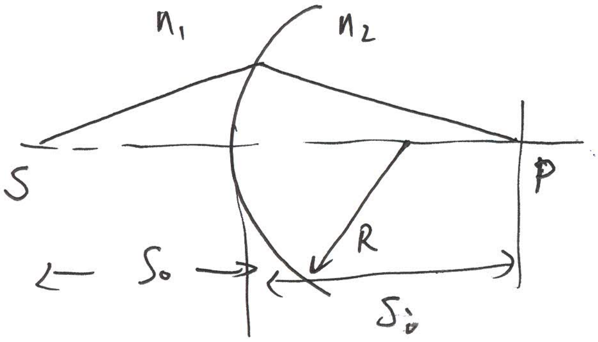
PHYS 3038

Ch5. Geometrical optics

5.2.2. Refraction at spherical surface



$$\frac{n_1}{S_o} + \frac{n_2}{S_i} = \frac{n_2 - n_1}{R}.$$

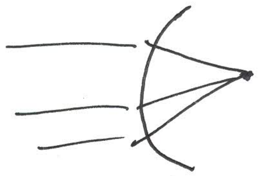
o : object

i : image

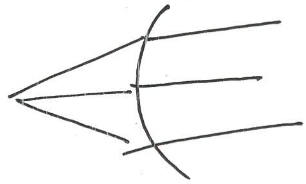
~~$n_2 > n_1$~~ $n_2 > n_1$

1). ~~$n_2 > n_1$~~ $R > 0$

* $S_o = \infty$ $\quad \frac{n_2}{f_i} = \frac{n_2 - n_1}{R} \Rightarrow f_i = \frac{n_2}{n_2 - n_1} R$

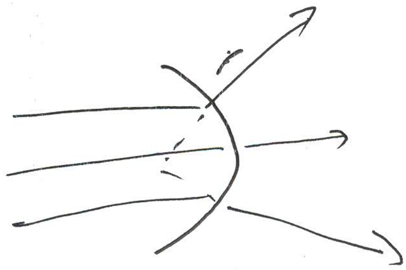


* $S_i = \infty$, $\quad \frac{n_1}{f_o} = \frac{n_2 - n_1}{R} \Rightarrow f_o = \frac{n_1}{n_2 - n_1} R$

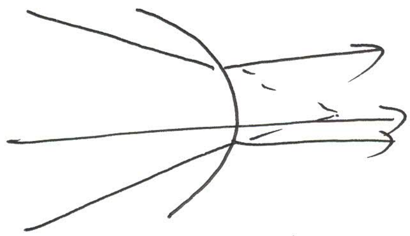


2) $R < 0$.

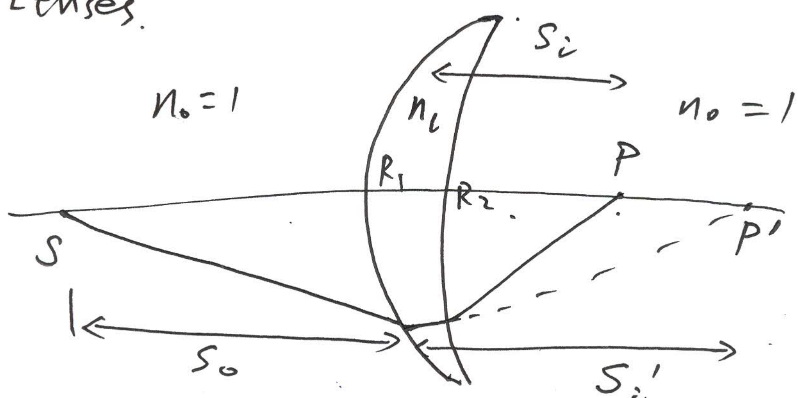
* $S_o = \infty$, $\quad f_i = \frac{n_2}{n_2 - n_1} R$



* $S_i = \infty$, $\quad f_o = \frac{n_1}{n_2 - n_1} R$



5.2.3. Thin Lenses



$$\left.\begin{aligned} \frac{n_o}{S_o} + \frac{n_l}{S_i'} &= \frac{n_l - n_o}{R_1} \\ \frac{n_l}{-S_i'} + \frac{n_o}{S_i} &= \frac{n_o - n_l}{R_2} \end{aligned}\right\} \Rightarrow \frac{n_o}{S_o} + \frac{n_o}{S_i} = (n_l - n_o)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\Rightarrow \frac{1}{S_o} + \frac{1}{S_i} = \frac{n_l - n_o}{n_o}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$n_o = 1$ air

$$\Rightarrow \boxed{\frac{1}{S_o} + \frac{1}{S_i} = (n_l - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \frac{1}{f}}$$

Newtonian Form

$$\frac{S_o}{S_i} = \frac{Y_o}{|Y_i|} = \frac{\overline{OA}}{\overline{P_1P_2}} = \frac{f}{S_i - f}$$

$$\Rightarrow S_o S_i - S_o f = S_i f$$

$$\Rightarrow S_o S_i = S_i f + S_o f$$

$$\Rightarrow \frac{1}{f} = \frac{1}{S_o} + \frac{1}{S_i}$$

$$\frac{1}{f} = \frac{1}{(x_o + f)} + \frac{1}{(x_i + f)} \Rightarrow (x_o + f)(x_i + f) = (S_i + S_o) f = (x_o + x_i + 2f) f$$

$$x_o x_i + \cancel{x_o f} + \cancel{x_i f} + f^2 = \cancel{x_o f} + \cancel{x_i f} + 2f^2$$

$$\Rightarrow \boxed{x_o x_i = f^2}$$