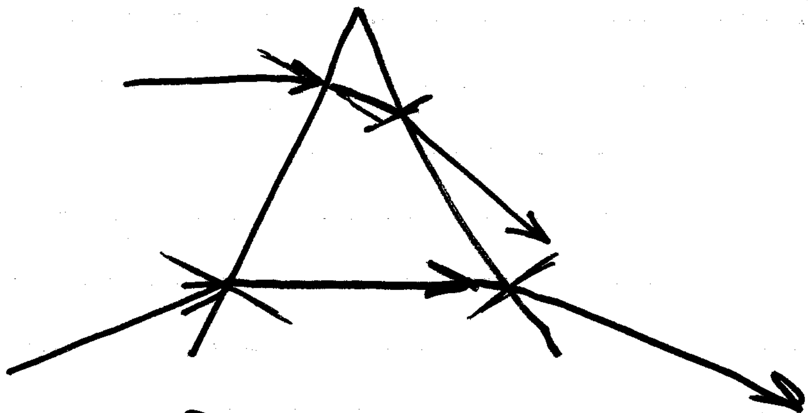
$p = |q|$

p = object distance

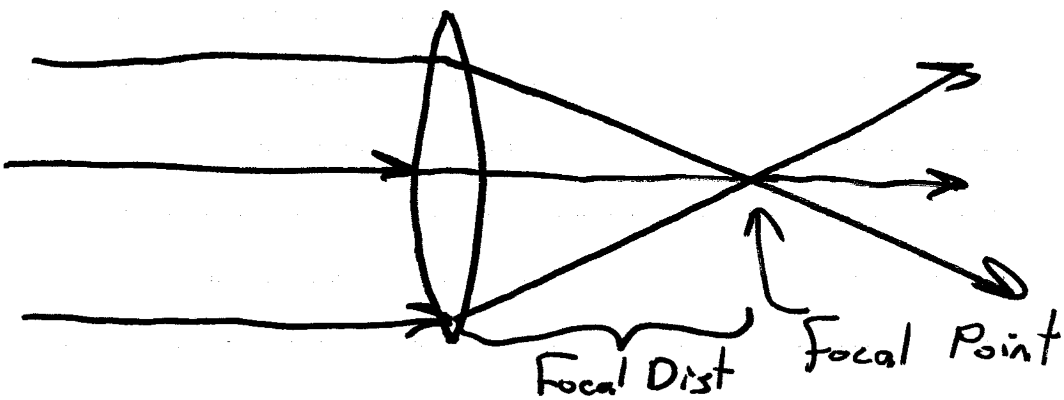
|q| = image distance magnitude

Virtual Image

Refraction From a Prism

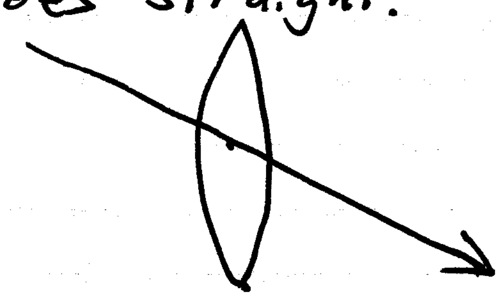


At both surfaces, the light bends away from the apex of the prism.



For a converging Lens, Any "Parallel Ray" bends to the focal point.

For any lens, a ray going thru the middle goes straight.



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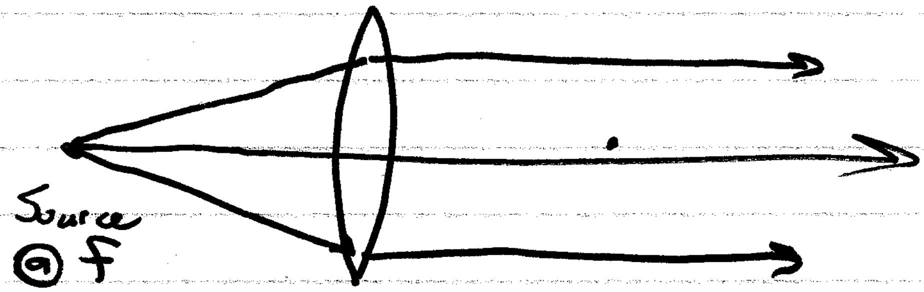
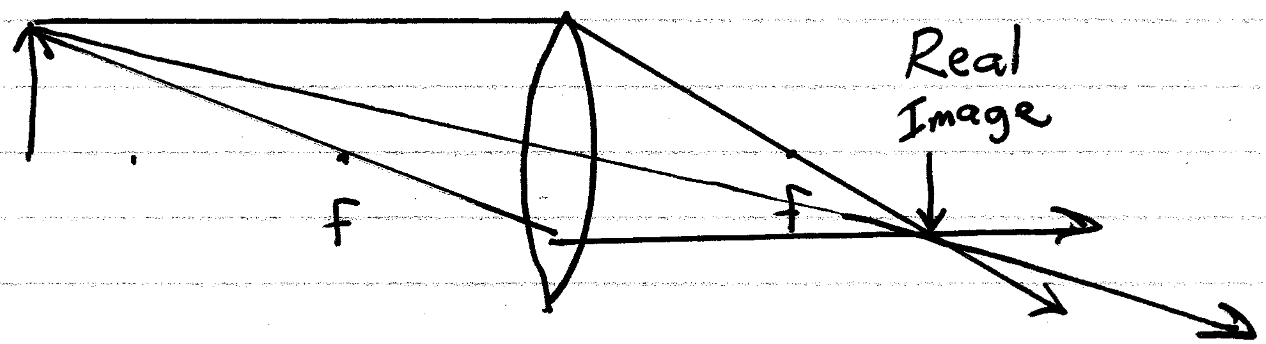


Object @ focal point makes parallel rays. Spotlight configuration.

Object at finite distance



p = obj dist
q = img dist
} both from lens

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

f = 20 cm
p = 50 cm

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p}$$

$$q = \left(\frac{1}{20} - \frac{1}{50}\right)^{-1} = 33.3 \text{ cm}$$

$$M = \frac{h'}{h} = \frac{-q}{p}$$