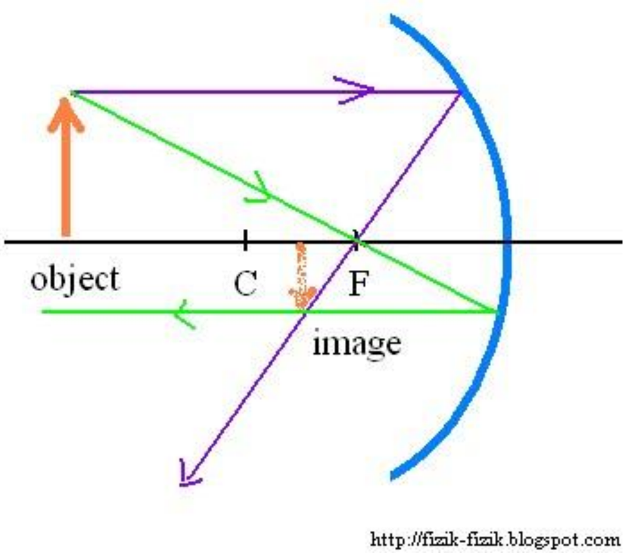
Ray Diagrams

Reflection for concave mirror:

- Any incident ray traveling parallel to the principal axis on the way to the mirror will pass through the focal point upon reflection.
- Any incident ray passing through the focal point on the way to the mirror will travel parallel to the principal axis upon reflection.



Ray Diagrams

Used for determining location, size, orientation, and type of image

Sign Convention for Spherical Mirrors

The sign conventions for the given quantities in the mirror equation and magnification equations are as follows:

f is + if the mirror is a concave mirror
f is - if the mirror is a convex mirror

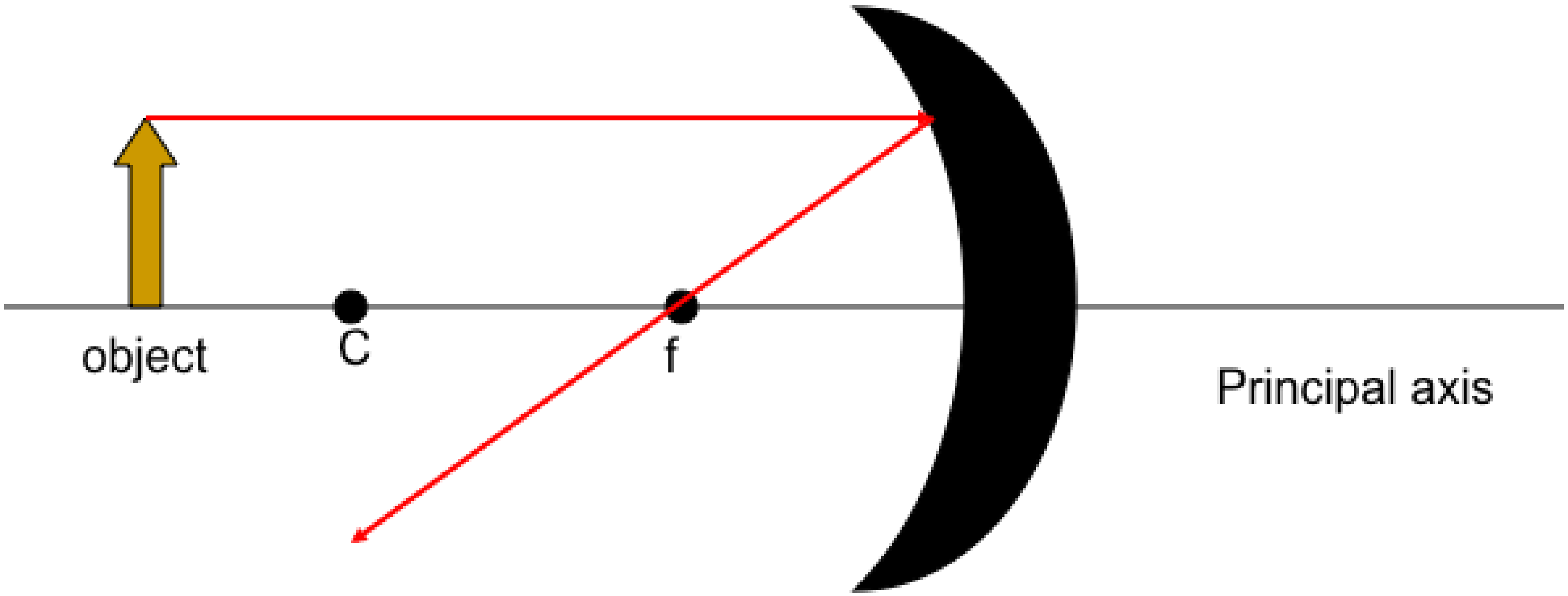
d_i is + if the image is a real image and located on the object's side of the mirror.
d_i is - if the image is a virtual image and located behind the mirror.

h_i is + if the image is an upright image (and therefore, also virtual)
h_i is - if the image an inverted image (and therefore, also real)

M is + if the image is enlarged
M is - if the image is reduced

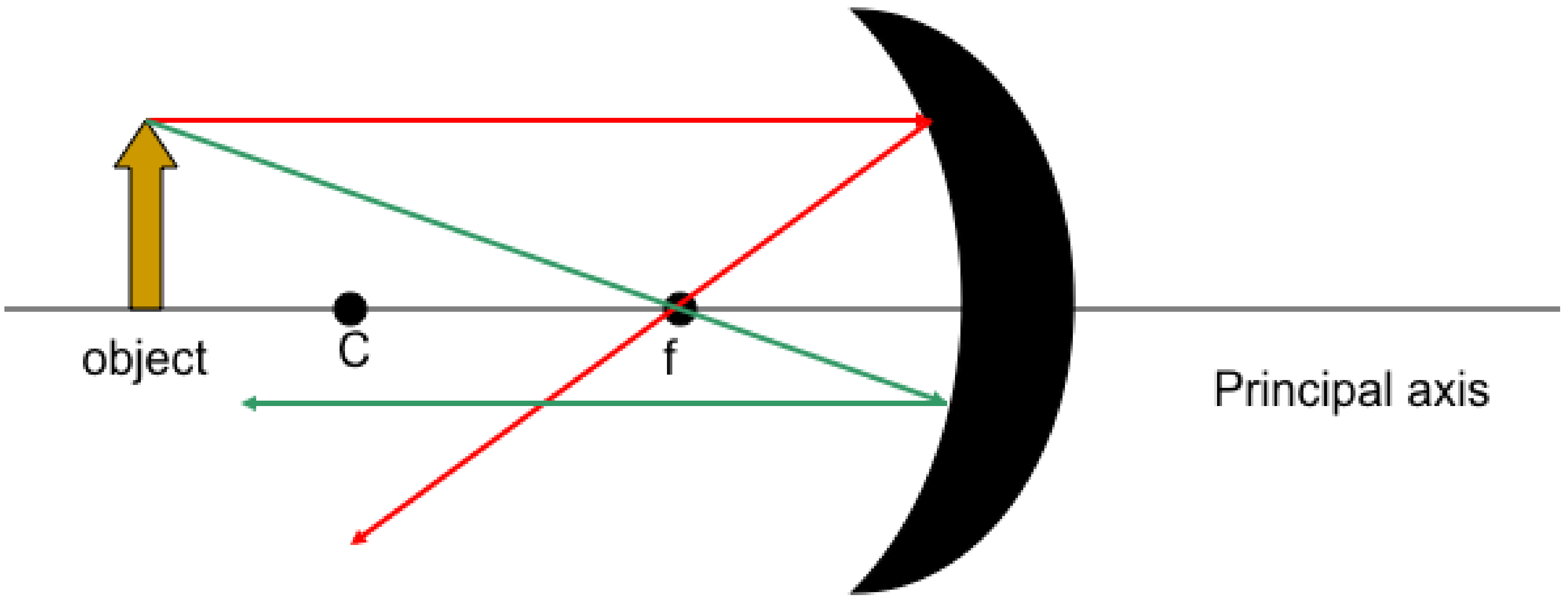
Ray Diagrams – Concave Mirrors

In a 3-step process, use three principal rays to draw a ray diagram.



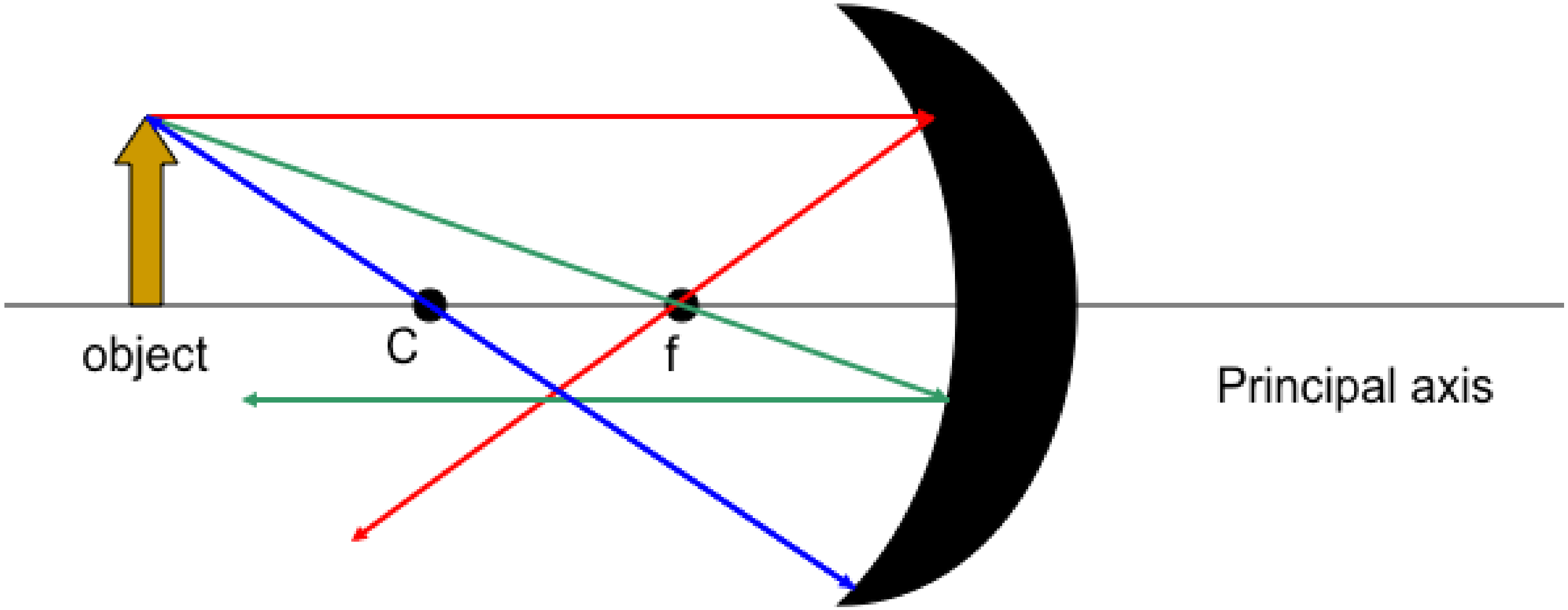
Step One: Draw a ray, starting from the top of the object, parallel to the principal axis and then through "f" after reflection.

Ray Diagrams – Concave Mirrors



Step Two: Draw a ray, starting from the top of the object, through the focal point, then parallel to the principal axis after reflection.

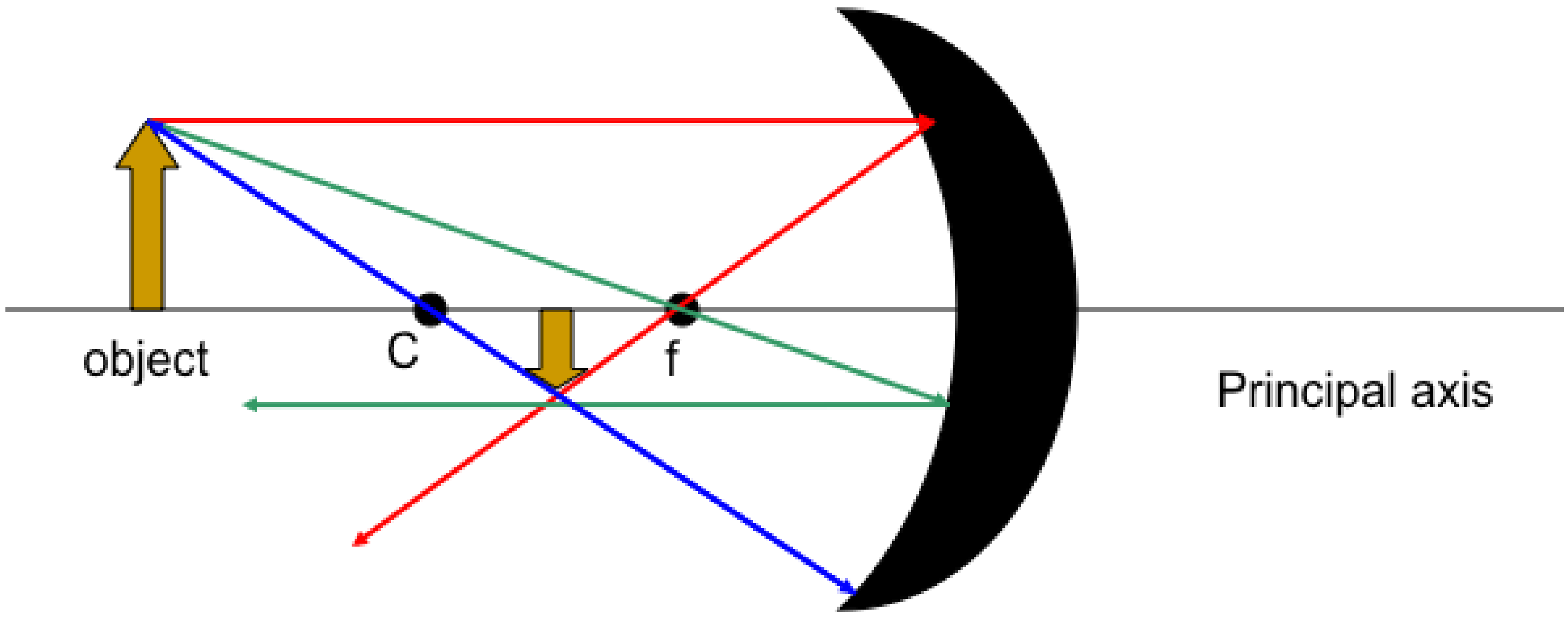
Ray Diagrams – Concave Mirrors



Step Three: Draw a ray, starting from the top of the object, through C, then back upon itself.

The intersection of these 3 lines is the location of the image.

Ray Diagrams – Image Characteristics



After getting the intersection, draw an arrow down from the principal axis to the point of intersection. Then notice:

1) Image is on the SAME (or opposite) side of the mirror
2) Image is REDUCED (or enlarged)
3) Image is INVERTED (or upright)

L-O-S-T art of Image Description

For CONCAVE MIRRORS:

The best means of summarizing this relationship is to divide the possible object locations into five general areas or points:

Case 1: the object is located *beyond* the center of curvature (C)

Case 2: the object is located at the center of curvature (C)

Case 3: the object is located between the center of curvature (C) and the focal point (F)

Case 4: the object is located at the focal point (F)

Case 5: the object is located *in front of* the focal point (F)

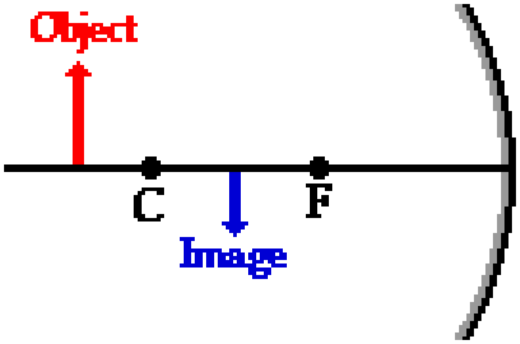
Case 1: Object beyond C

Location: image will always be located somewhere in *between the center of curvature and the focal point*.

Orientation: image will be an *inverted* image.

Size: *reduced* in size (M is less than 1).

Type: image is a *real image*.



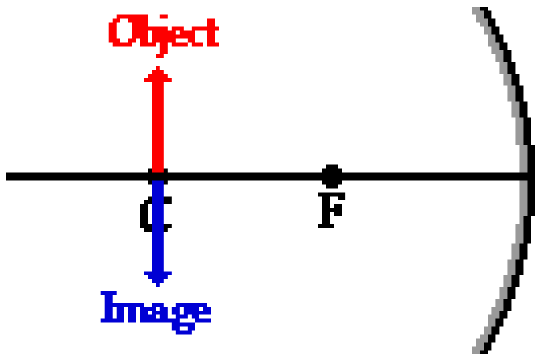
Case 2: Object located at C

Location: image will also be located *at the center of curvature*.

Orientation: image will be an *inverted* image.

Size: *same size (M = 1)*.

Type: image is a *real image*.



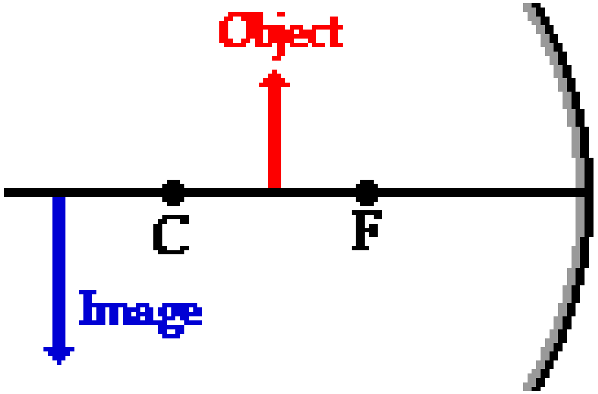
Case 3: Object between C &f

Location: object is located in front of the center of curvature, the image will be located *beyond the center of curvature*.

Orientation: image will be an *inverted* image.

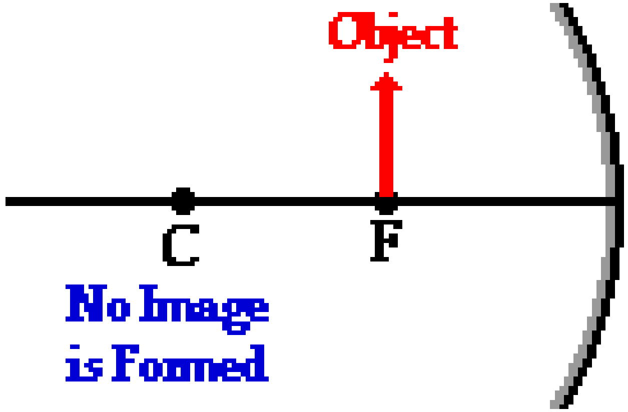
Size: *image is enlarged (M is greater than 1*).

Type: image is a *real image*.



Case 4: The object is located at f

No image is formed. Light rays from the same point on the object will reflect off the mirror and neither converge nor diverge. After reflecting, the light rays are traveling parallel to each other and do not result in the formation of an image.



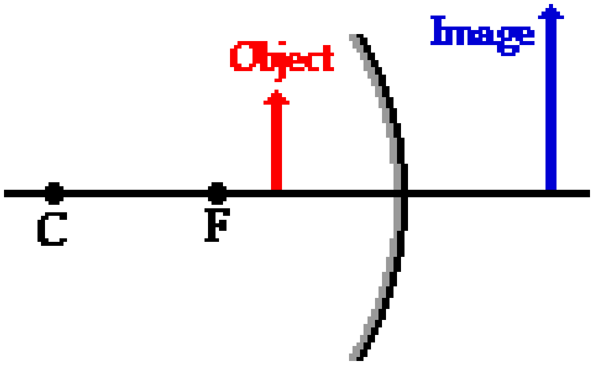
Case 5: Object located in front of f

Location: object is located at a location beyond the focal point, the image will always be *located somewhere on the opposite side of the mirror (behind mirror)*.

Orientation: image will be an *upright* image.

Size: *image is enlarged (M is greater than 1*).

Type: image is a *virtual image*. Light rays from the same point on the object reflect off the mirror and diverge upon reflection. For this reason, the image location can only be found by extending the reflected rays backwards beyond the mirror. The point of their intersection is the virtual image location.



Example 25.5

A concave spherical mirror has a focal length of 20 cm.
Find L-O-S-T for object distances of:

(a) 40 cm

Example 25.5

A concave spherical mirror has a focal length of 20 cm.

Find L-O-S-T for object distances of:

(b) 20 cm

Example 25.5

A concave spherical mirror has a focal length of 20 cm.
Find L-O-S-T for object distances of:

(c) 10 cm

Example 25.18

A man standing 1.52 m in front of a shaving mirror produces an inverted image 18.0 cm in front of it. How close to the mirror should he stand if he wants to form an upright image of his chin that is twice the actual size of his chin?

Example 25.18

A man standing 1.52 m in front of a shaving mirror produces an inverted image 18.0 cm in front of it. How close to the mirror should he stand if he wants to form an upright image of his chin that is twice the actual size of his chin?

Example 25.66

An object placed 10 cm from a concave spherical mirror produces a real image 8 cm from the mirror. If the object is moved to a new position 20 cm from the mirror, what is the position of the image? Is the final image real or virtual?