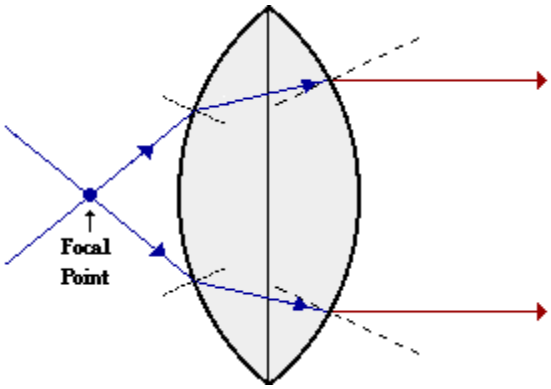
W10.02

Ray-Tracing Rules for Lenses.

Unlike mirrors, rays pass through lenses. In principle, we need to apply Snell's law twice, once for the ray entering the lens and once for it leaving the lens.



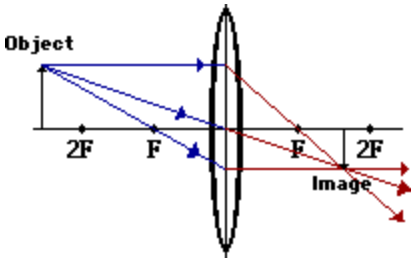
The curvature of the surface of the lens means that the light will be bent. In general, though, we will consider the case of a thin lens and use a somewhat simplified version of the refraction rules. Like mirrors, we could use any ray of light, but there are three particular rays of light which have easy paths to trace.

A converging lens is a lens which converges rays of light which are traveling parallel to its principal axis. A diverging lens is a lens which diverges rays of light which are traveling parallel to its principal axis. A lens which is convex on both sides is a converging lens which acts in a similar manner to a concave mirror. A lens which is concave on both sides is a diverging lens and acts in a similar manner to a convex mirror.

Unlike a mirror, a lens does not have a radius of curvature, but the point at twice the focal length is still important. We will use both the notation R and 2F for this point.

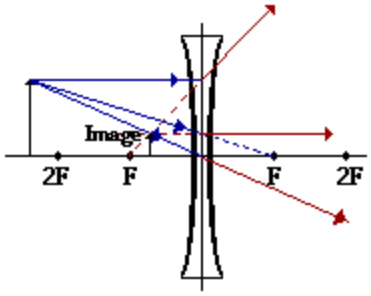
Refraction Rules for a Converging Lens

- Any incident ray traveling parallel to the principal axis of a converging lens will refract through the lens and travel through the focal point on the opposite side of the lens.
- Any incident ray traveling through the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.
- An incident ray which passes through the center of the lens will in effect continue in the same direction that it had when it entered the lens.



Refraction Rules for a Diverging Lens

- Any incident ray traveling parallel to the principal axis of a diverging lens will refract through the lens and travel in line with the focal point (i.e., in a direction such that its extension will pass through the focal point).
- Any incident ray traveling towards the focal point on the way to the lens will refract through the lens and travel parallel to the principal axis.
- An incident ray which passes through the center of the lens will in effect continue in the same direction that it had when it entered the lens.



The above lens images are from http://www.physicsclassroom.com. This side has excellent tutorials on optics.

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Sketch a ray diagram for the following lenses and complete the chart. (Note f>0 is converging; f<0 is diverging.)

f	d_o	h_o	d_i	h_i	Notes: (enlarged/reduced) (erect/inverted) (real/virtual)
+6	18	4			
+6	9	4			
+6	3	4			
+6	12	4			
+6	6	4			
-6	9	6			