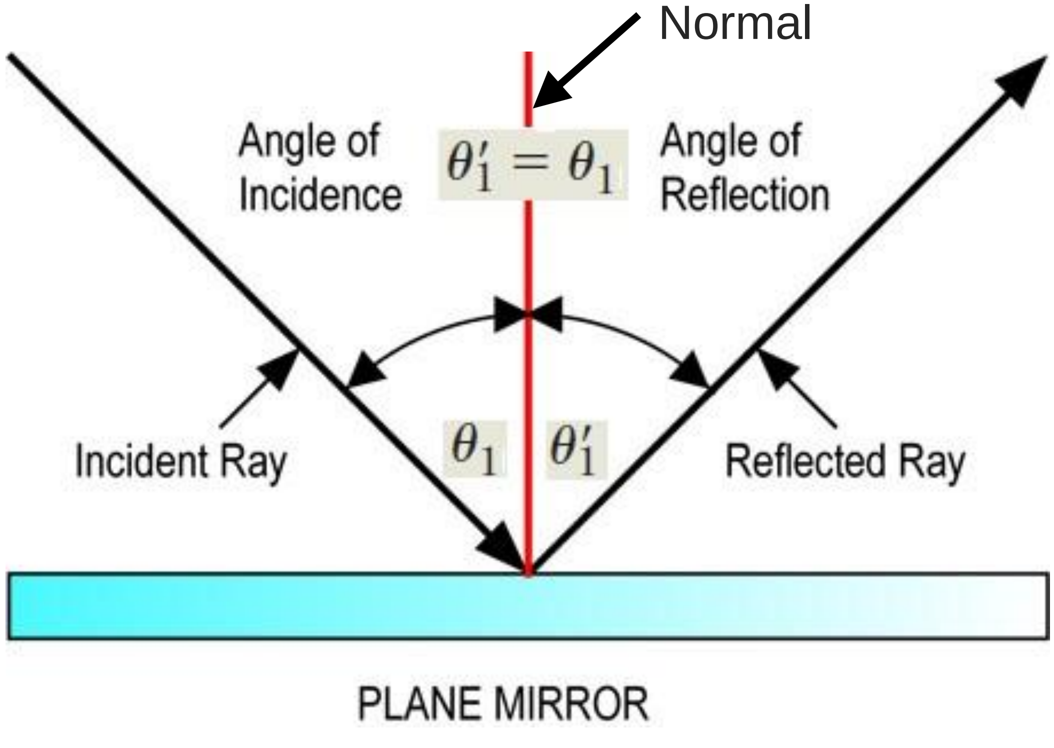
Image formation

Reflection Laws

The laws of reflection are as follows:

1. The incident ray, the reflected ray and the normal to the reflection surface at the point of the incidence lie in the same plane.
2. The angle which the incident ray makes with the normal is equal to the angle which the reflected ray makes to the same normal.
3. The reflected ray and the incident ray are on the opposite sides of the normal.



Images Formed by Mirrors

1. Images Formed by Flat Mirrors

2. Images Formed by Spherical Mirrors

a- Concave Mirrors

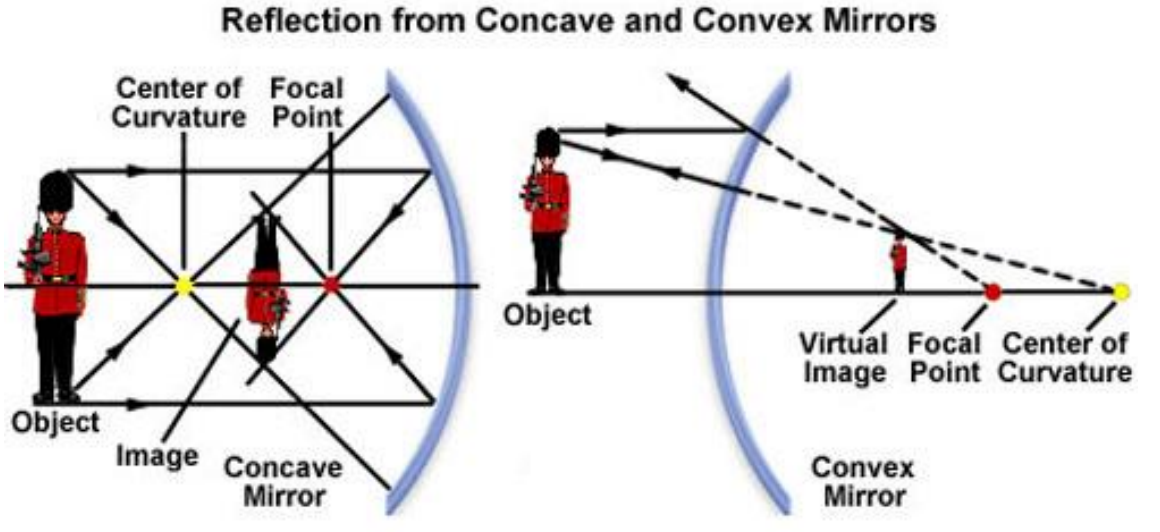
b- Convex Mirrors

Images Formed by Thin Lenses

Images are classified as:

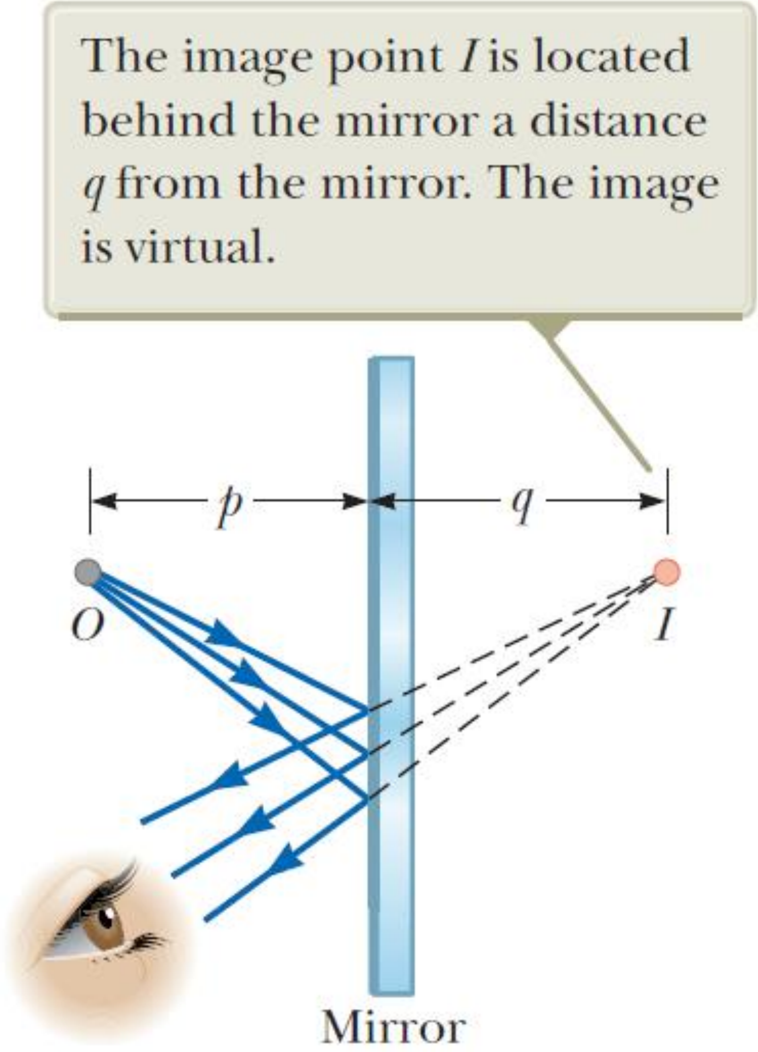
* **real image** is formed when light rays pass through and diverge from the image point.

* **virtual image** is formed when the light rays do not pass through the image point but only appear to diverge from that point.



real image **virtual image**

1. Images Formed by Flat Mirrors



p :object distance

q : image distance

Point [I] is called the image of the object at [O]

Flat mirror has the following properties:

1. The i ... the

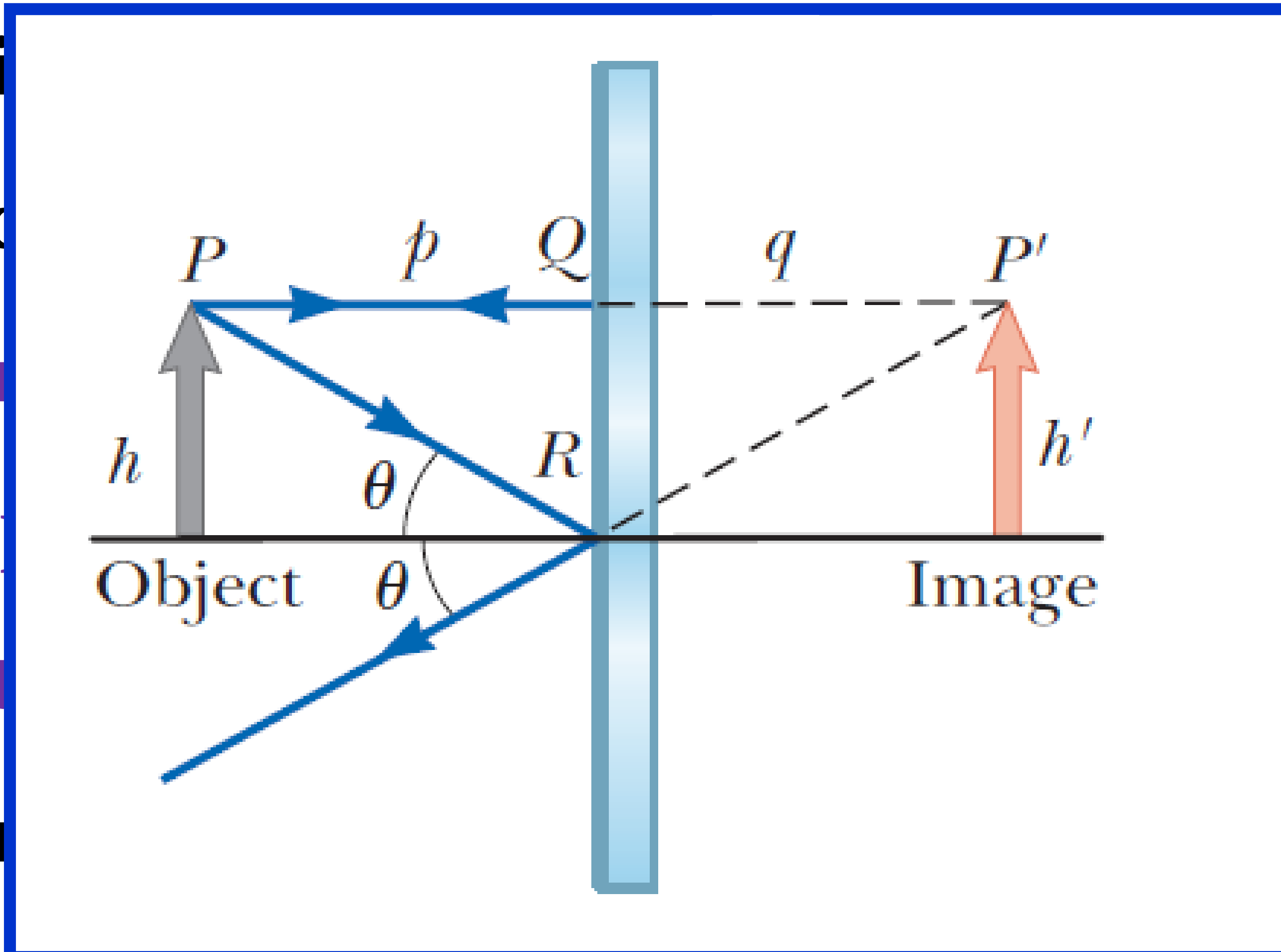
   objec

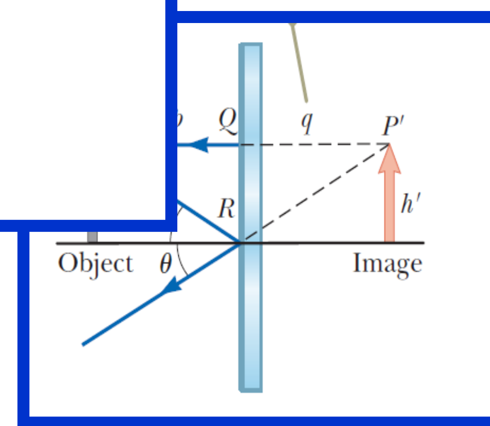
2. The i ... pright.

   (By u ... rrow

   point

3. The i



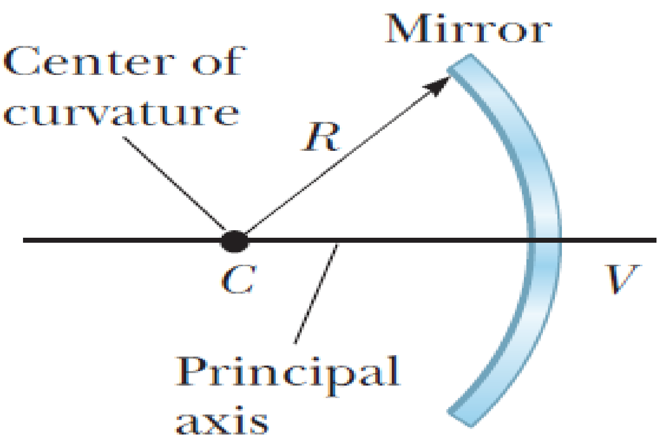


2. Images Formed by Spherical Mirrors

Spherical Mirrors are classified as:

2.1- Concave Mirrors

that is, one silvered so that light is reflected from the inner, concave surface. This is sometimes called a **converging mirror.**

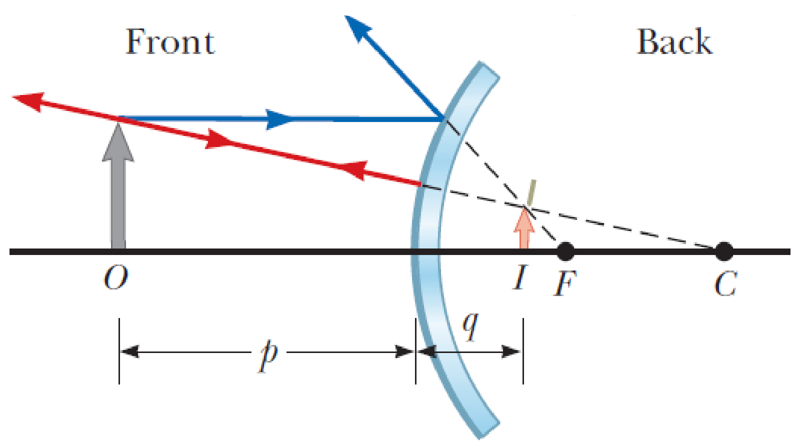


2. Images Formed by Spherical Mirrors

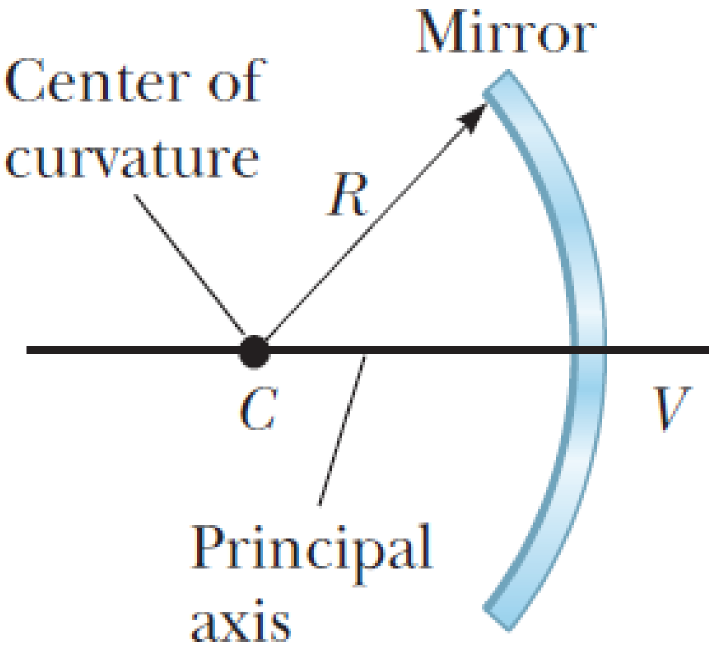
Spherical Mirrors are classified as:

2.2- Convex Mirrors

that is, one silvered so that light is reflected from the outer, convex surface. This is sometimes called a **diverging mirror.**



The component of the Spherical Mirrors is :



A concave mirror of radius R

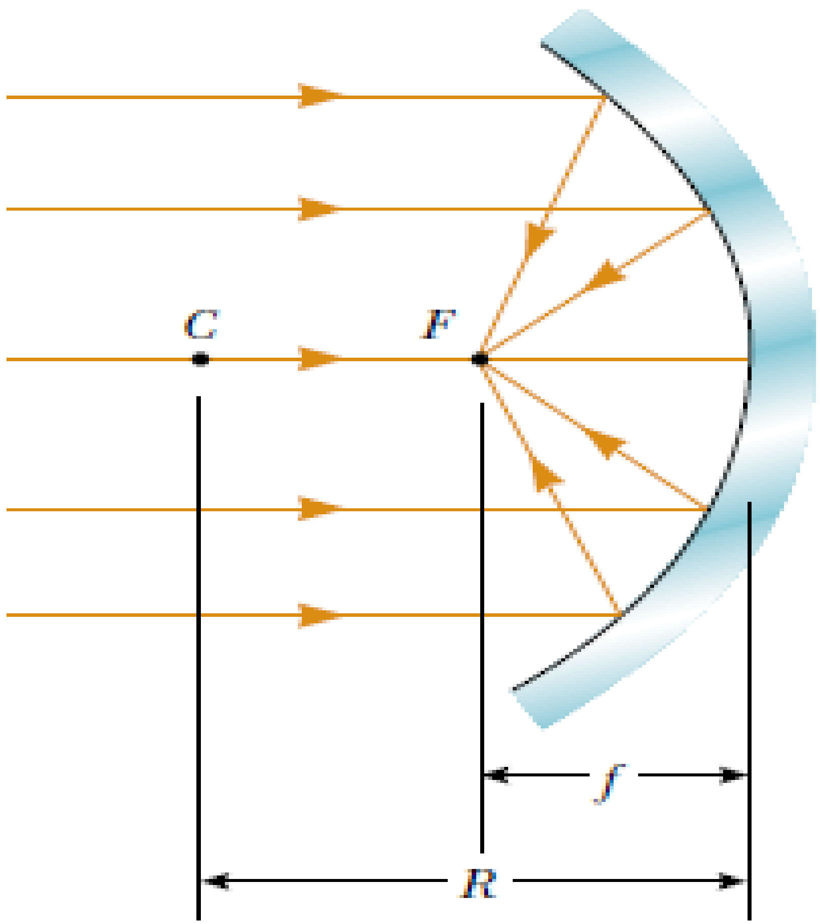
R: the mirror radius of curvature

C: center of curvature

V : the center of the mirror.

The line through C and V is called the principal axis of the mirror.

– Other component of the Spherical Mirrors



F : the focal point, which depends only on the curvature of the mirror and not on the material from which the mirror is made.

(This is because the formation of the image results from rays reflected from the surface of the material.)

The line through F and V is called the focal length *f* , which represents the image distance that corresponds to an infinite object distance.

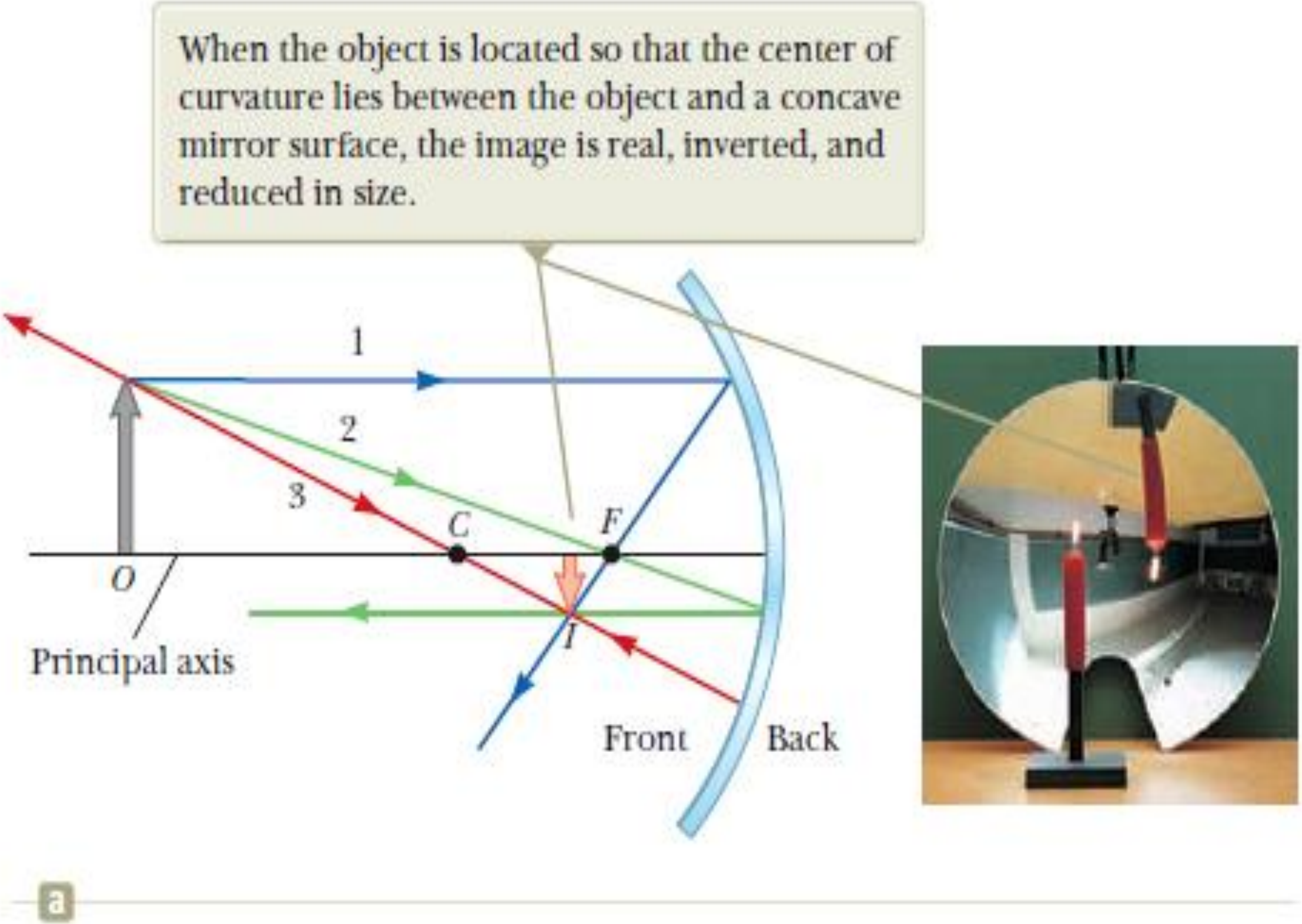
Ray Diagrams for Mirrors

- **Ray 1** is drawn from the top of the object parallel to the principal axis and is reflected through the focal point *F.*

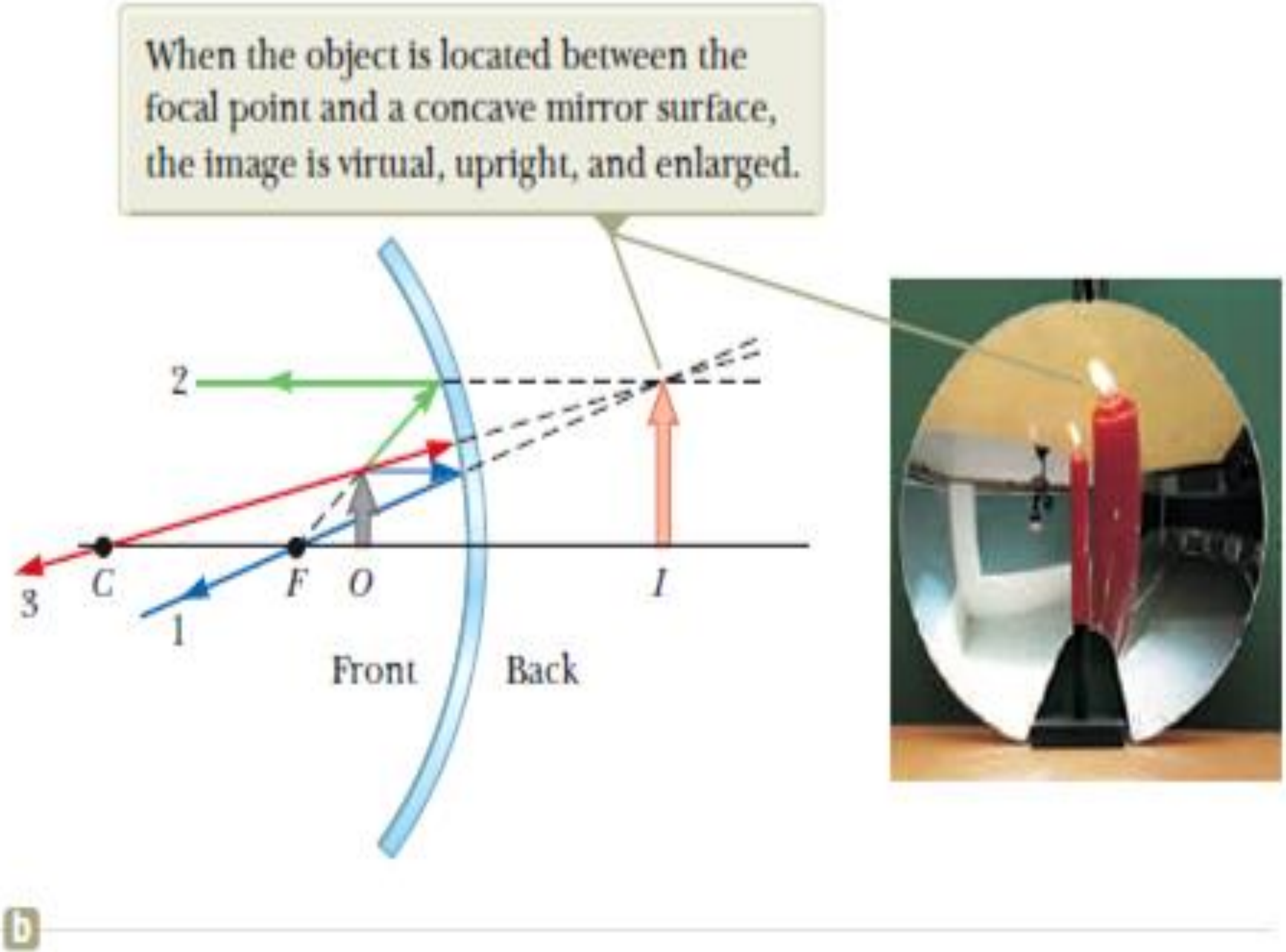
- **Ray 2** is drawn from the top of the object through the focal point and is reflected parallel to the principal axis.

- **Ray 3** is drawn from the top of the object through the center of curvature *C* and is reflected back on itself.

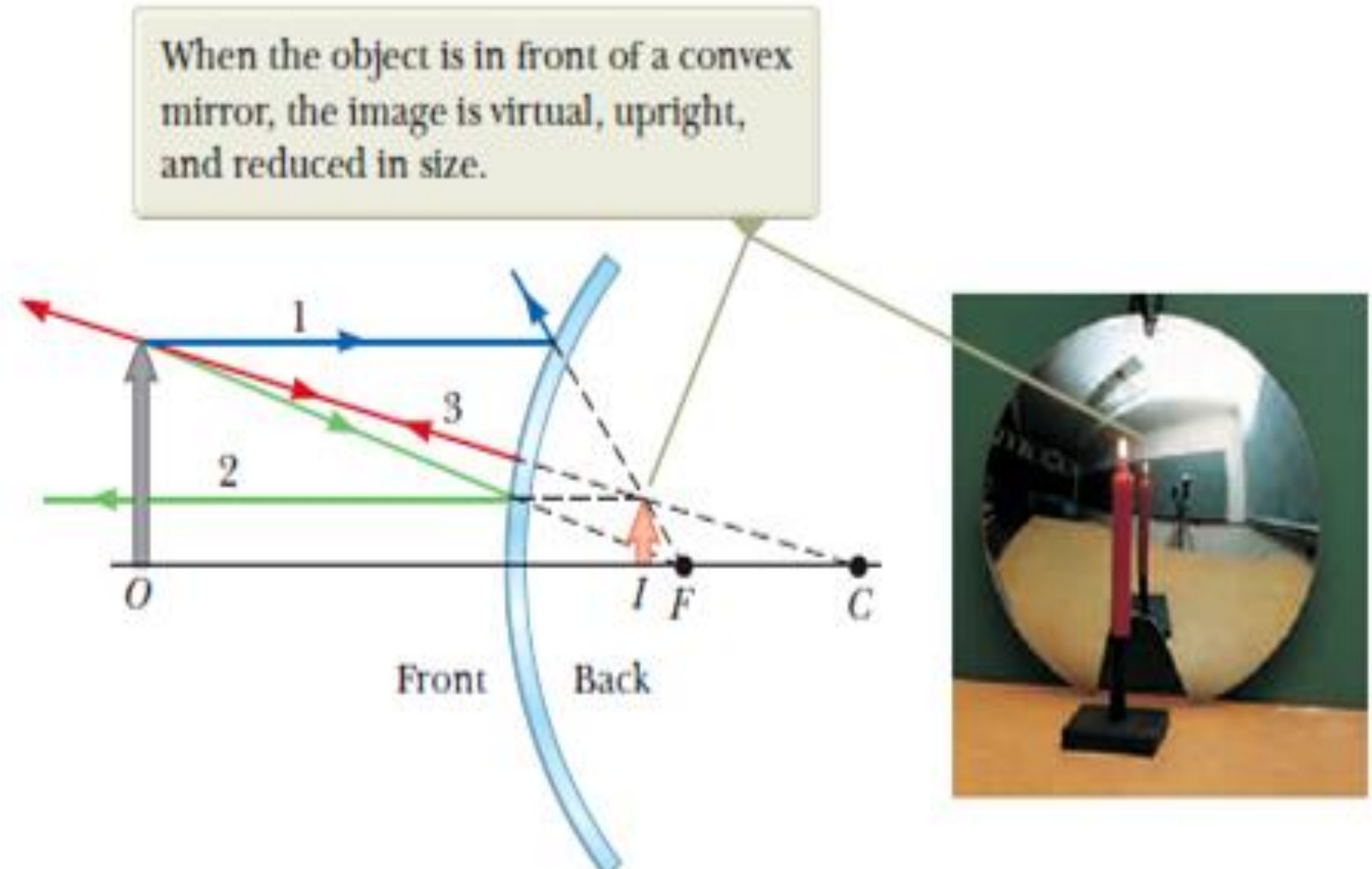
2.1 Images Formed by <u>Concave Mirrors</u>



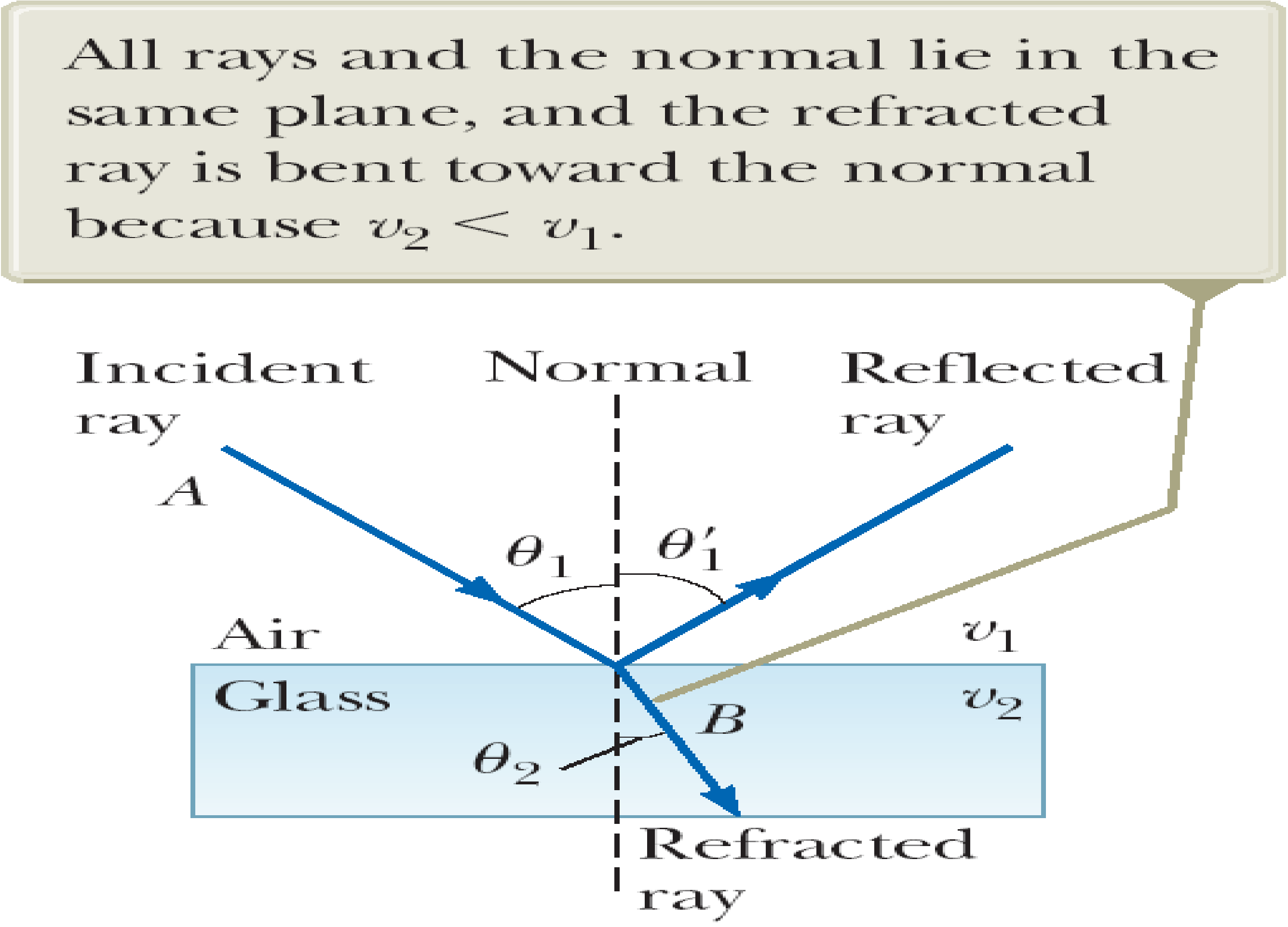
2.1 Images Formed by Concave Mirrors



2.2 Images Formed by Convex Mirrors



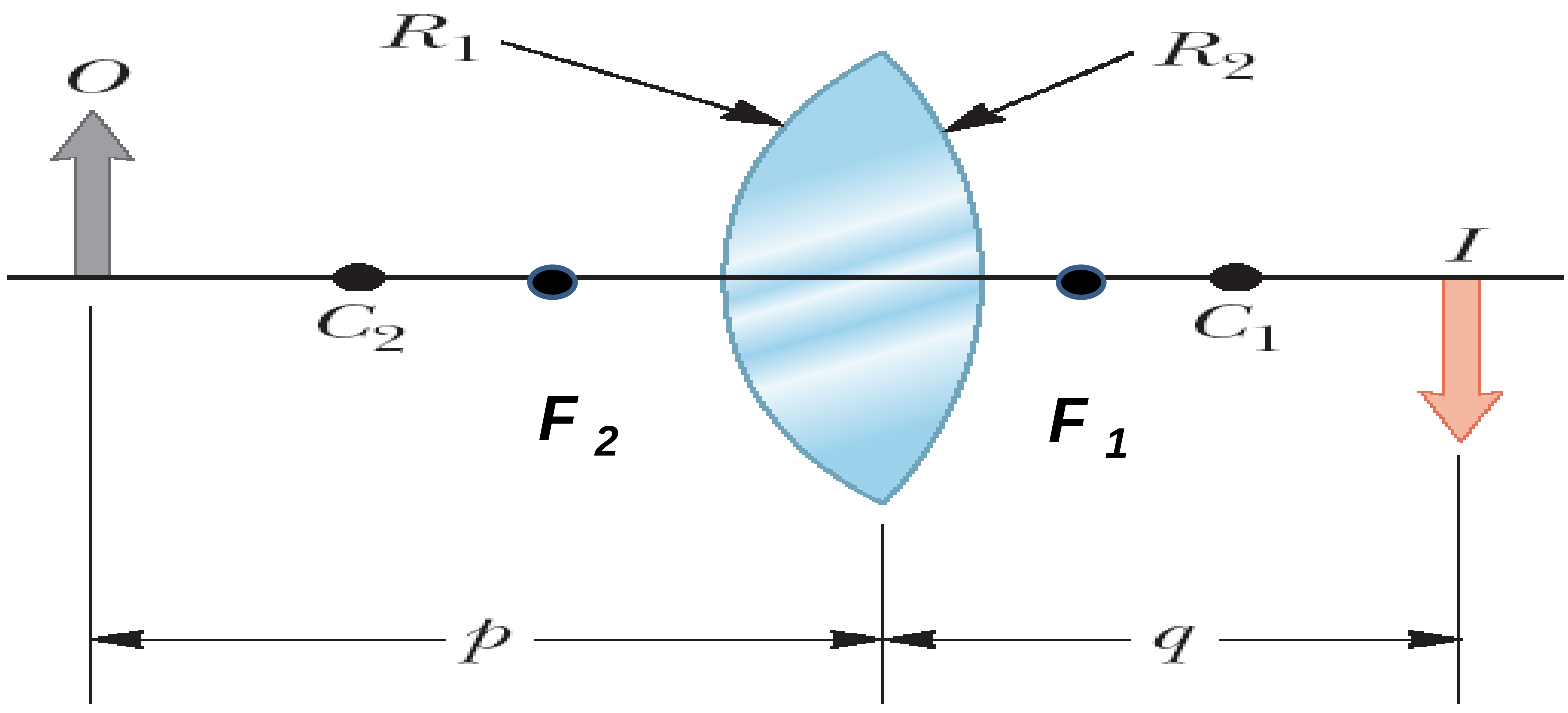
Refraction



All rays and the normal lie in the same plane, and the refracted ray is bent toward the normal because $v_2 < v_1$.
Incident ray
Normal
Reflected ray
A
θ_1
θ'_1
Air
v_1
Glass
v_2
B
θ_2
Refracted ray

3. Images Formed by Thin Lenses

Lenses are commonly used to form images by refraction in optical instruments such as cameras, telescopes, and microscopes.

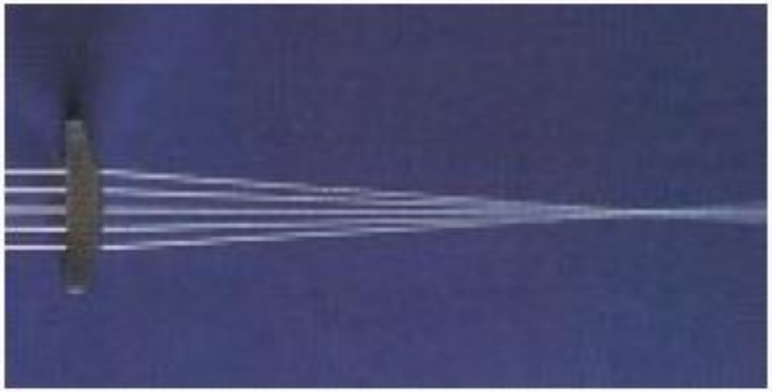


Simplified geometry for a thin lens.

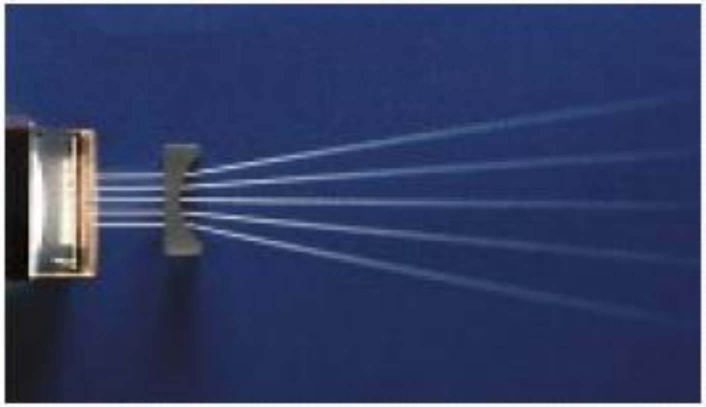
The image formed by the first surface acts as the object for the second surface.

Convex and concave lenses

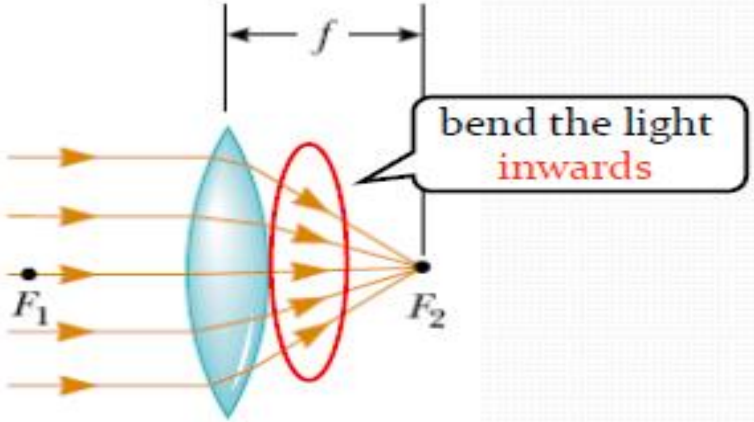
Converging or Diverging?

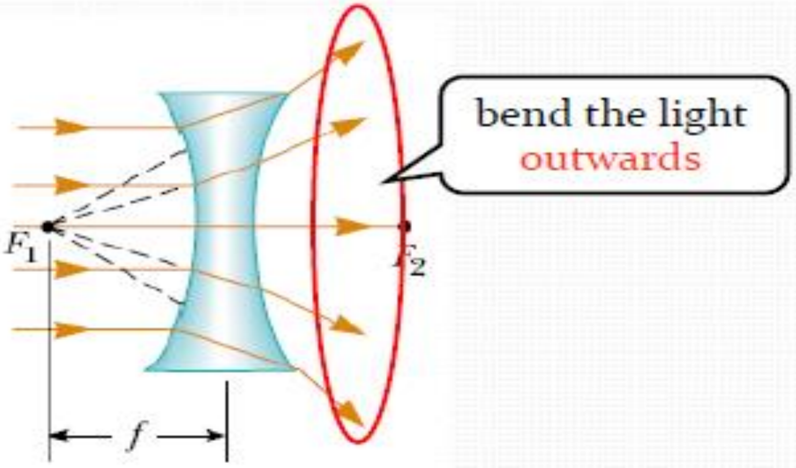


convex lens
(converging lens)

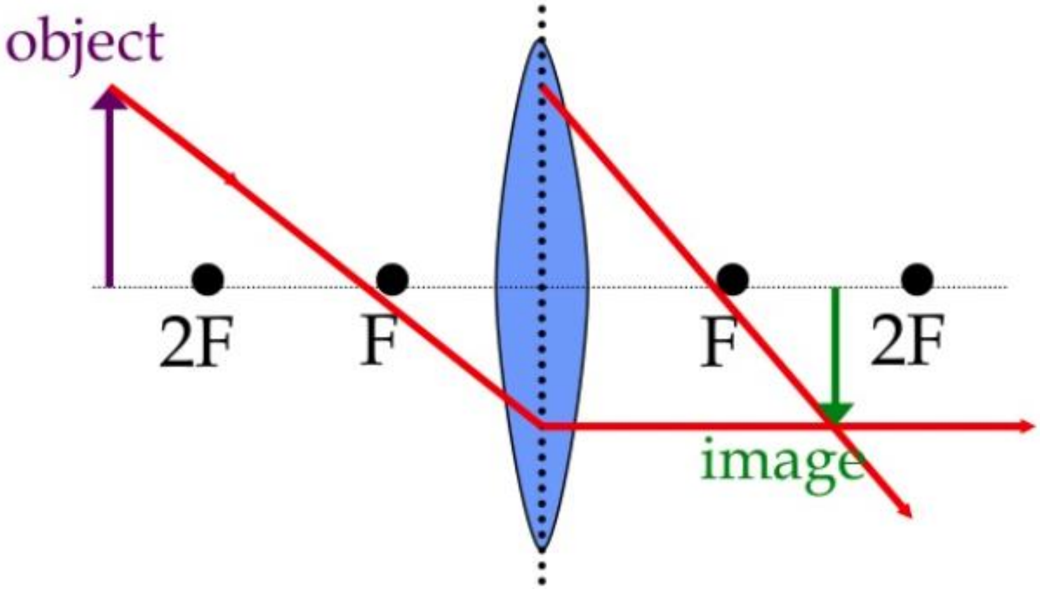


concave lens
(diverging lens)



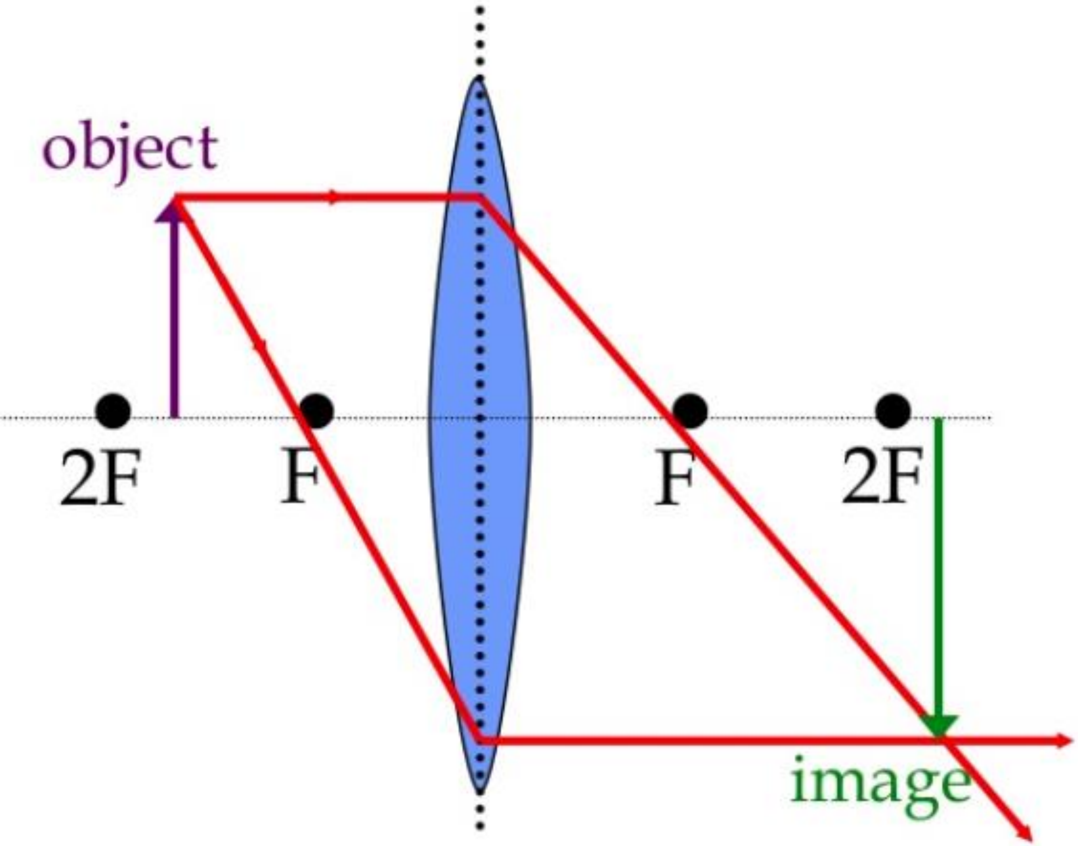


Convex lenses (object beyond 2F)



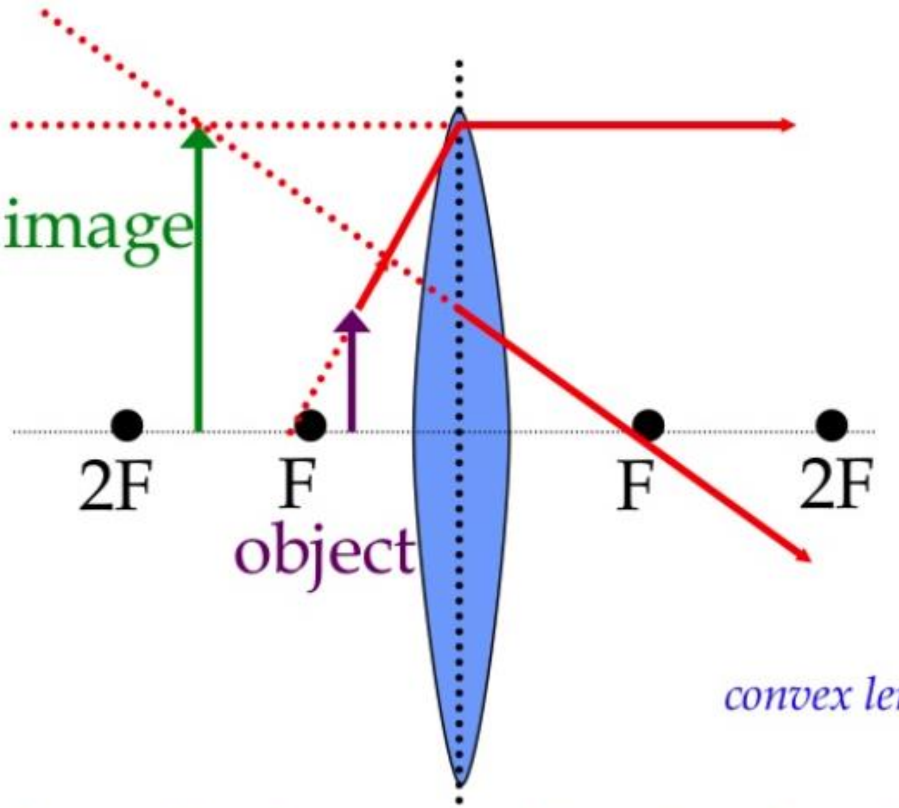
The image formed when an object is placed **beyond** 2F is located behind the lens between F and 2F. It is a **real**, **inverted** image which is **smaller** than the object itself.

Convex lenses (object between 2F and F)



The image formed when an object is placed between 2F and F is located beyond 2F behind the lens. It is a **real**, **inverted image**, larger than the object.

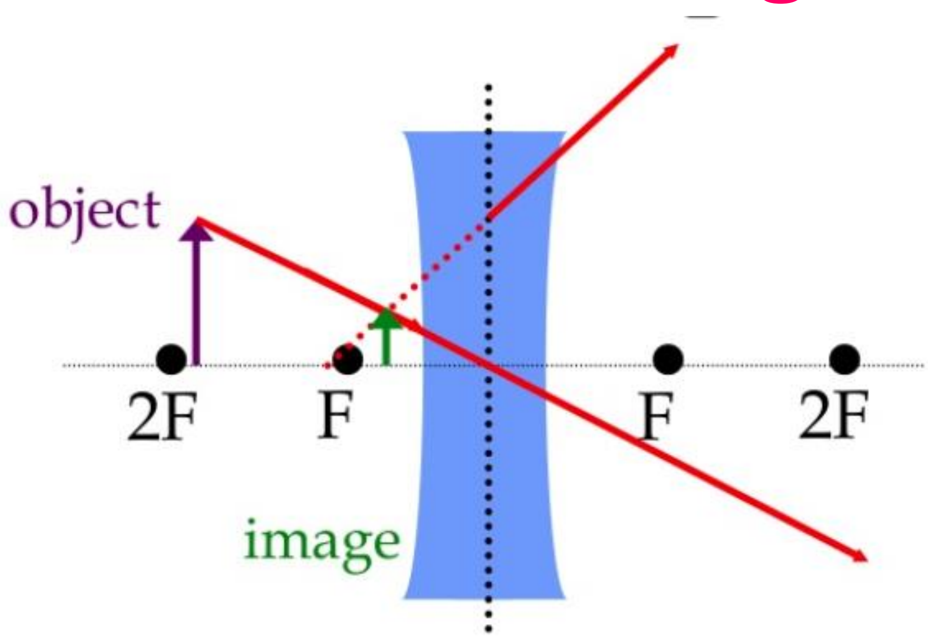
Convex lenses (object located within F)



convex lens used as a magnifier

The image formed when an object is placed in front of F is located somewhere beyond F on the same side of the lens as the object. It is a **virtual**, **upright image** which is **larger** than the object.

Concave lenses diagram



Experiment with this diagram

No matter where the object is placed, the image will be on the **same side** as the object. The image is **virtual**, **upright**, and **smaller** than the object with a concave lens.

Mirrors & Lens Equation

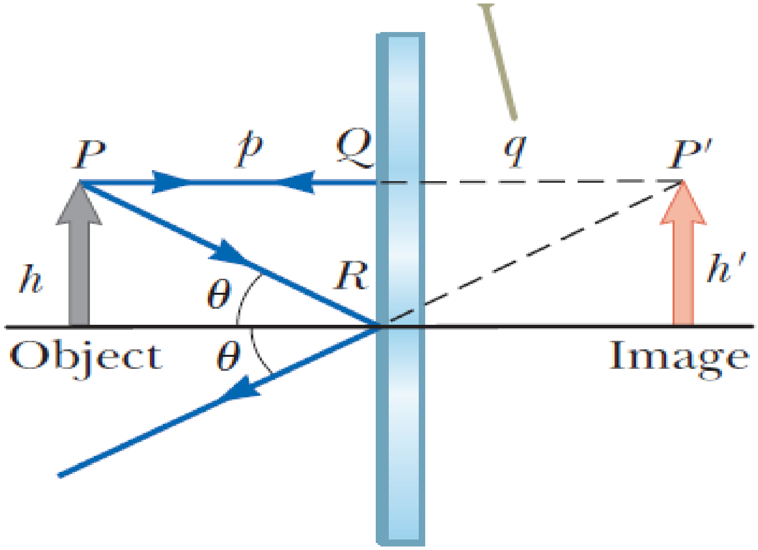
$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

Were p is the object distance
q is the image distance
f is the focal length

Magnification equation of an images for mirror and lenses:

$$M = \frac{h'}{h} = -\frac{q}{p}$$

Where; M is Magnification coefficient
h' is image height
h is object height



Homework

- The image formed in a convex mirror is smaller than the object. This would make a convex mirror useful for which application?
- The inside of a spoon bowl is a concave surface with a radius of curvature of a couple of inches (depending on the spoon). If you hold it about a foot from your face, what will your face look like? Explain.
- Find the distance of the object from a concave mirror of focal length 10 cm so that the image size is 4 times the size of the object.