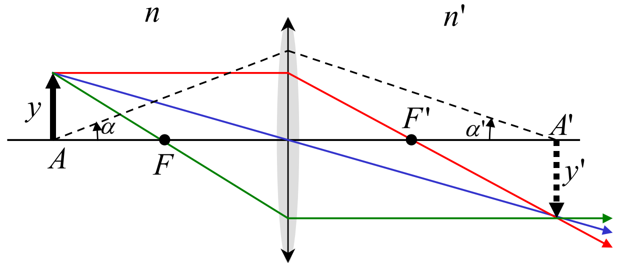
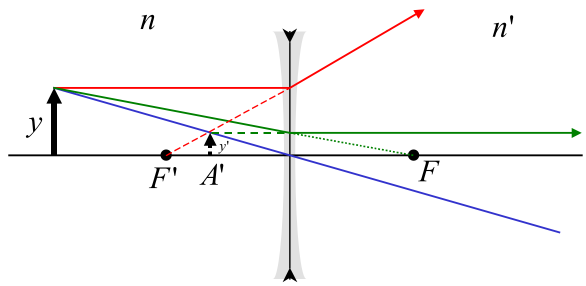
# Thin Lens

Positive Lens (C>0)




Negative Lens (C<0)




## General Thin Lens Equations

Power: $C = -\dfrac{n}{f} = \dfrac{n'}{f'}$

Shape Factor: $\gamma = \dfrac{1}{2}\left(\dfrac{1}{R_1} + \dfrac{1}{R_2}\right)$

Focal Lengths: $f' = -f$

Lens Maker's Equation: $C = (N-1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$ Thin lens in air with glass index N

$$C = -\frac{n_1}{f} = \frac{n_3}{f'} = \frac{N - n_1}{R_1} + \frac{n_3 - N}{R_2}$$

$n_1 \equiv$ Index before Lens

$n_2 \equiv$ Index after Lens

Distance for Magnification: $x = f'\left(\dfrac{1}{m_y}\dfrac{n}{n'} - 1\right)$

## At the conjugate points A and A'

Imaging Equation: $\dfrac{n'}{x'} = \dfrac{n}{x} + \dfrac{n'}{f'}$

Optical Invariance: $ny\alpha = n'y'\alpha'$

Newton's Equation: $m_y = \dfrac{y'}{y} = -\dfrac{f}{\overline{FA}} = -\dfrac{\overline{F'A'}}{f'}$

Transverse Magnification: $m_y = \dfrac{y'}{y} = \dfrac{x'}{x}\dfrac{n}{n'} = -\dfrac{1}{m_\alpha}\dfrac{n}{n'} = \dfrac{1}{m_x}\dfrac{x}{x'} = -\dfrac{m_\alpha}{m_x}$

Angular Magnification: $m_\alpha = \dfrac{\alpha'}{\alpha} = -\dfrac{x}{x'} = -\dfrac{1}{m_y}\dfrac{n}{n'} = -m_x\dfrac{x'}{x}\dfrac{n}{n'} = -m_x m_y$

Axial Magnification: $m_x = \dfrac{dx}{dx'} = \dfrac{n}{n'}\left(\dfrac{x}{x'}\right)^2 = \dfrac{1}{m_y}\dfrac{x}{x'} = -m_\alpha\dfrac{x}{x'}\dfrac{n'}{n} = -\dfrac{m_\alpha}{m_y}$