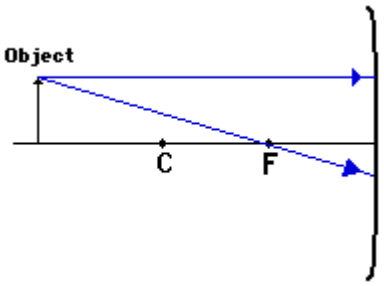
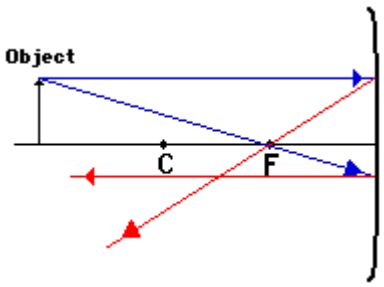
Tutorial: Drawing Ray Diagrams for concave mirrors

A method for finding the image of an object in a concave mirror is using ray diagrams.

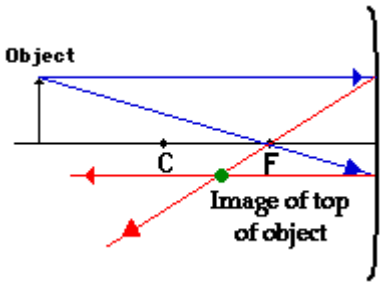
This tutorial describes how you can find the image of an object located beyond the center of the mirror:



1. Pick a point on the top of the object and draw to incident rays traveling toward the mirror. Choose one ray so that it passes exactly through the focal point on the way to the mirror. Draw the second ray such that it travels parallel to the principal axis toward the mirror. Place arrowheads upon the rays to indicate their direction of travel.
2. Once the incident rays strike the mirror, reflect them according to the two rules of reflection for concave mirrors, which you verified in Part A.
    a. The ray that passes through the focal point on the way to the mirror will reflect and travel away from the mirror parallel to the principal axis. (Use a ruler to accurate draw the path).
    b. The ray that traveled parallel to the principal axis on the way to the mirror will reflect and travel through the focal point.
    c. Place arrowheads upon the rays to indicate their direction of travel, and extend the rays past their point of intersection.

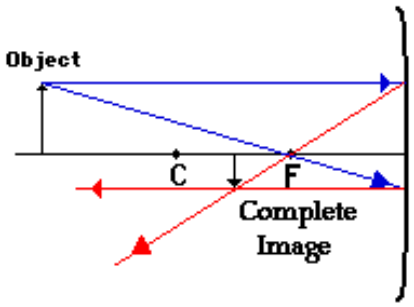


3. Mark the image of the top of the object.



The image point of the top of the object is the point where the two reflected rays intersect. This is the point where all lights from the top of the object will intersect upon reflecting off the mirror. Of course, the rest of the object has an image as well and that can be obtained by applying the same three steps to another chosen point.

4. Repeat the process for the bottom of the object.
   Since the bottom of the objects is located on the principal axis, a ray traveling to the mirror will be reflected in itself, and the image of that point will also lie upon the principal axis, and will be the same distance from the mirror as the image of the top of the object. At this point the entire image can be filled in.

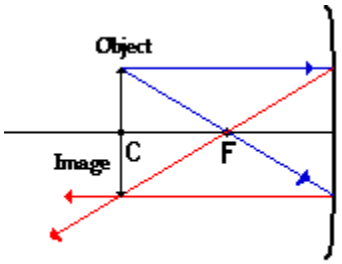


Summarizing: For an object located *beyond* the center of curvature, the image is located at a position between the center of curvature and the focal point. Furthermore,
the image is inverted, reduced in size and real. This is the type of information that we wish to obtain from a ray diagram.

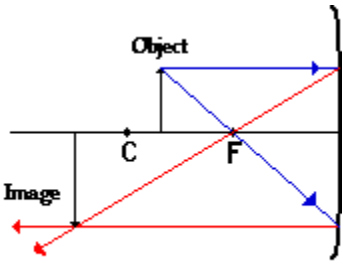
Practice drawing ray diagrams for the following two situations:

a. The object is located at the center of curvature C

b. The object is located between C and the focal point F



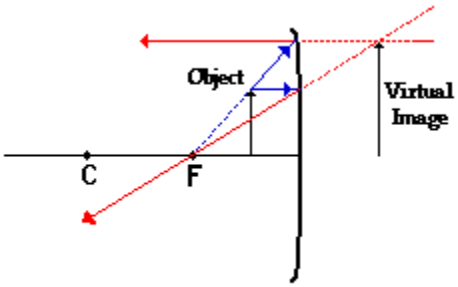
Ray Diagram for Object Located at C



Ray Diagram for Object Located Between C and F

In all three cases described above, the image is inverted, and real, i.e. located on the same side of the mirror as the object.

Ray diagram for the formation of a virtual image



Ray Diagram for Object Located in Front of F

In the above diagram, the object is located *in front of* the focal point. Observe that in this case the light rays diverge after reflecting off the mirror. When light rays diverge after reflection, a virtual image is formed. As in the case of plane mirrors, the image location can be found by tracing all reflected rays backward until they intersect.

Thus, the point of intersection of the extended reflected rays is the image point. Since light does not actually pass through this point (light never travels beyond the mirror), the image is referred to as virtual image.

Observe, that when the object is located *in front of* the focal point, its image is an upright and enlarged image that is located on the other side of the mirror.

Use the two figures below to practice constructing the image of the arrow: