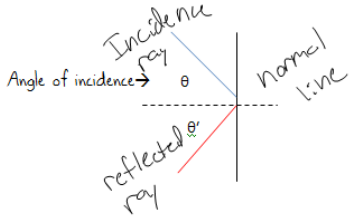
Geometric Optics Review

Note: Images from The Physics Classroom, (www.physicsclassroom.com)

Fates of light at a boundary:

- Reflected – some of the light bounces off of the new medium
- Transmitted – some of the light passes through the new medium
- Absorbed – some of the light causes the temperature of the new medium to increase



- Indexes of refraction
  - Not less than 1

Medium	*n*
Water	1.33
Glass	1.5
Ethyl alcohol	1.36
Sodium Chloride	1.53
Diamond	2.41

- If small n to big n, then bends towards normal
- If big n to small n, then bends away from normal

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

- C = the speed of light in a vacuum (3×10^8 m/s)
- V = the speed of light in the substance
  - Speed of light ↓ then n ↑

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

- **Remember:** the frequency of the wave is constant as it changes medium

$$n_1 v_1 = n_2 v_2$$

$$\frac{n_1}{n_2} = \frac{v_2}{v_1} = \frac{f\lambda_2}{f\lambda_1}$$

$$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1}$$

- Critical Angle
  - The speed of light is increasing – light **must** be going **from a high** n **to a lower** n
  - $n_1 \sin\theta_1 = n_2 \sin 90$ (note: $n_1 > n_2$)
- Lens equation: $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$
- Magnification: $m = \frac{h_i}{h_o} = \frac{d_i}{d_o}$

Sign Conventions

Mirrors

Quantity	*Positive if*	*Negative if*
Object location	In front of mirror	Behind mirror
Image location	behind mirror	In front of mirror
Image height	Upright	Inverted
Focal Length and Radius	Concave Mirror	Convex Mirror
Magnification	Image is upright	Image is inverted

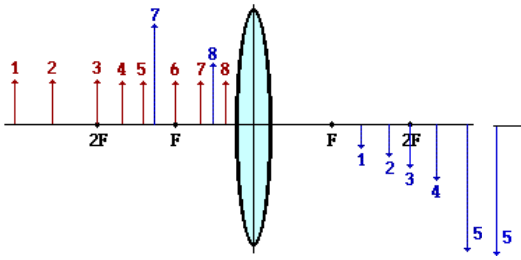
Thin Lenses

Quantity	*Positive if*	*Negative if*
Object location	In front of lens	Behind lens
Image location	Behind lens	In front of lens
Image Height	Upright	Inverted
Focal Length	Converging lens	Diverging lens

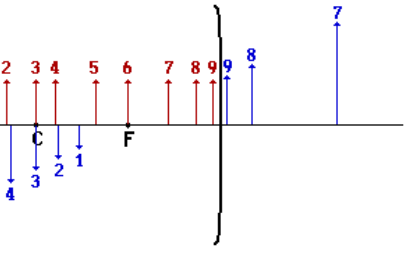
Convex Lens/Concave Mirror (Converging)

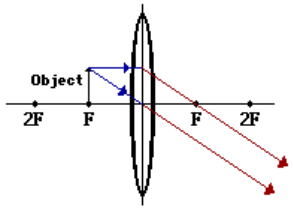
Cases

Case	Object Location	Image Location	Image Type	Image Size	Image Orientation
1	∞ (Gives F)	F	Virtual	Smaller	---
2	Beyond 2F	Between F & 2F	Real	Smaller	Inverted
3	At 2F	At 2F	Real	Same	Inverted
4	Between 2F and F	Beyond 2F	Real	Larger	Inverted
5	Closer than F	On object side	Virtual	Larger	Right side up
6	At F	No image	---	---	---



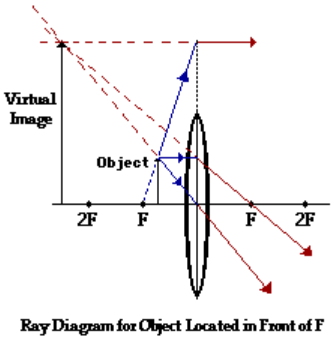
Each of the numbered objects (except #6) has an image with the corresponding number; its relative location, size, and orientation are shown.





Ray Diagram for Object Located at F
(an image is not formed)

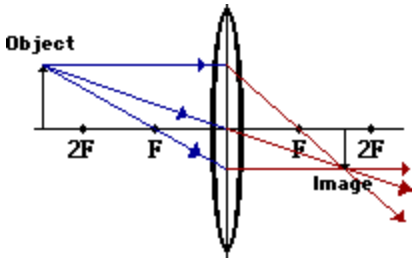
Ray Diagrams



Ray Diagram for Object Located in Front of F

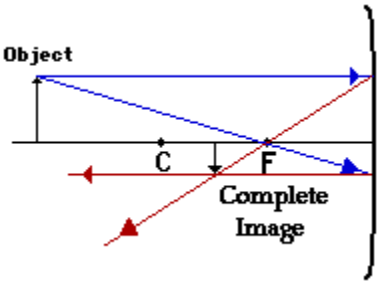
Convex Lenses

1. Draw incident ray from object parallel to principle axis & refracting through focal point of opposite side
2. Draw incident ray from object traveling through focal point refracting through lens to be parallel to the principal axis
3. Draw incident ray from object through center of lens w/o refraction



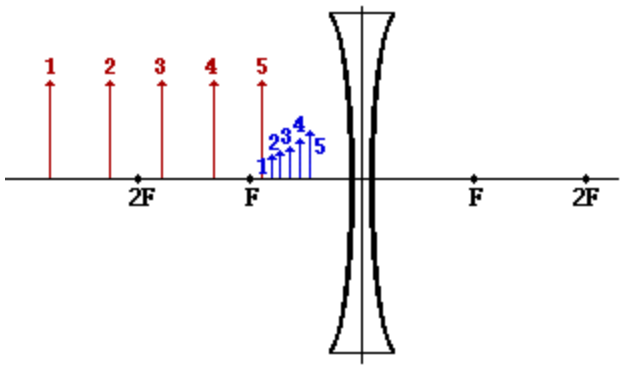
Concave Mirror

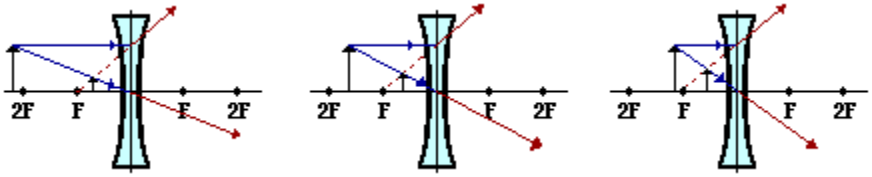
1. Draw incident ray from object parallel to principle axis & reflecting through F at lens
2. Draw incident ray from object through F & reflecting parallel to principle axis at lens

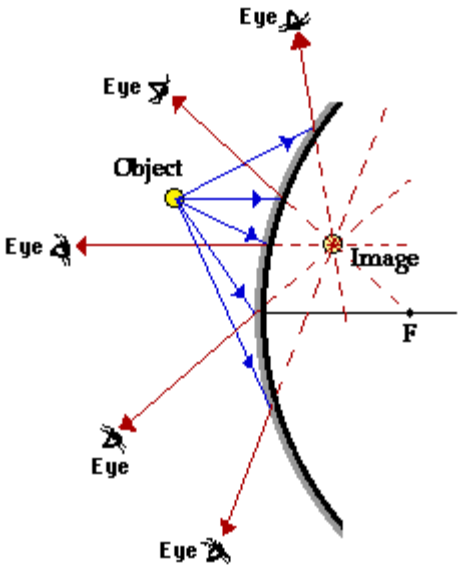


Concave Lens/Convex Mirror (Diverging)

Case	Object Location	Image Location	Image Type	Image Size	Image Orientation
1	---	Object Side	Virtual	Smaller	Right Side up



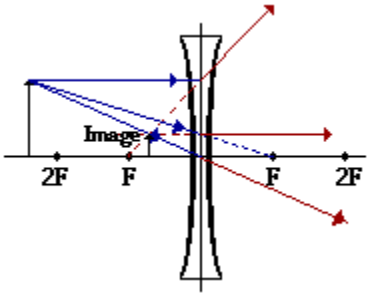




Ray Diagrams

Concave Lens

1. Draw incident ray from object parallel to principle axis & refracting imaginarily to F on object side
2. Draw incident ray from object towards F on opposite side but refracting parallel to principal axis at the lens, extend the horizontal line backwards towards the object
3. Draw incident ray from object through center of lens



Convex Mirror

1. Draw incident ray from object towards F on opposite side but refracting parallel to principal axis at the mirror
2. Draw incident ray from object parallel to principal axis refracting at the lens towards F on the opposite side