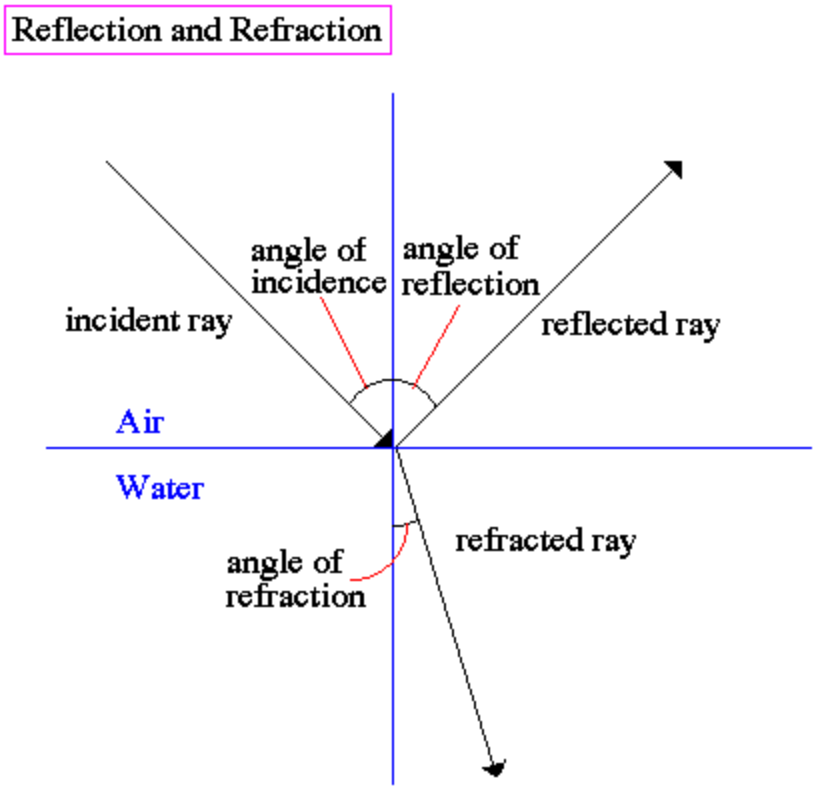
REFRACTION

Refraction - the bending of light as it travels from one medium to another

If light travels from one medium to another at any angle other than an incident ray that is perpendicular to the surface (a line parallel to the normal to the surface), the light ray will change direction at the boundary.

Refraction notes:

1. The angles of the incident and refracted rays are **measured** with respect **to the normal**.
2. The normal line is **extended into the refracting medium**.
3. The ***angle of incidence*** is θ_i.
4. The angle between the refracted ray and the normal is called the ***angle of refraction*** or θ_r.



Law of index of refraction - the **ratio** of the **speed of light in a vacuum** to its **speed in a given transparent medium**.

The index of refraction can be calculated with the following formula:

$$index\ of\ refraction = \frac{speed\ of\ light\ is\ vacuum}{speed\ of\ light\ in\ medium} \qquad \text{or} \qquad \boldsymbol{n} = \frac{c}{v}$$

The index of refraction will always be greater than one because the speed of light always slows with it inters a medium. For simplicity use a value of **1** for ***n*** for air when solving problems.

Wavelength can affect the index of refraction. When white light enters a prism, a spectrum is produced. Each color of light has a different wavelength and thus refracted a different amount. The formula for calculating index of refraction when given the wavelengths is:

$$n = \frac{l_o}{l_n}$$

n - index of refraction
λ_o - wavelength of light in a vacuum
λ_n - wavelength of light in a medium

LENSES

Lens - a transparent object that refracts light rays, causing them to converge or diverge to create an image.

convex (converging) lens - thin at the edges, thicker at the center; focuses light to a point by converging the rays of light.

concave (diverging) lens - thicker at the edges, thinner in the middle; scatters light by diverging the rays of light

Below shows the ray path for a **convex (converging) lens**.

Ray One - travels from the object parallel with the principle axis, converges through the focal point.
Ray two - travels from the object and intersect the point of the principle axis and the center of the lens.

The image of the object will extended from the principle axis up or down to the intersection of ray one and ray two

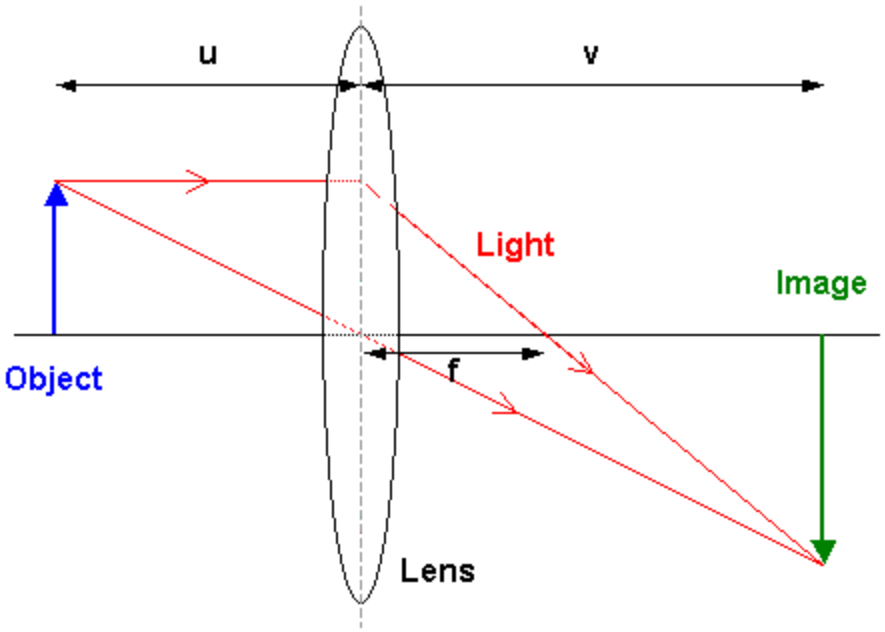


image from: http://www.doitpoms.ac.uk/tlplib/diffraction/images/diagram10.gif

Below shows the ray path for a **concave (diverging) lens**.

Ray One (parallel ray) - travels from the object parallel with the principle axis, diverges back through the focal point in front of the lens.
Ray two (chief ray) - travels from the object and intersect the point of the principle axis and the center of the lens.
Ray three (focal ray) - travels from the object, through the lens, through the focal point on the back side of the lens

The image of the object will extended from the principle axis up or down to the intersection of ray one and ray two

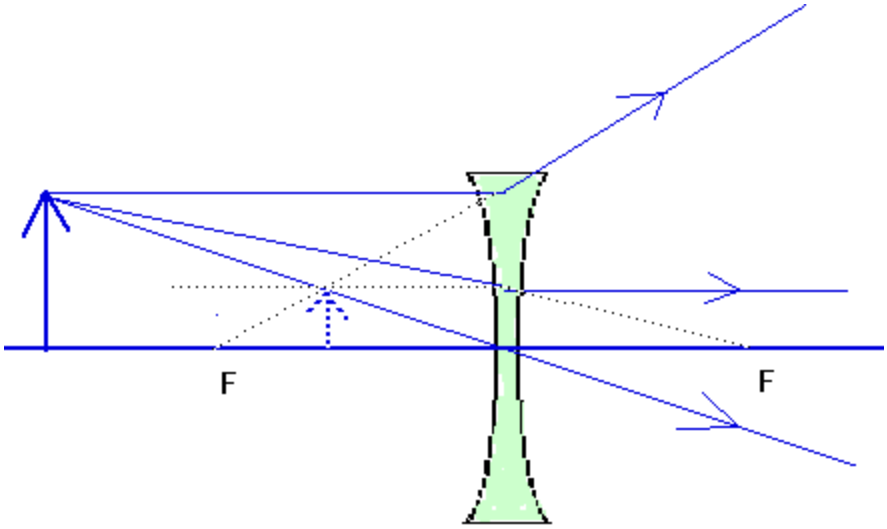


image from: http://www.ux1.eiu.edu/~cfadd/1160/Ch24ML/Images/image32.gif

For calculating image location, image size, and image type, the formulas and parameters are the same as for concave and convex mirrors.

Sign conventions for lenses - When working with convex lens, the focal point is positive. When working with concave lens, the focal point is negative.