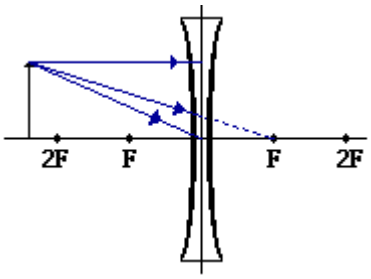
Tutorial: Ray Diagram for Concave Lenses

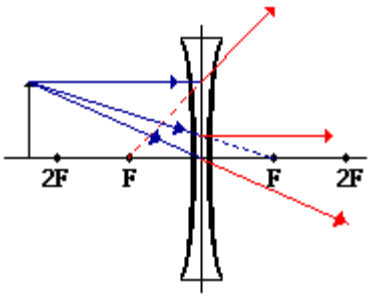
Here we describe the method of drawing a ray diagram for a concave (diverging) lens for which the object is located beyond the 2F point of the lens.

1. Pick a point on the top of the object and draw three incident rays traveling towards the lens.



   a. Draw a ray so that it travels toward the focal point on the opposite side of the lens. This ray will strike the lens before reaching the focal point. Stop the ray at the point of incidence with the lens.
   b. Draw a 2nd ray such that it travels parallel to the principal axis.
   c. Draw a 3rd ray to the center of the lens.
   d. Place arrowheads upon the rays to indicate their direction of travel.

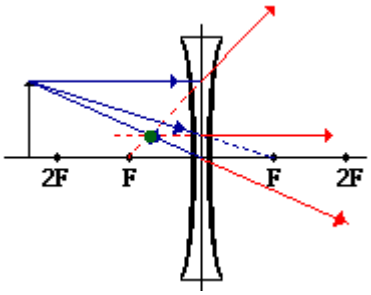
2. Once the incident rays strike the lens, refract them according to the three rules of refraction.



   a. The ray that traveled toward the focal point will refract through the lens and travel parallel to the principal axis.
   b. The ray that traveled parallel to the principal axis on the way to the lens will refract and travel in a direction such that its extension passes through the focal point on the object's side of the lens.

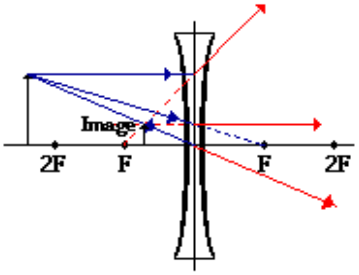
c. The ray that traveled to the center of the lens will continue to travel in the same direction.
d. Place arrowheads upon the rays to indicate their direction of travel.
e. The three rays should be diverging upon refraction.

3. Locate and mark the image of the top of the object.



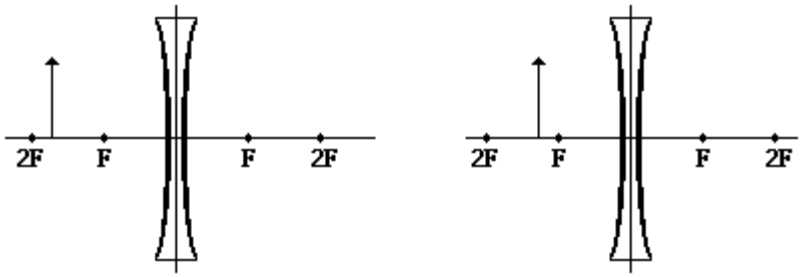
a. The image point of the top of the object is the point where the three refracted rays intersect.
b. Since the three refracted rays are diverging, they must be extended behind the lens in order to intersect.
c. Draw the extensions until they intersect.
d. The point of intersection is the image point of the top of the object.
e. Of course, the rest of the object has an image as well and it can be found by applying the same three steps to another chosen point.

4. Repeat the process for the bottom of the object.

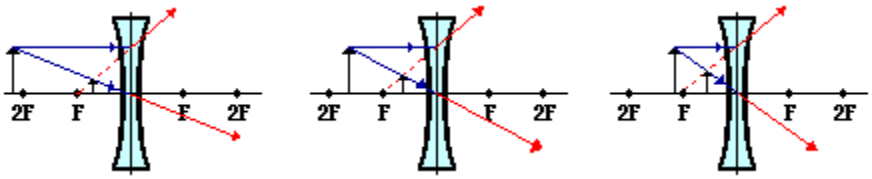


If the bottom of the object lies upon the principal axis (as is the case in the example), then the image of this point will also lie on the principal axis, and will be the same distance from the lens as the image of the top of the object.

5. Practice to construct the image for the following situations



6. You should arrive at the following diagrams:



7. The diagrams above show that in each case the image is
    a. Located on the object's side of the lens
    b. A virtual image
    c. An upright image
    d. Reduced in size, i.e. smaller than the object