\[ \sin \theta = \frac{h}{R} \]

\[ \cos \theta = \frac{R - \varepsilon}{R} \]

\[ \text{R = radius of curvature} \]

Vertical angles are equal.

Reflection law.

Sides are equal.
Paraxial rays

\[ h \ll R \]

\[ \sin \theta = \frac{h}{R} \approx \theta \]

\[ \frac{\varphi \theta}{\frac{R}{2}} = 1 - \frac{h}{R} \]

\[ \frac{\varphi \theta}{\frac{R}{2}} = 1 - \frac{1}{2} \theta^2 \]

\[ \frac{h}{R} \approx \frac{1}{2} \theta^2 \]

\[ (R - a)^2 = h^2 + a^2 \]

\[ R^2 - 2aR + a^2 = h^2 + a^2 \]

\[ R^2 - h^2 = 2aR \]

\[ a = R - \frac{h}{2} \approx \frac{R}{2} \]

Focal length is \( \boxed{\frac{R}{2}} \) independent of \( h \).

All paraxial rays go through \( f \).

\( f \) is the focal point of the mirror.
Snell's Law

\[ n_1 \sin \theta_1 = n_2 \sin \theta_2 \]

From Principle of Least Time

\[ t_{time_1} + t_{time_2} = \text{minimum} \]
\[ \sin \theta = n \sin \theta_w \]
\[ \tan \Theta_w = \frac{l}{d} \quad \tan \Theta = \frac{\ell}{y} \]

\[ y = d \frac{\tan \Theta_w}{\tan \Theta}. \]

**Small angle** \[ \sin \Theta = \tan \Theta \]

\[ y = d \frac{\sin \Theta_w}{\sin \Theta} \]

**Snell's law** \[ \sin \Theta = \frac{n \sin \Theta_w}{n} \]

\[ y = d \frac{\sin \Theta}{\sin \Theta} = \frac{d}{n} \]

The apparent depth is independent of \( \Theta_w \), so all nearby rays come from \( y \).