Images Formed by Concave Mirrors

To draw a scale ray diagram, we will do the following:

1) Draw the mirror, showing the principle axis, centre of curvature (*C*), and the focal point (*f*).
2) Draw an arrow on principle axis to illustrate the position and size of the object
3) Draw two rays from the tip of the object arrow to the mirror.
   Ray 1 is parallel to the principle axis and is reflected through the focal point.
   Ray 2 is drawn to pass through the focal point on its way to the mirror. It then reflects parallel to the principle axis.
   The point where these two rays meet gives the location and size of the image.

Case 1: Object is beyond the centre of curvature

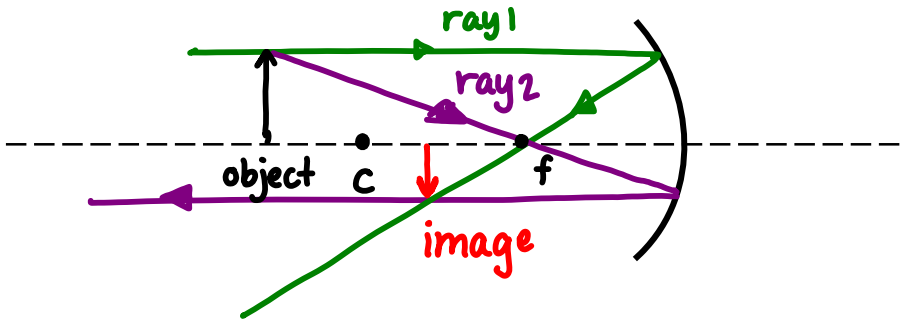


image is :
- inverted
- smaller (than the object)
- real

Case 2: Object is at the centre of curvature

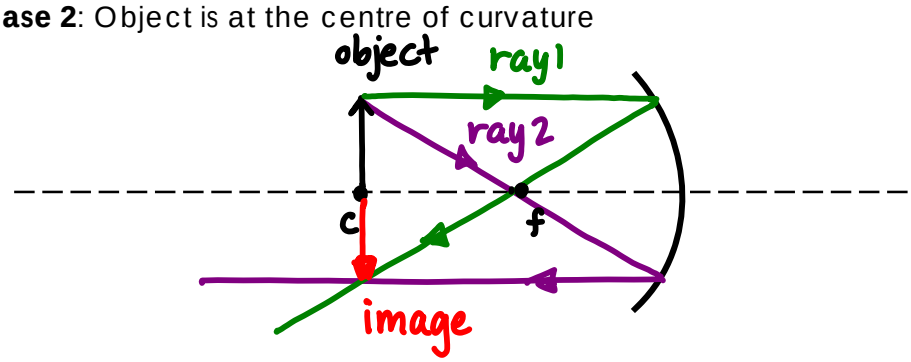


image is :
- inverted
- same size (as the object)
- real
- located at C

Case 3: Object is between the centre of curvature and the focal point

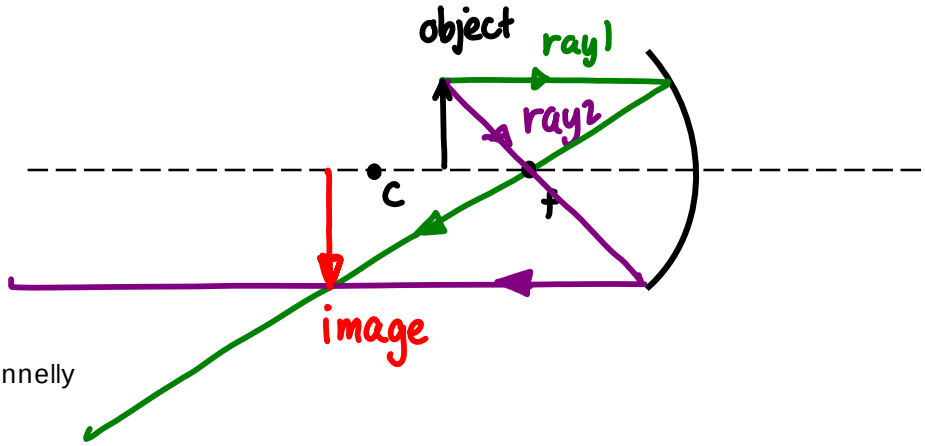
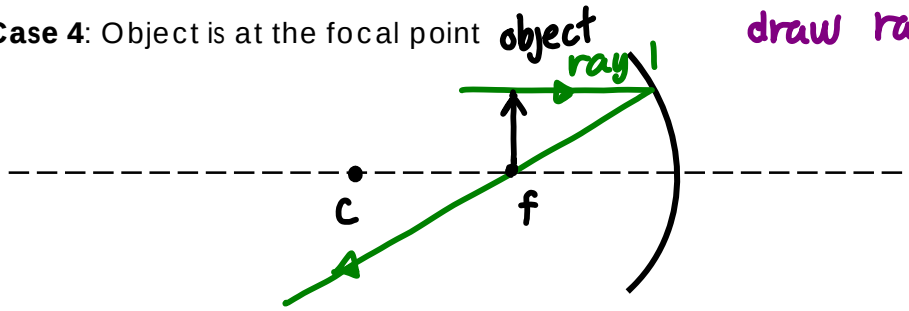


image is :
- inverted
- larger (than the object)
- real

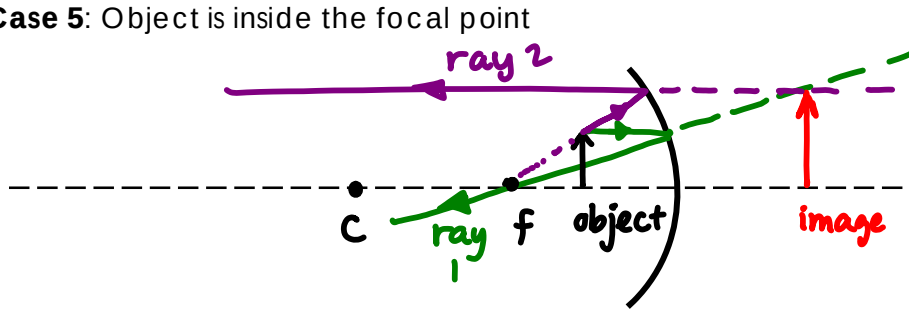
Case 4: Object is at the focal point



unable to draw ray 2

No image can form (all reflected rays are parallel and don't converge)

Case 5: Object is inside the focal point



ray extensions

image is :
- upright
- larger (than the object)
- virtual

Images Formed by Convex Mirrors

Since the reflected rays from a convex mirror always diverge, real images are never formed. The focal point is placed behind the mirror. The images are always the same in a convex mirror.

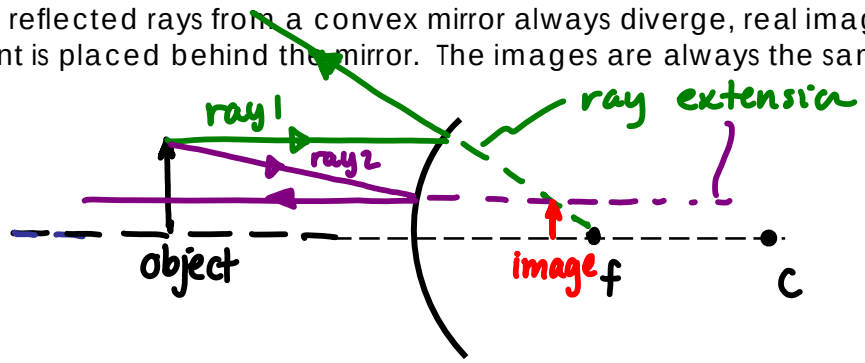


image is :
- upright
- smaller (than the object)
- virtual

Sign Convention for Mirrors

As we have seen: Focal points can be real (concave) or virtual (convex)

Images can be real or virtual

Images can be upright or inverted

So, we use the following sign conventions:

Real focal points or images are positive

Virtual focal points or images are negative

Upright images are positive

Inverted images are negative

Magnification

necessary because of sign convention

The ratio of the size of the image, h_i , to the size of the object, h_o , is called the **magnification** (m):

$$m = \frac{h_i}{h_o} \quad \text{or} \quad m = \frac{-d_i}{d_o}$$

$$\frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

If d_i and d_o are both positive (both are on the same side of the mirror), then both m and h_i are **negative**. This means the image is **inverted**.

Mirror Equation

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

f = focal length

d_o = distance of object from mirror

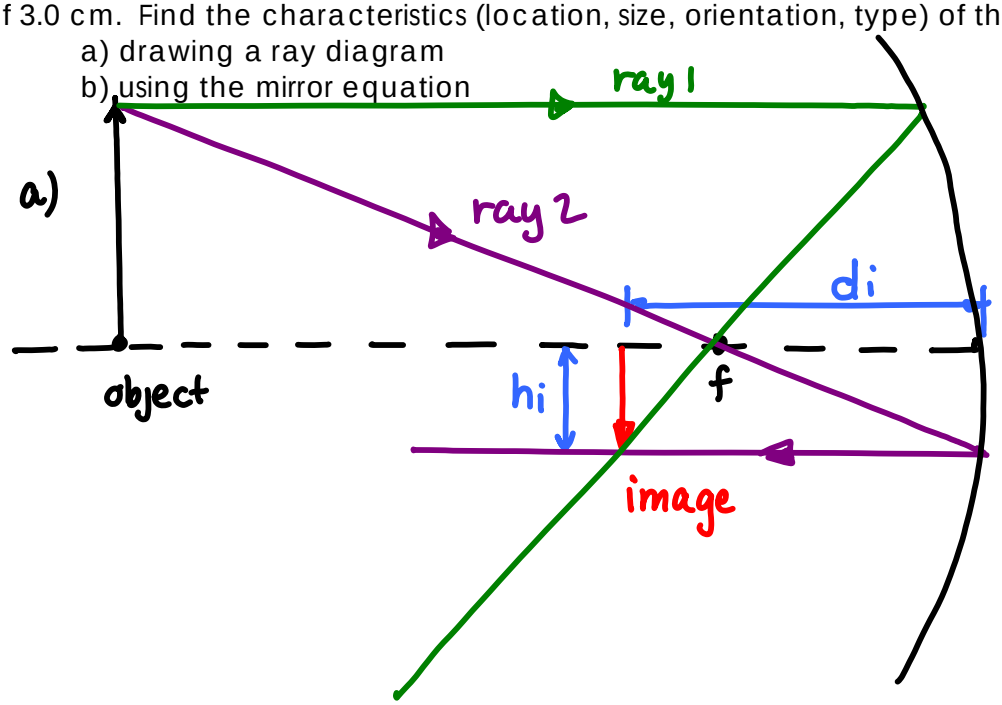
d_i = distance of image from mirror

Example: An object 3.00 cm tall is placed 10.0 cm in front of a concave mirror that has a focal length of 3.0 cm. Find the characteristics (location, size, orientation, type) of the image produced by:

a) drawing a ray diagram

b) using the mirror equation

a)



$h_i = -1.2$ cm (inverted image)

$d_i = 4.1$ cm

real image

b)

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{3.0} = \frac{1}{10.0} + \frac{1}{d_i}$$

$$-\frac{1}{10.0} \qquad -\frac{1}{10.0}$$

$$(0.2\overline{3})^{-1} = \left(\frac{1}{d_i}\right)^{-1}$$

$$4.29_{cm} = d_i$$

since d_i is positive, the image is <u>real</u>.

$$\frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

$$\frac{\cancel{(3.0)}\, h_i}{\cancel{3.0}} = \frac{-4.29}{10.0}(3.0)$$

$$h_i = -1.29 \text{ cm}$$

since h_i is negative, the image is inverted.

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