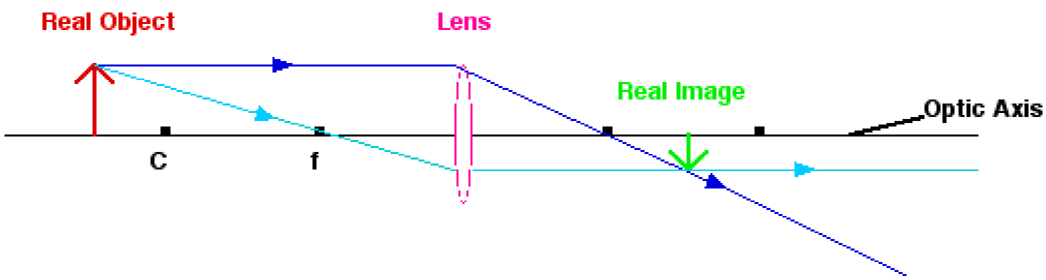
Image Formation by Lenses and Mirrors

7 April 2014

1. Convex (Converging) Lenses

1.1

<u>Convex (converging) Lens with object outside of the center of curvature</u>



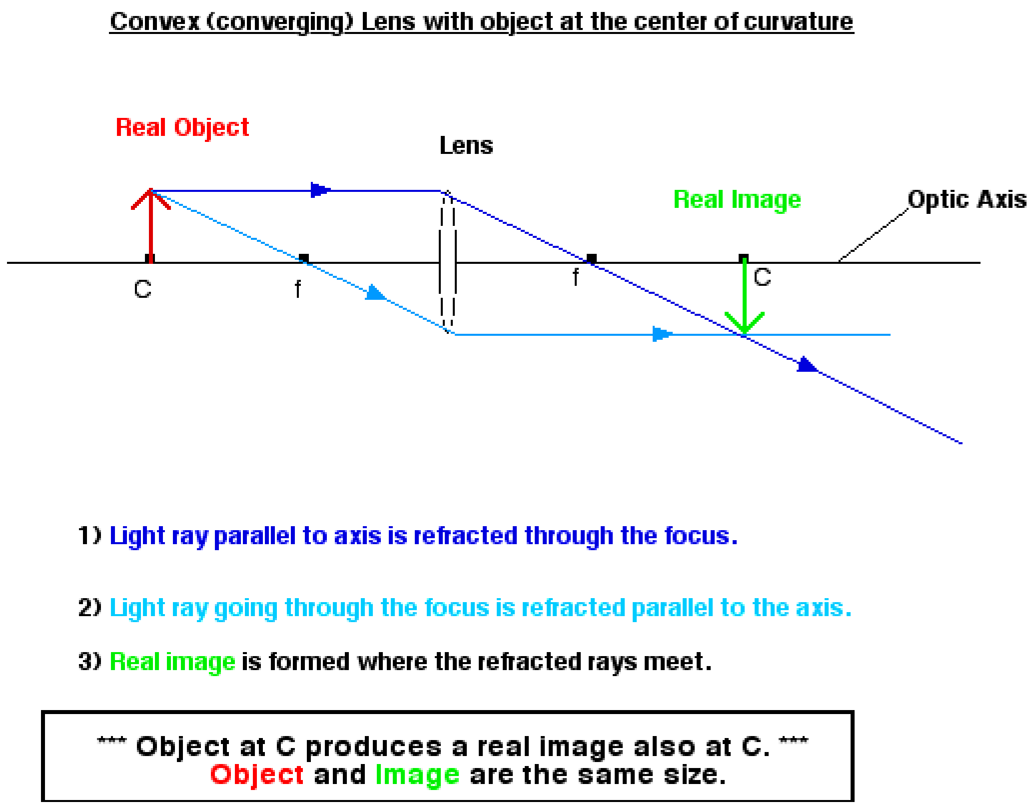
1) Light ray parallel to axis is refracted through the focus.

2) Light ray going through the focus is refracted parallel to the axis.

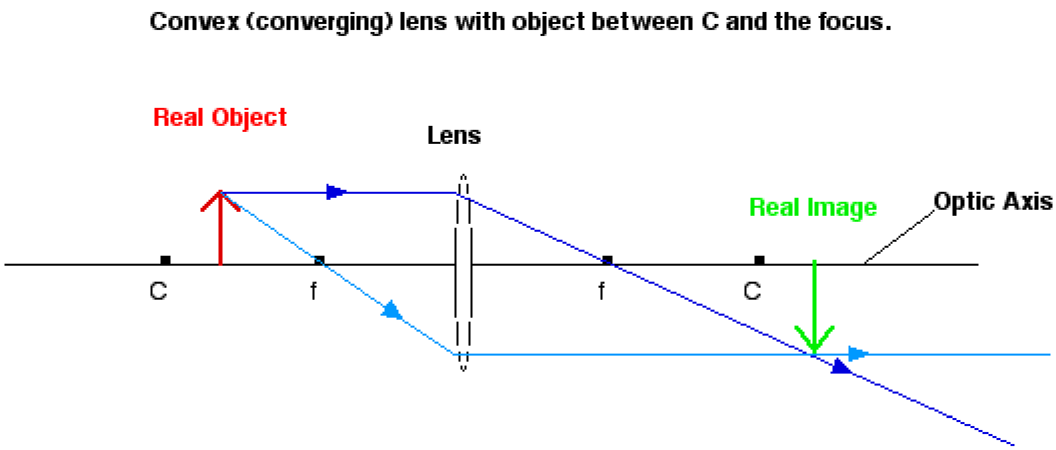
3) Real image is formed where the refracted rays meet.

*** Object outside C produces a real image between focus and C. ***
Image is smaller than Object.

1.2


Convex (converging) Lens with object at the center of curvature
Real Object
Lens
Real Image
Optic Axis
C
f
f
C
1) Light ray parallel to axis is refracted through the focus.
2) Light ray going through the focus is refracted parallel to the axis.
3) Real image is formed where the refracted rays meet.
*** Object at C produces a real image also at C. ***
Object and Image are the same size.

1.3



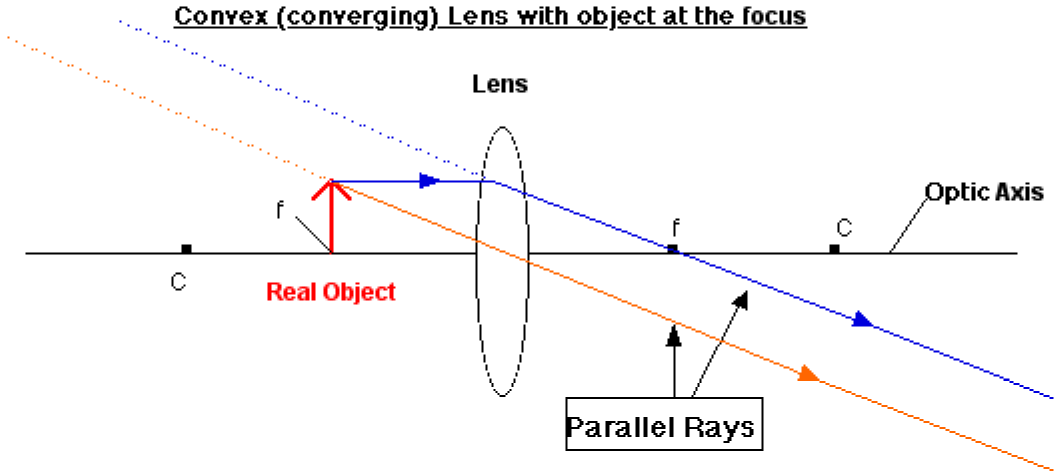
1) Light ray parallel to axis is refracted through the focus.

2) Light ray going through the focus is refracted parallel to the axis.

3) Real image is formed where the refracted rays meet.

*** Object between C and f produces a real image outside C. *** The Image is larger than the Object.

1.4

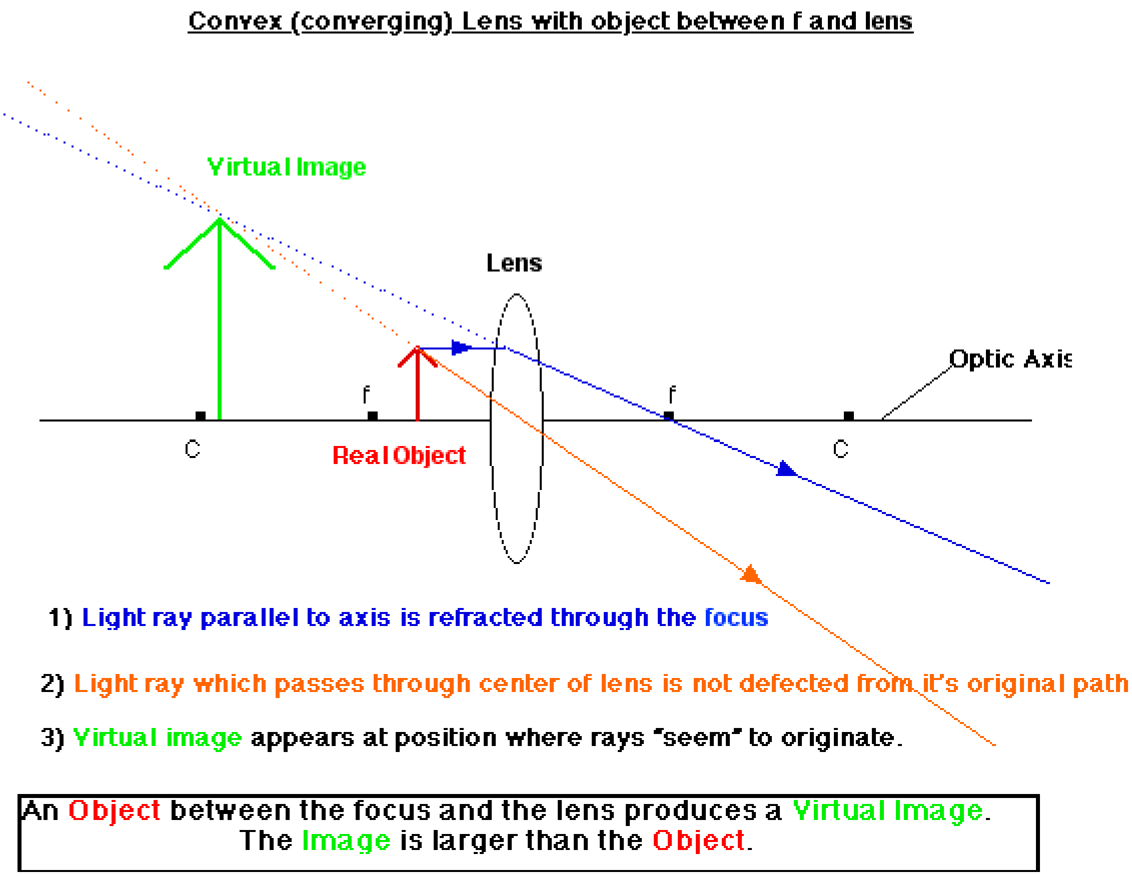


1) Light ray parallel to axis is refracted through the focus

2) Light ray passing through center of lens is undefected from it's original path.

Object at the focus of the lens does not produces any image. Refracted rays are parallel and never meet to form an image.

1.5

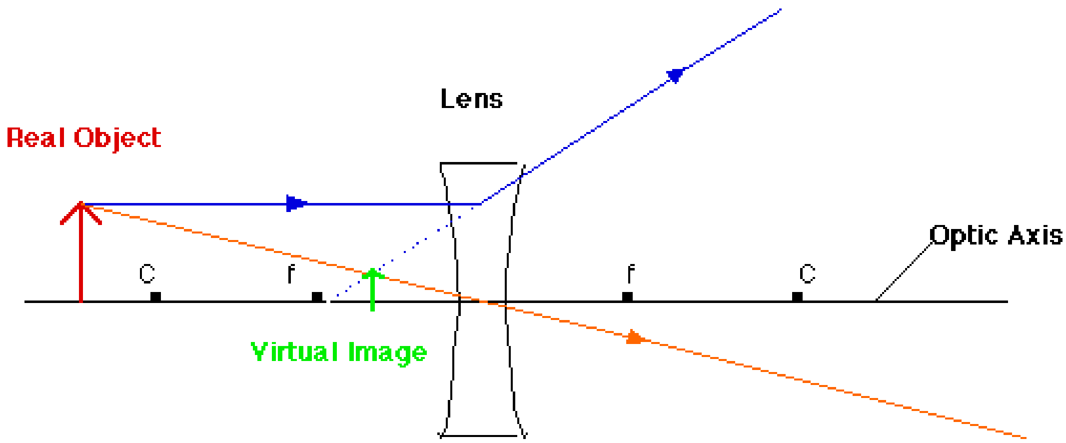


Source: http://www.physics.mun.ca/~jjerrett/lenses/convex.html

2. Concave (Diverging) Lens

2.1

<ins>Concave (diverging) lens with object anywhere behind the lens.</ins>



1) Ray parallel to optic axis is refracted as though it had come from the focus, f.

2) A ray passing through the center of the lens is not deflected from it's original path.

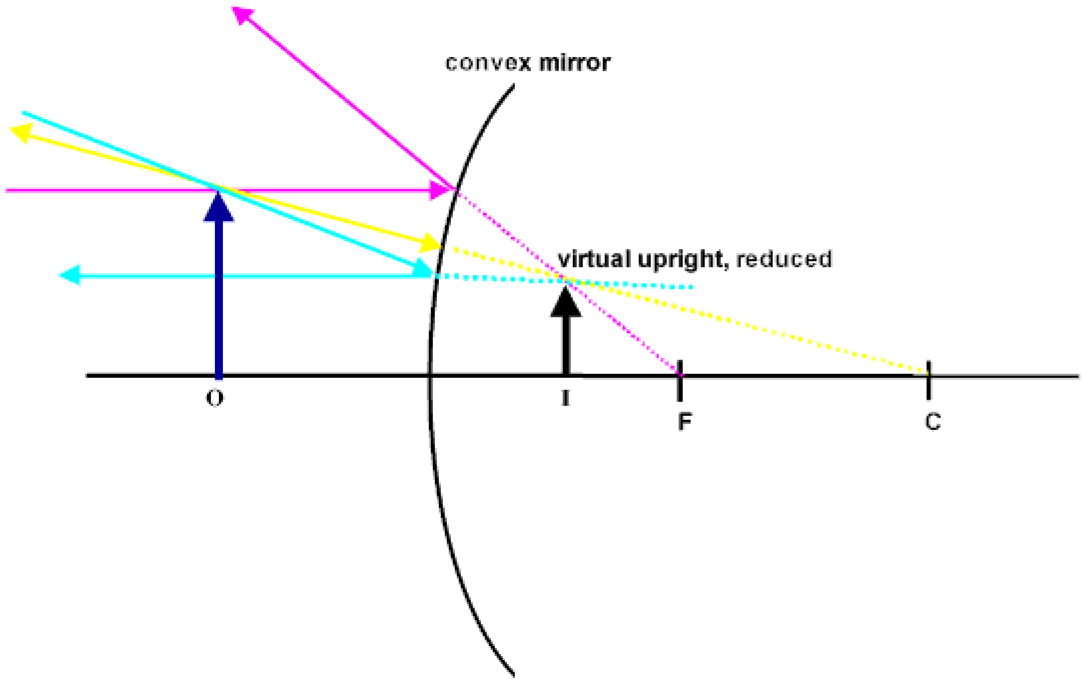
3) The Virtual image appears to form at the intersection of the Orange ray passing through the center and the line created by tracing the refracted Blue ray back to the focus.

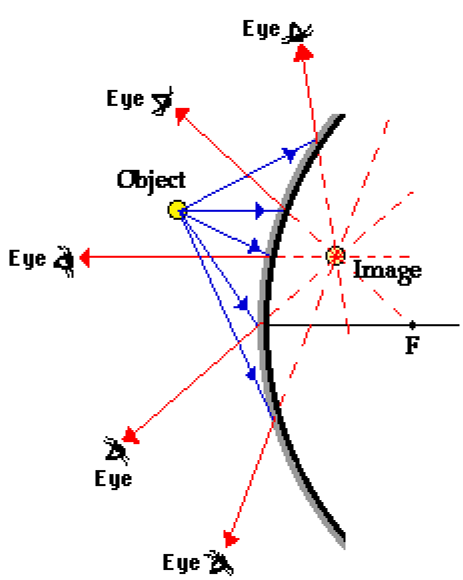
A Real Object placed anywhere along the optic axis will always produce a *smaller, Virtual Image located between the focus, f, and the lens.*

Source: http://www.physics.mun.ca/~jjerrett/lenses/concave.html

3. Convex (Converging) Mirror

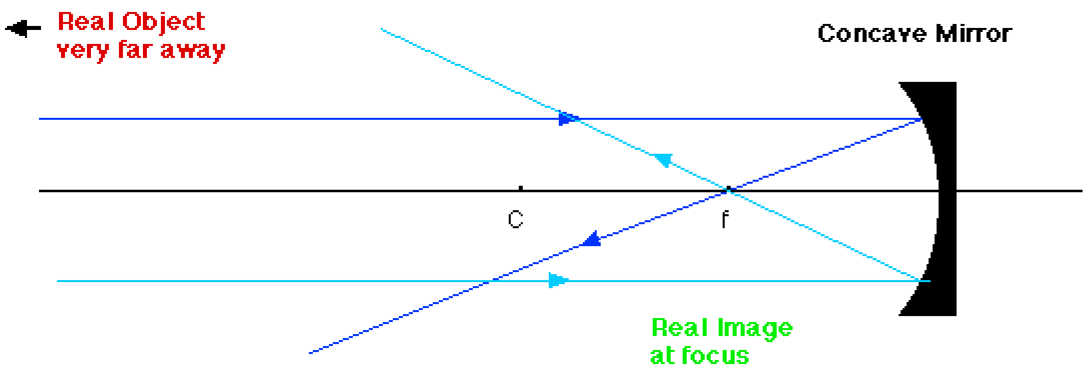
3.1



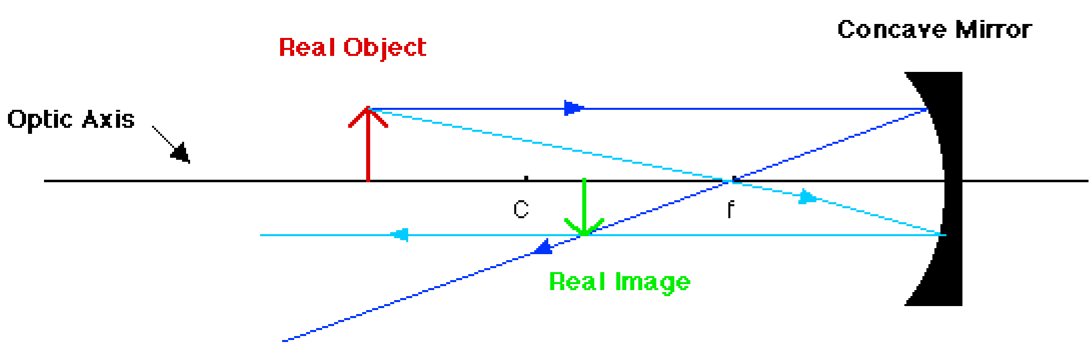


4. Concave (Diverging) Mirror

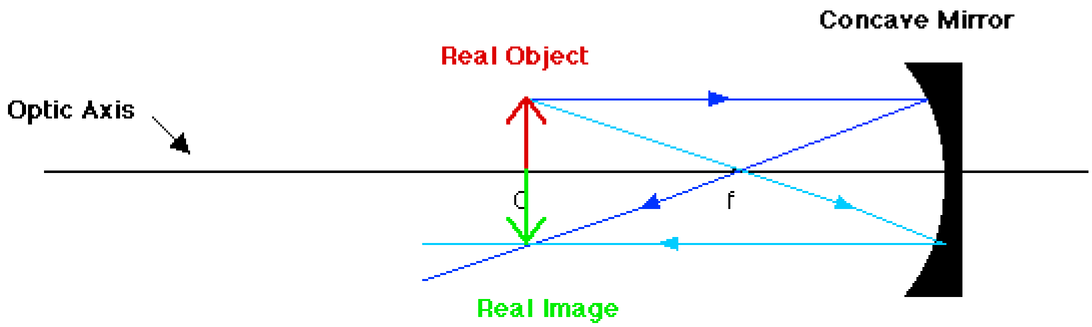
4.1.) For a real object very far away from the mirror, the real image is formed at the focus.



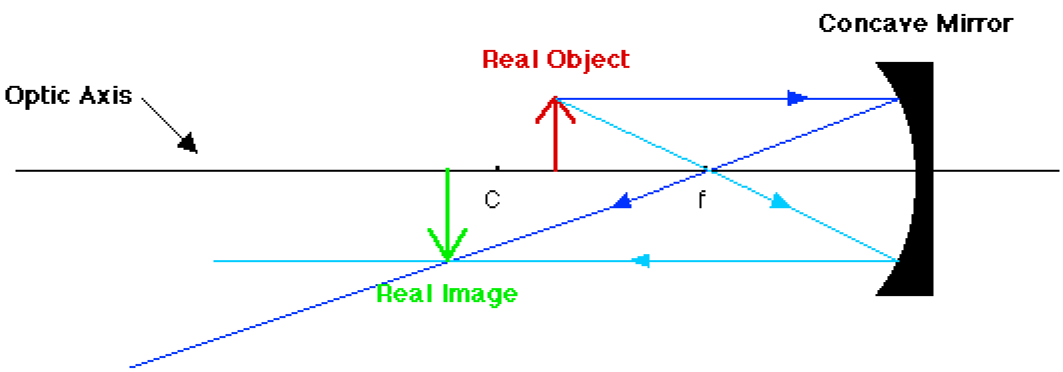
4.2.) For a real object close to the mirror but outside of the center of curvature, the real image is formed between C and f. The image is inverted and smaller than the object.



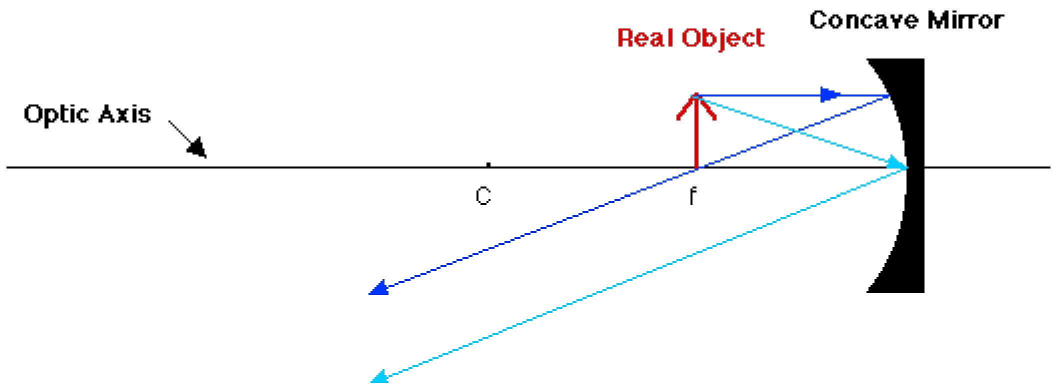
4.3.) For a real object at C, the real image is formed at C. The image is inverted and the same size as the object.



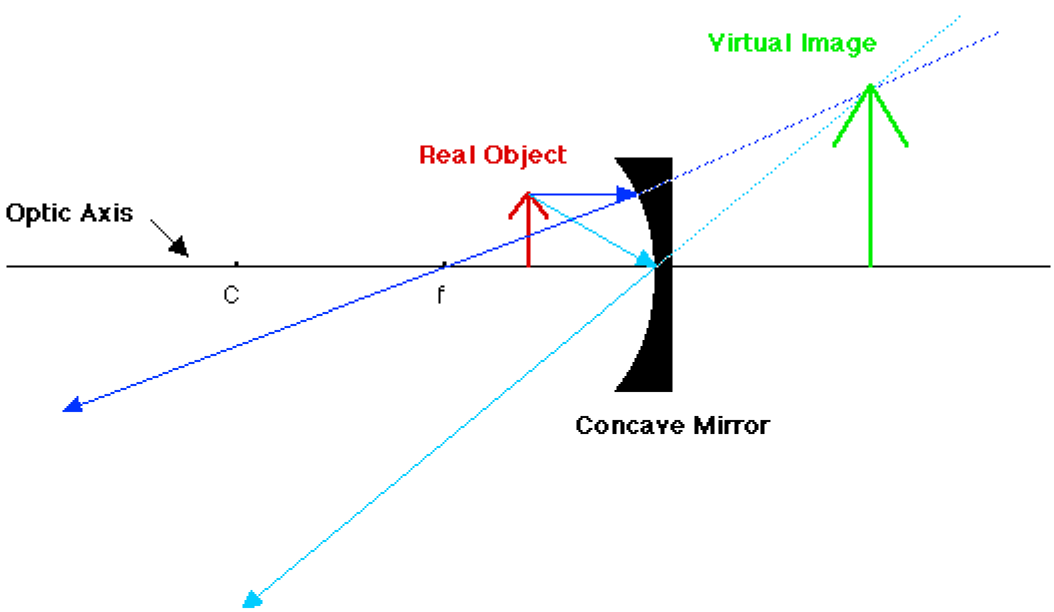
4.4.) For a real object between C and f, a real image is formed outside of C. The image is inverted and larger than the object.



4.5.) For a real object at f, no image is formed. The reflected rays are parallel and never converge.



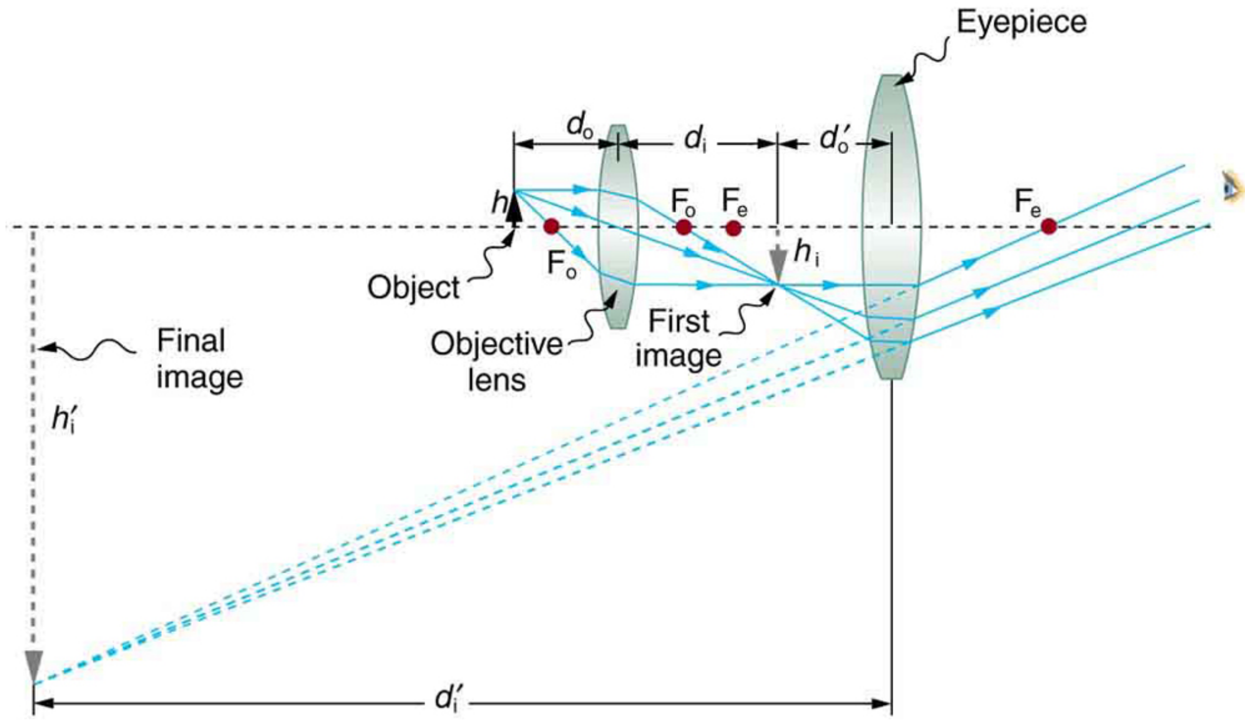
4.6.) For a real object between f and the mirror, a virtual image is formed behind the mirror. The position of the image is found by tracing the reflected rays back behind the mirror to where they meet. The image is upright and larger than the object.



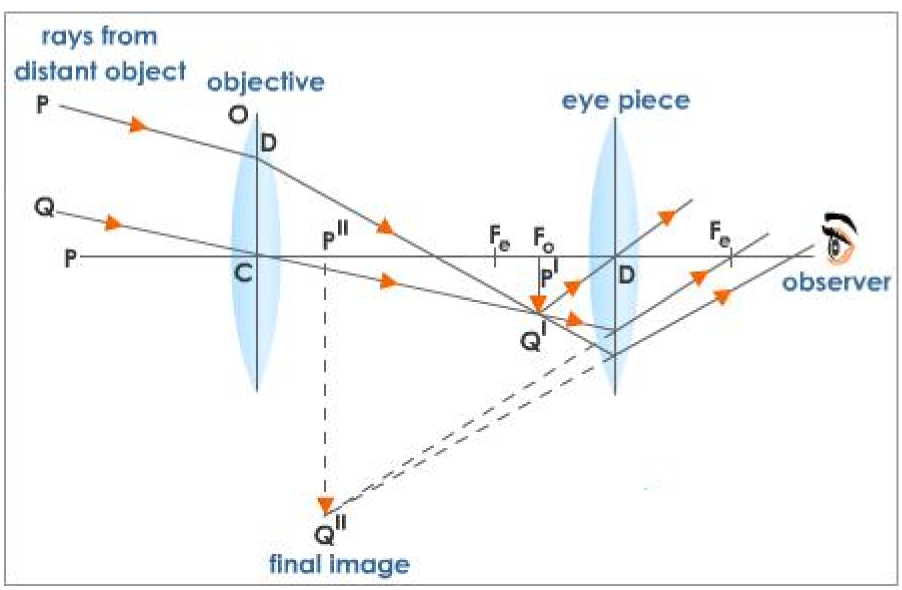
Source: http://www.physics.mun.ca/~jjerrett/mirror/concavem.html

5. Two Convex (Converging) Lenses

5.1 Two Convex Lenses Far Apart - Foci Do Not Overlap



5.2 Two Convex Lenses Far Apart - Foci Overlap

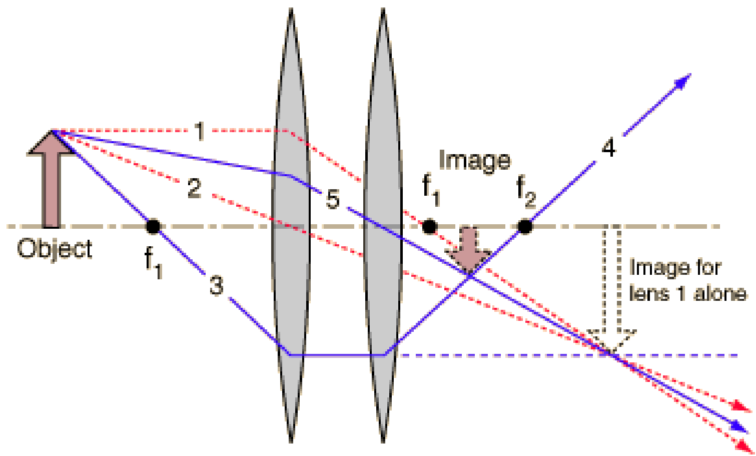


5.3 Two Convex Lenses Close Together

1. The principal rays 1 and 2 are used to determine the location of the of the image for lens 1 alone.

2. Ray 3 through f_1 will approach lens 2 parallel to the axis and will project through focal point f_2, forming one principal ray (4) for the final image.

3. Back projecting from the single lens image through the center of lens 2 will define the second needed ray (5) since that ray will be undeflected.



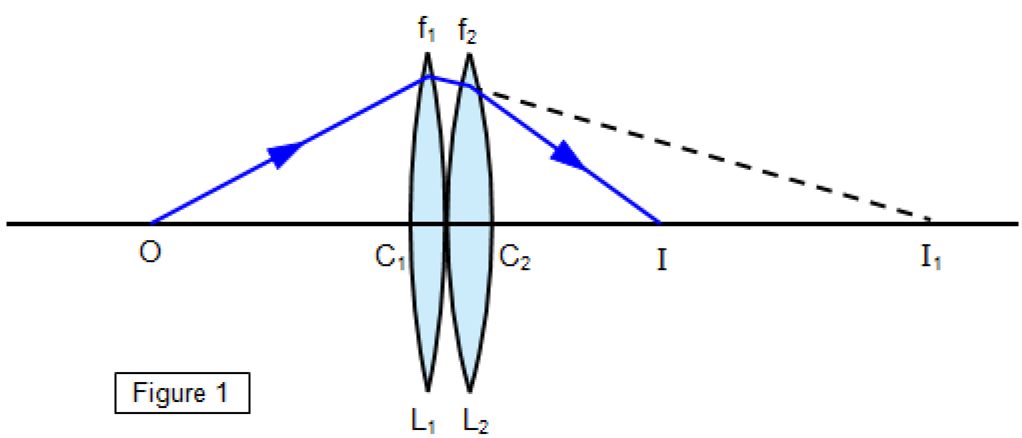


Figure 1