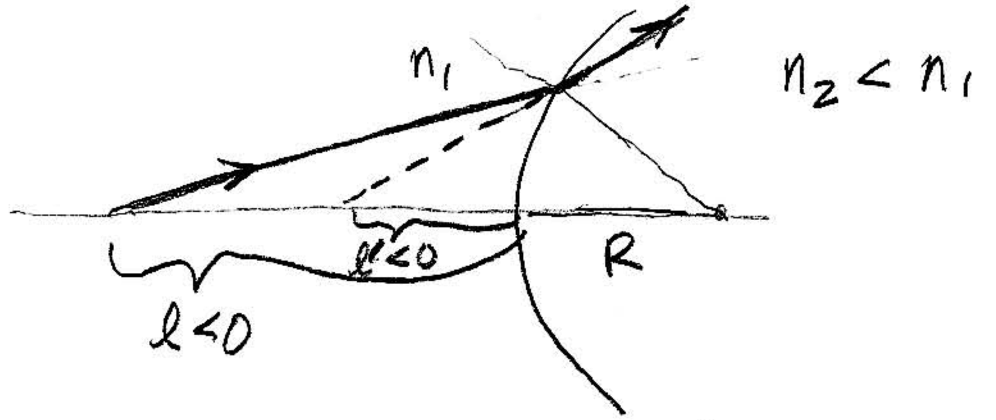
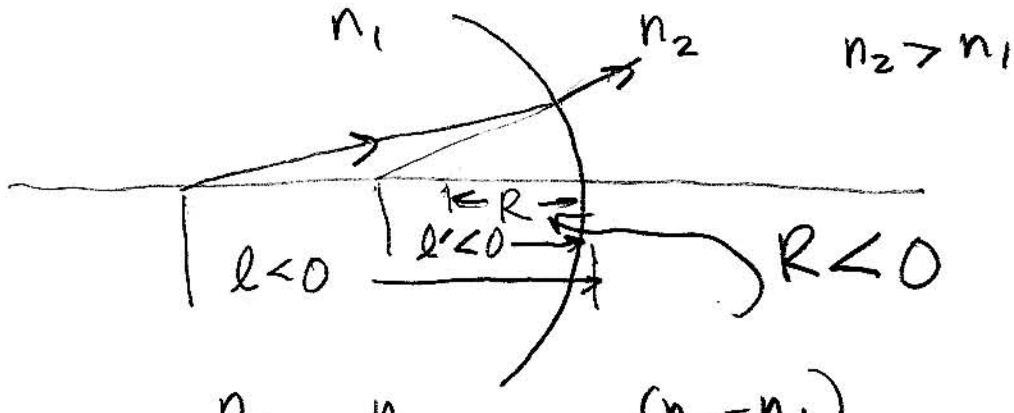


(see figure on web)

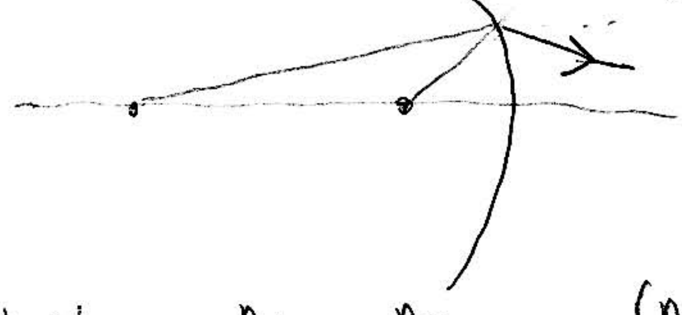
still true that

$$-\frac{n_1}{\ell} + \frac{n_2}{\ell'} = \frac{(n_2 - n_1)}{R} \Leftarrow \text{now, R.H.S} < 0 \quad n_2 < n_1$$

Further: can make $R < 0$:

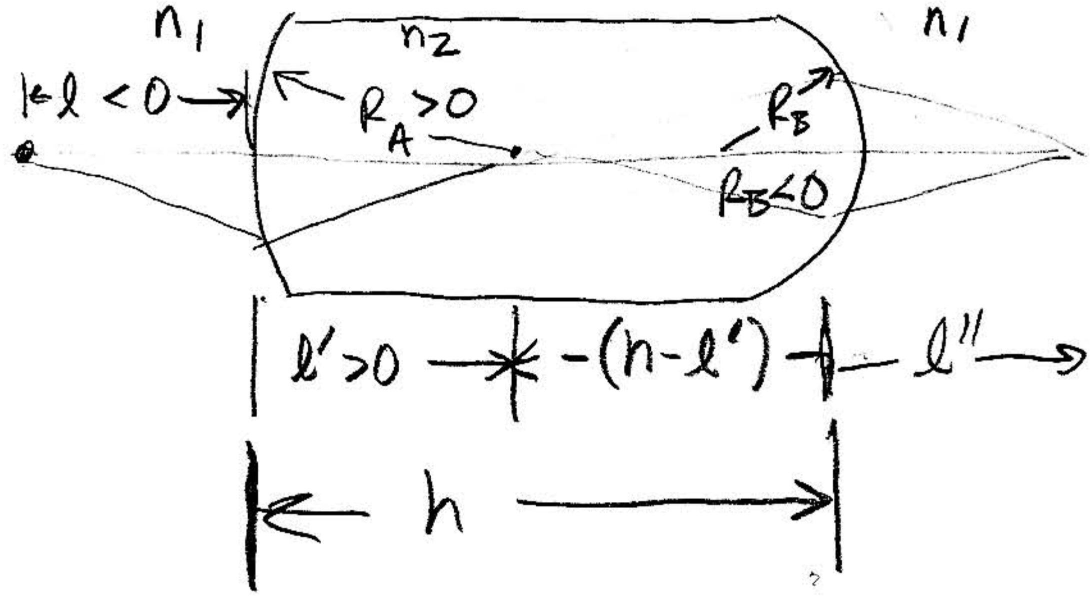


$$-\frac{n_1}{\ell} + \frac{n_2}{\ell'} = -\frac{(n_2 - n_1)}{R}$$



still $-\frac{n_1}{\ell} + \frac{n_2}{\ell'} = -\frac{(n_2 - n_1)}{R} \Leftarrow$ now, > 0

Multiple Surfaces



$$-\frac{n_1}{l} + \frac{n_2}{l'} = \frac{(n_2 - n_1)}{R_A} \qquad \frac{n_2}{h - l'} + \frac{n_1}{l''} = \frac{(n_1 - n_2)}{(R_B)}$$

$R_B < 0$

relate l to l''

hard : $h \neq 0$

"thin lens": $h \to 0$

then $$\frac{n_2}{l'} = \frac{(n_2 - n_1)}{R_A} + \frac{n_1}{l}$$

$$-\frac{(n_2 - n_1)}{R_A} - \frac{n_1}{l} + \frac{n_1}{l''} = -\frac{n_2 - n_1}{R_B}$$

$>0, <0$

$$\boxed{-\frac{n_1}{l} + \frac{n_1}{l''} = (n_2 - n_1)\left(\frac{1}{R_A} - \frac{1}{R_B}\right)}$$

Focal Length of a Lens

$$\frac{1}{f} \equiv (n_2 - n_1)\left(\frac{1}{R_A} - \frac{1}{R_B}\right)$$

air

$R_A < R_B$, $\frac{1}{R_A} - \frac{1}{R_B} > 0$

$R_A > 0$ $R_B > 0$

glass $n_2 > n_1$

$f > 0$

$R_A > 0$, $R_B < 0$, $\frac{1}{R_A} - \frac{1}{R_B} > 0$

$f > 0$

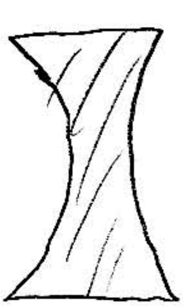
$R_A < 0$, $R_B < 0$

$|R_A| > |R_B|$

$\frac{1}{R_A} - \frac{1}{R_B} =$

$-\frac{1}{|R_A|} + \frac{1}{|R_B|} > 0$

$f > 0$



$R_A < 0$, $R_B > 0$

$\frac{1}{R_A} - \frac{1}{R_B} < 0$

$f < 0$.

Meaning of Focal Length

$n_1 = 1$
air

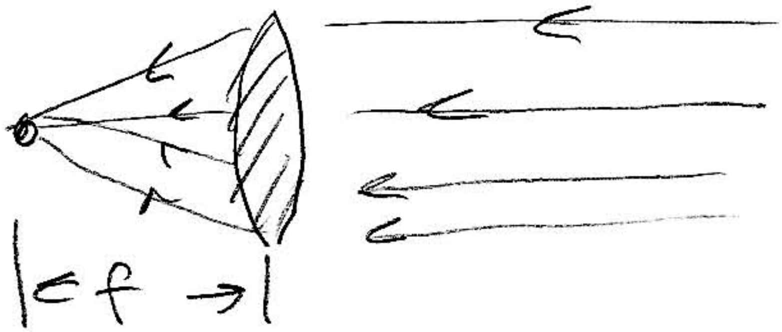
$f > 0$

parallel light
(like $l = -\infty$)

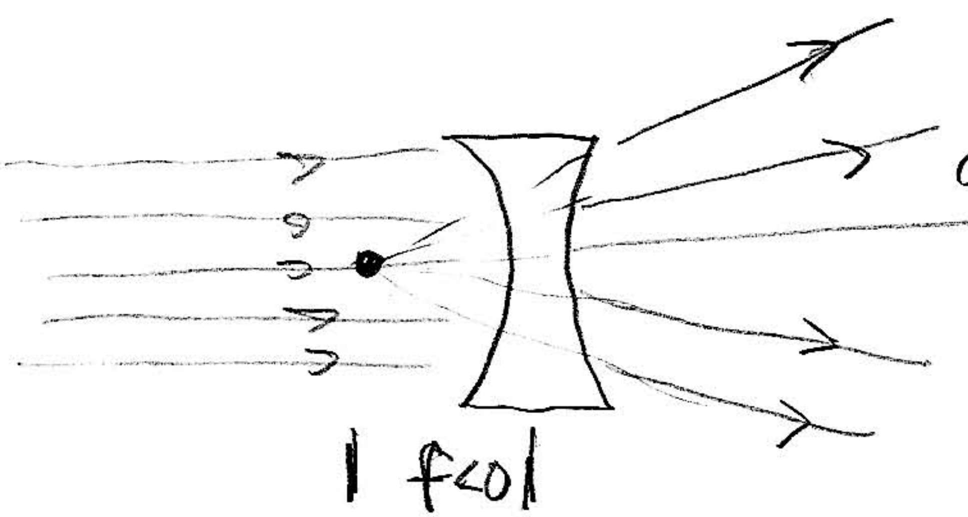
light focused a distance f behind

$$-\underbrace{\cancel{\frac{1}{l}}}_{0} + \frac{1}{l'} = \frac{1}{f}$$

$$l' = f$$

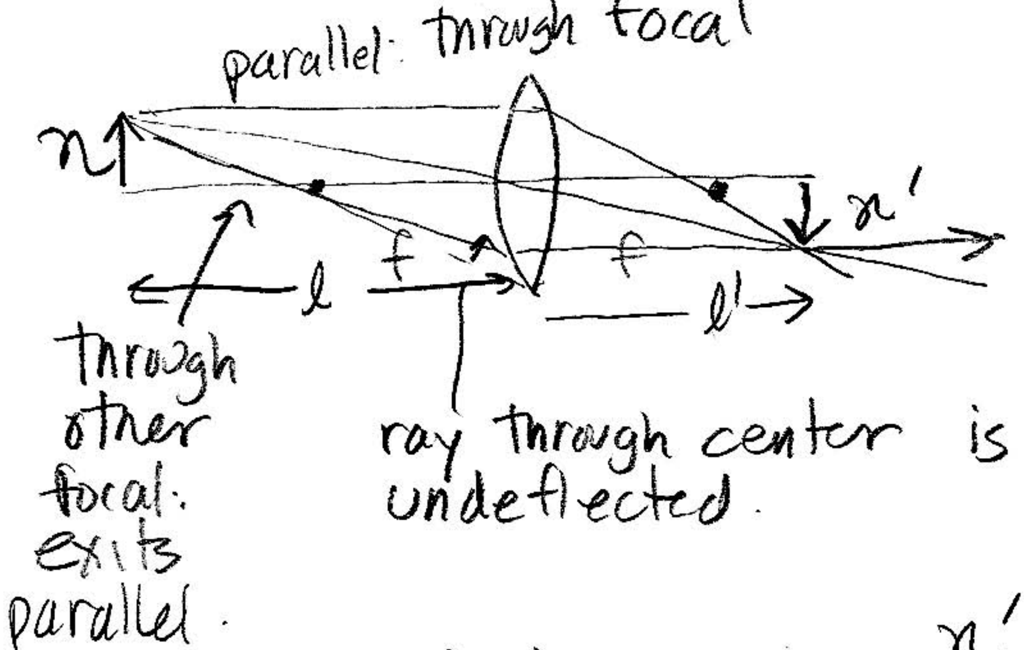


$f < 0$



diverges, like coming from a point at the $f<0$

Magnification



Magnification: $m \equiv \frac{x'}{x}$ (<0)

$$= \frac{l'}{l}$$