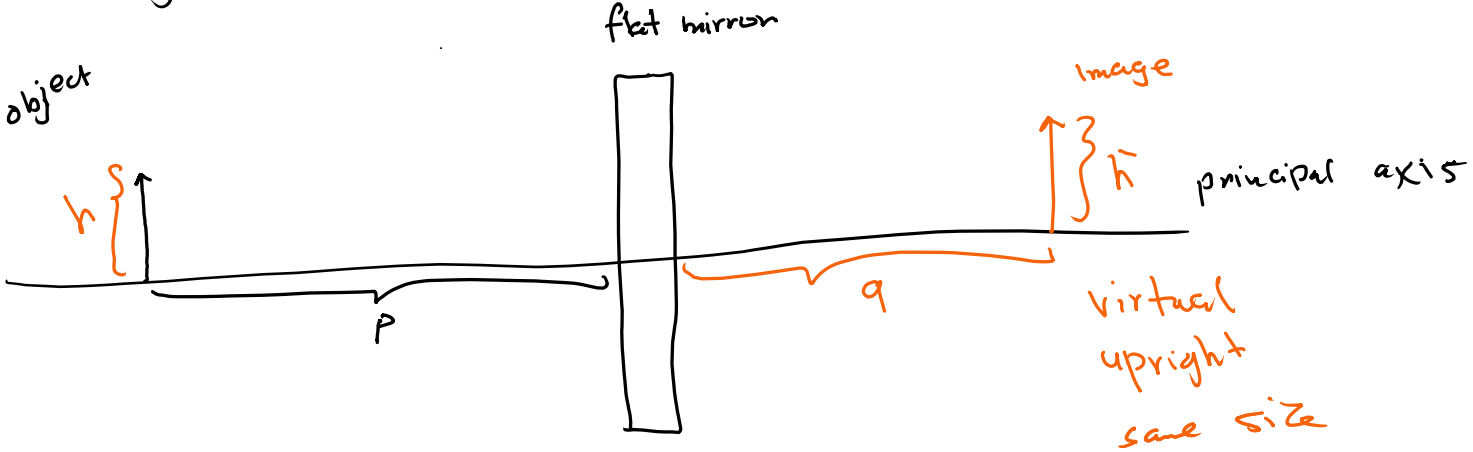
Images by Reflection:



p: object distance
q: image distance
M: Magnification

$p = q$;

$M = +1$ (upright image)

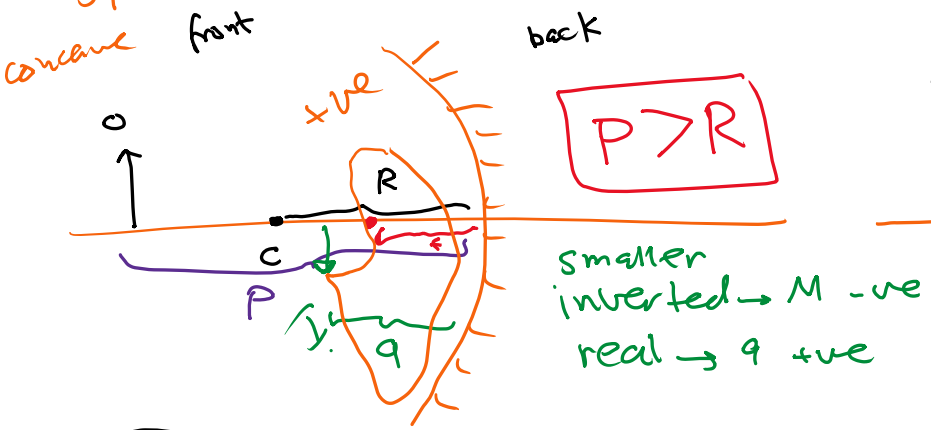
positive → upright
negative → inverted

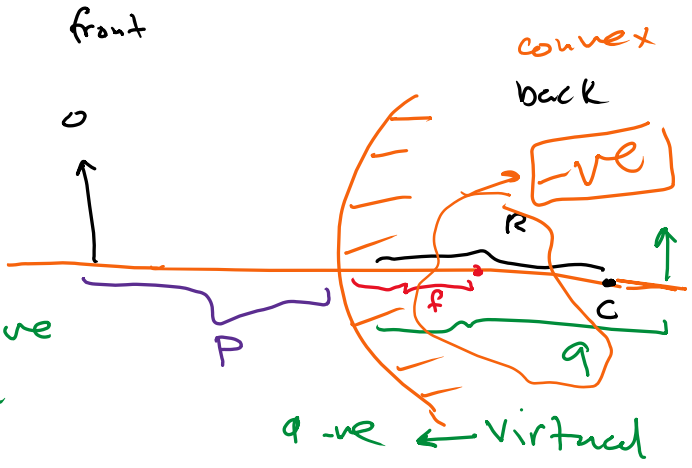
$M > 1 \Rightarrow$ larger
$M < 1 \Rightarrow$ smaller

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

Image
- real → q is +ve
- virtual → q is negative

Spherical Mirrors





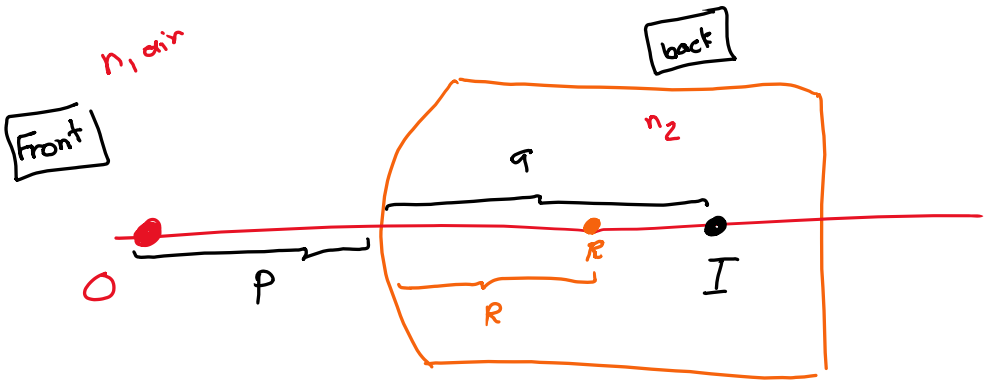
$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f} = \frac{2}{R}$$

f = focal point

Concave $\Rightarrow P < R$

Images by Refraction

$$\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$$



$n_1 < n_2$

R +ve

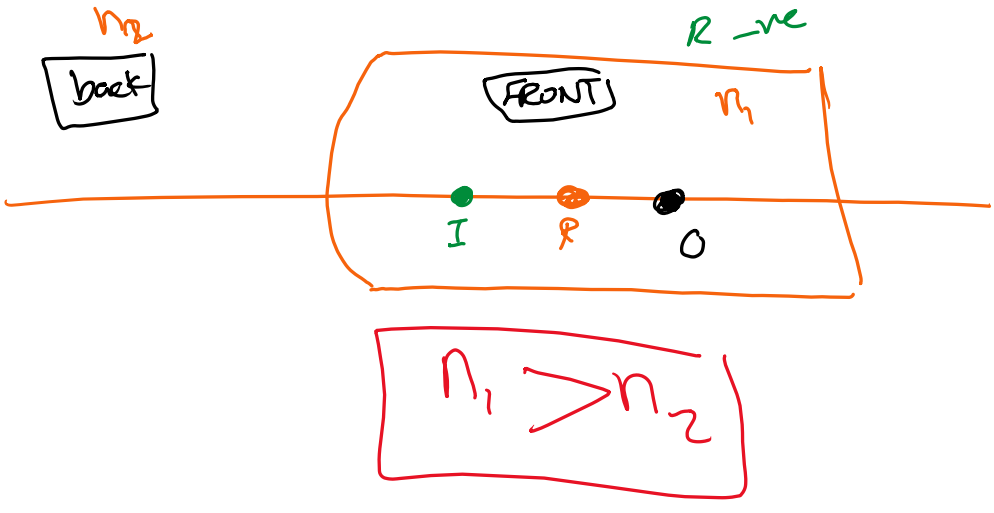
Image is real (back)

q +ve

$M = -\frac{q}{p}$ -ve

↓

inverted



$n_1 > n_2$

q -ve

Image is virtual

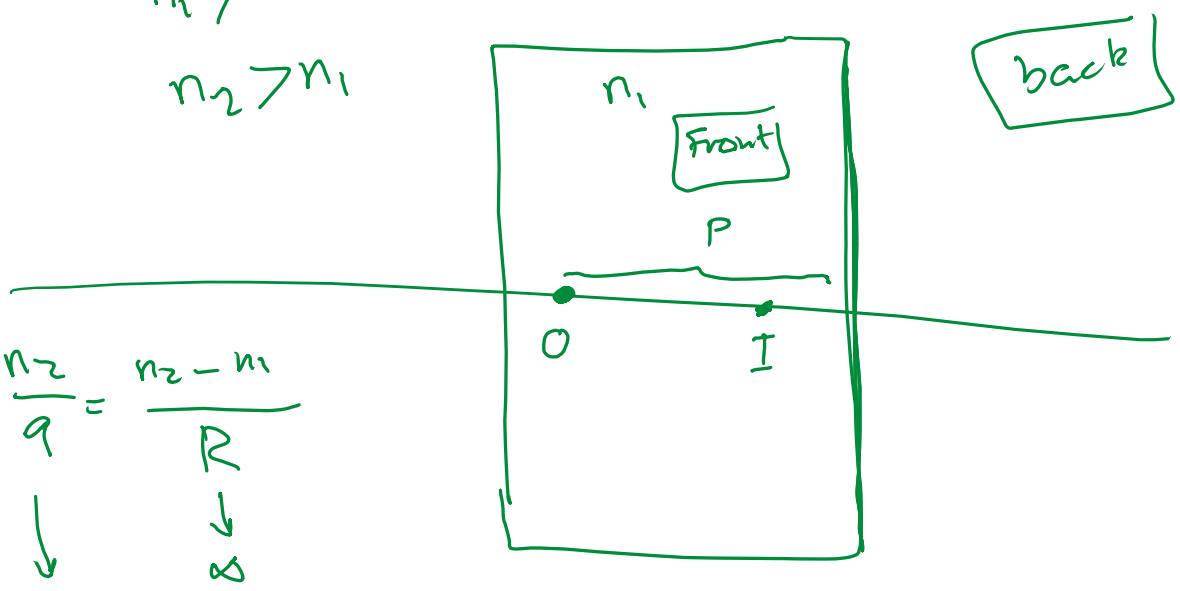
Front

M ⇒ +ve

upright

$n_1 > n_2$

$n_2 > n_1$



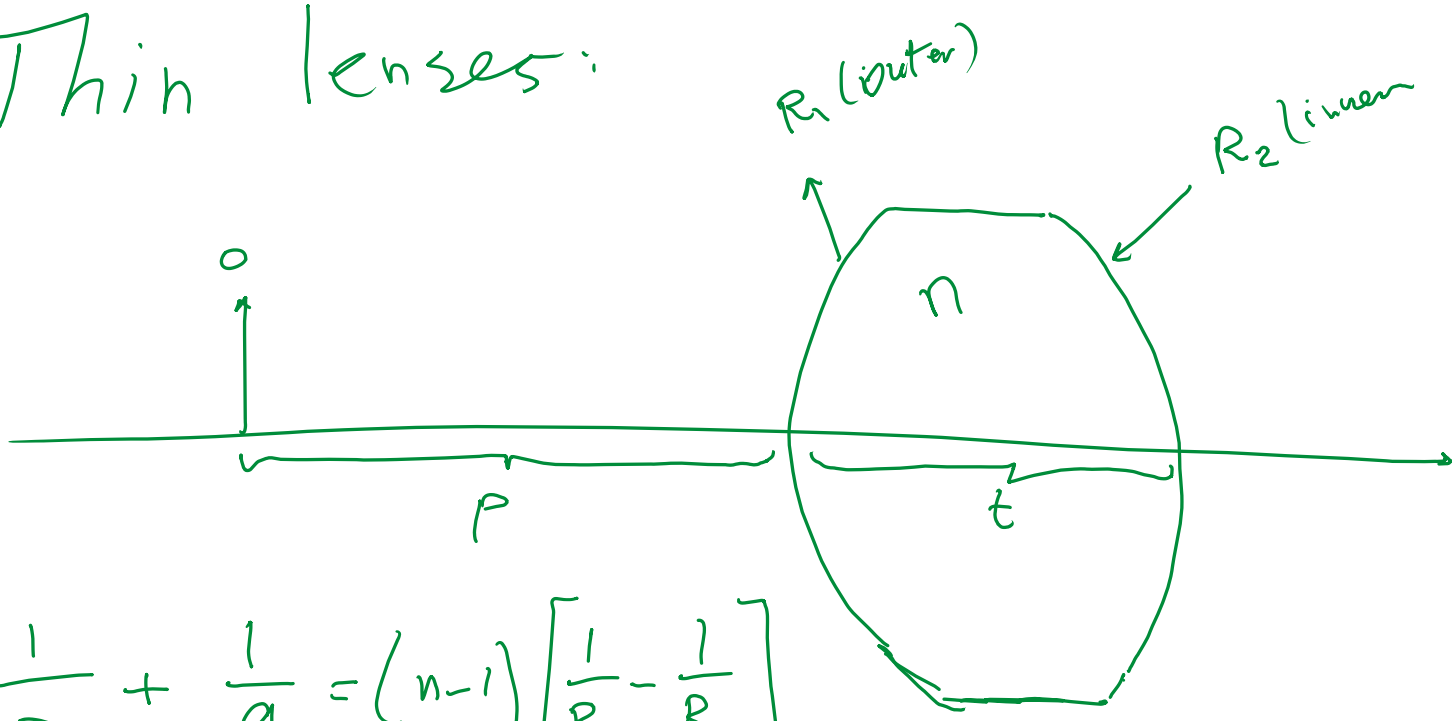
$$\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$$

$p \downarrow$, $R \downarrow \infty$

$$\frac{n_1}{p} + \frac{n_2}{q} = 0 \Rightarrow q = -\left(\frac{n_2}{n_1}\right) p$$

$q \longrightarrow$ -ve $\longrightarrow$ virtual, front

Thin lenses:



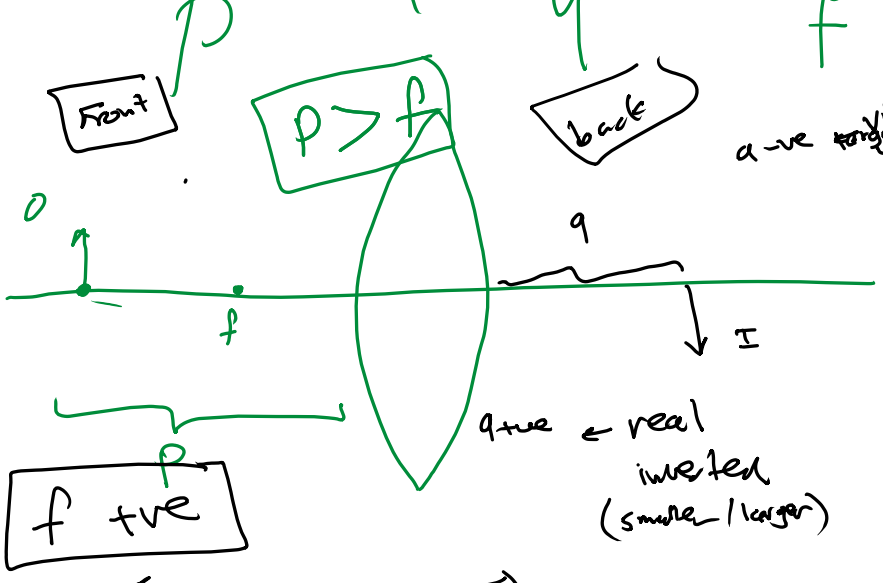
$$\frac{1}{p} + \frac{1}{q} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

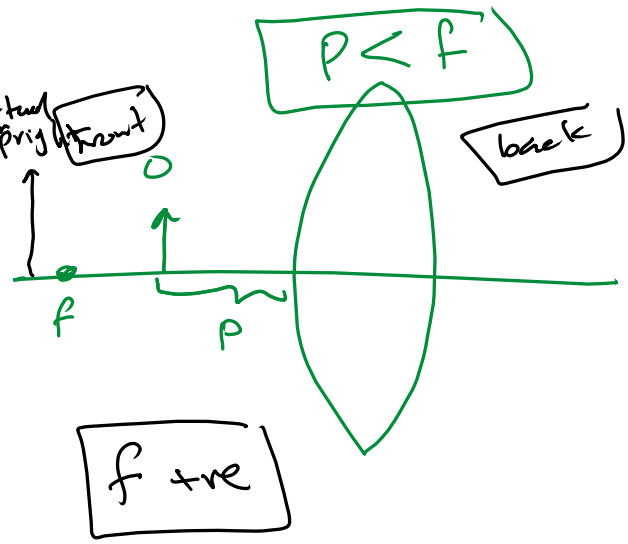
$$= \frac{1}{f}$$

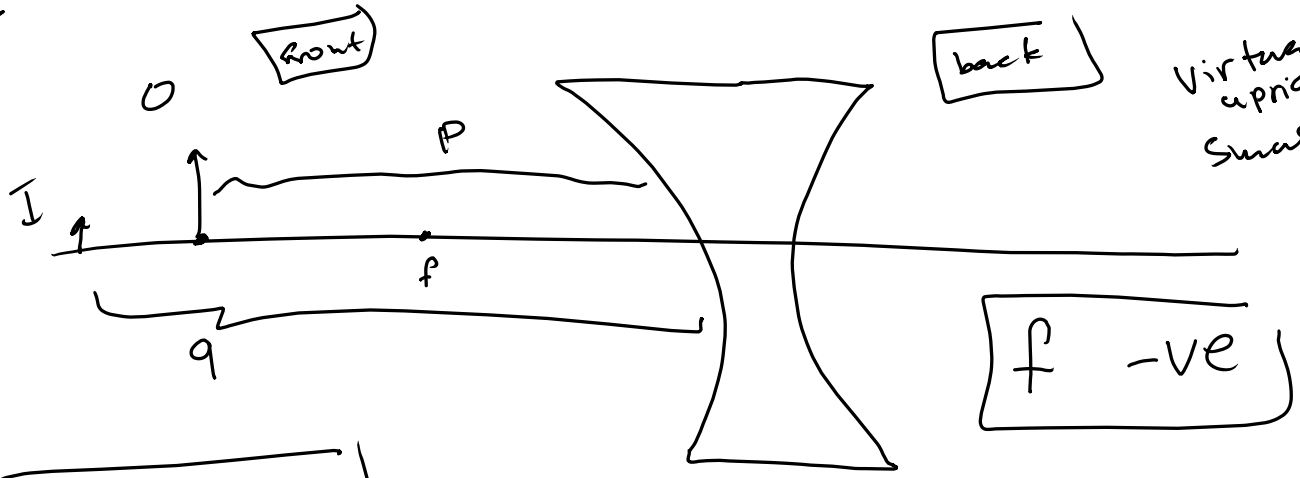
converging

diverging

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







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

Camera: $f\text{-number} = \frac{f}{D}$ → focal length / diameter

$$I \propto \frac{1}{(f\text{-number})^2}$$

I → intensity of the light

near_point = 25 cm

far_point = ∞

> 25 cm — Farsighted — converging

$< \infty$ — nearsighted — diverging

Power of a lens

$$P = \frac{1}{f} \text{ diopters}$$

Magnifier

$$M_{max} = 1 + \frac{25\text{ cm}}{f}$$

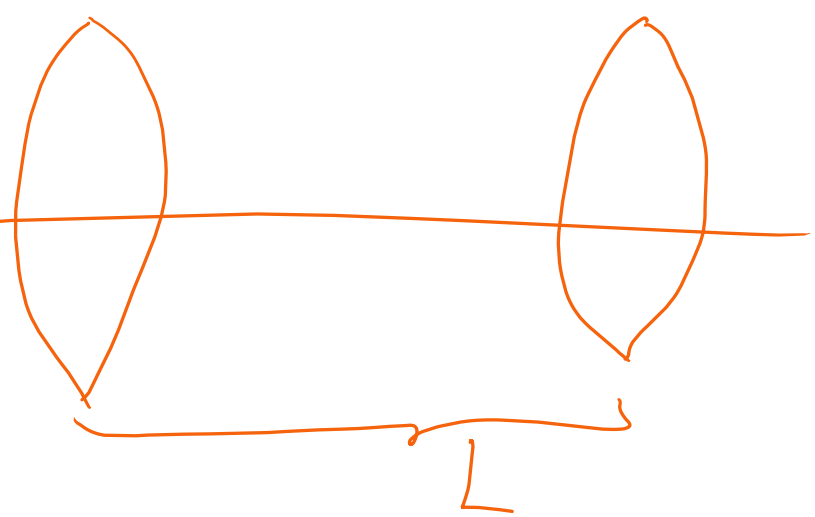
$$m_{min} = \frac{25\text{ cm}}{f}$$

$$P = \frac{25 f}{25 + f}$$

Microscope

f_o : objective

f_e : eyepiece

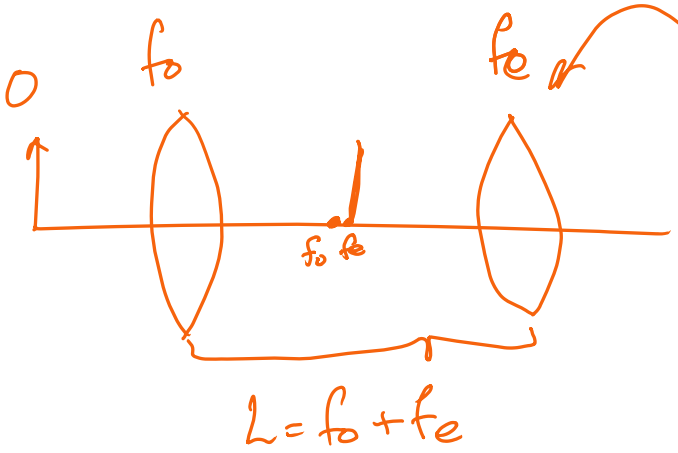


$$M = M_o M_e = \left(\frac{-L}{f_o}\right)\left(\frac{25}{f_e}\right)$$

Telescope

refraction

Reflection



$$M = -\frac{f_o}{f_e} = M_1 M_2$$