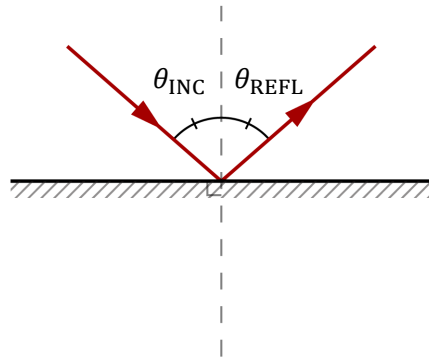


Geometric (ray) optics

Law of reflection

$$\theta_{\text{INC}} = \theta_{\text{REFL}}$$



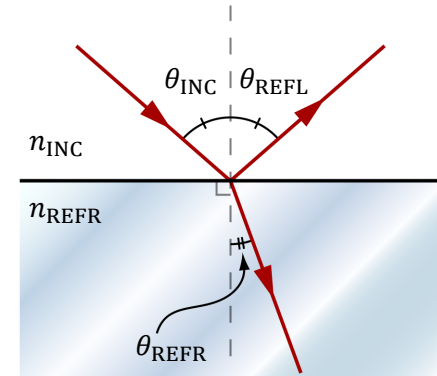
Index of refraction

$$v = \frac{c}{n}$$

Snell's law of refraction

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

When $n_{\text{INC}} > n_{\text{REFR}}$ and $\theta_{\text{REFR}} = 90^\circ$, θ_{INC} is called θ_{CRIT} .
TIR



	Rays reflect back toward original side	Rays pass through to other side	Sign of focal length f
Rays converge	Concave mirror	Convex lens	$f > 0$
Rays diverge	Convex mirror	Concave lens	$f < 0$

Sketch rays to find image

1. **Parallel** to optical axis, through **focus**
2. Through **focus**, **parallel** to optical axis
3. Through **center**, **unbent/pure U-turn**

Relate distances from mirror/lens plane

$$\frac{1}{s_{\text{OBJ}}} + \frac{1}{s_{\text{IMG}}} = \frac{1}{f}$$

$$\frac{h_{\text{OBJ}}}{h_{\text{IMG}}} = -\frac{s_{\text{OBJ}}}{s_{\text{IMG}}}$$

$$M = -\frac{s_{\text{IMG}}}{s_{\text{OBJ}}}$$

$$R = 2f$$

Object on side of device light comes from (goes to):

$$s_{\text{OBJ}} > 0 \quad (s_{\text{OBJ}} < 0)$$

Image on side of device light goes to (comes from):

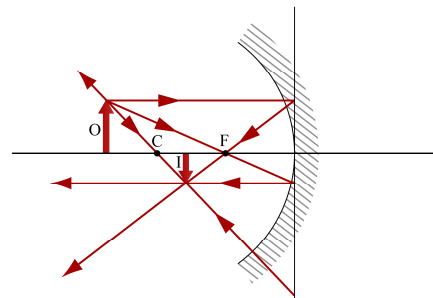
$$s_{\text{IMG}} > 0 \quad (s_{\text{IMG}} < 0)$$

Resulting **image types**

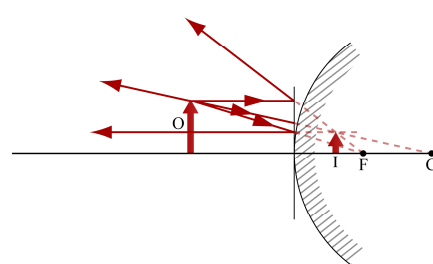
Real \Leftrightarrow Inverted

Virtual \Leftrightarrow Upright

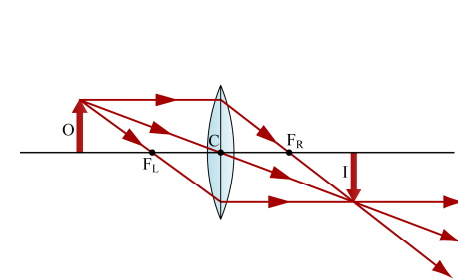
Concave mirror



Convex mirror



Convex lens



Concave lens

