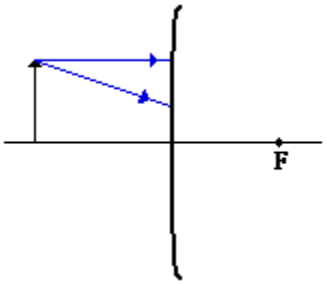
Answer on Question #48660, Physics, Optics

An object is placed 10 cm in front of a convex mirror of focal length 4 cm. Find the image location by drawing a ray tracing diagram to scale. Verify your answer using the lens equation

Solution:

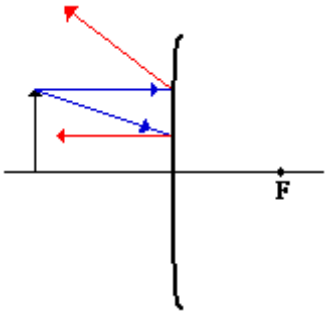
The method of drawing ray diagrams for convex mirrors is described below.

1. Pick a point on the top of the object and draw two incident rays traveling towards the mirror.

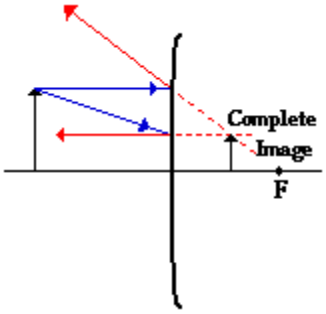


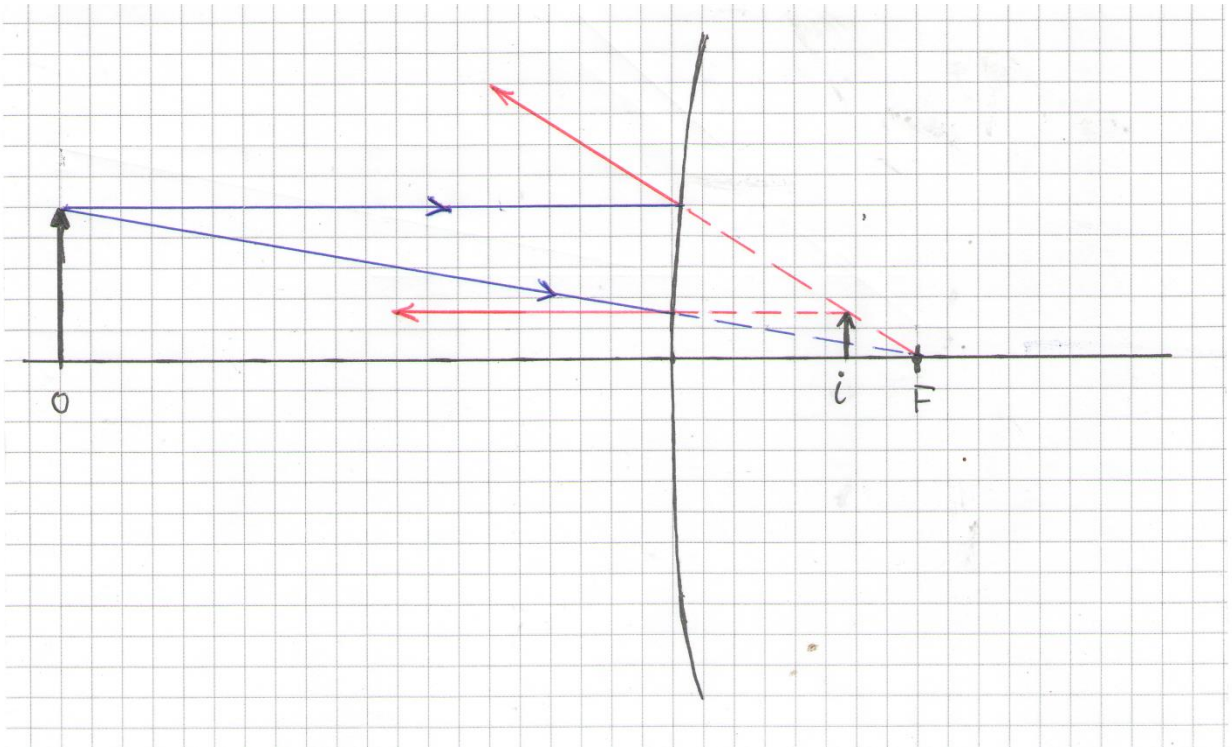
Using a straight edge, accurately draw one ray so that it travels towards the focal point on the opposite side of the mirror; this ray will strike the mirror before reaching the focal point; stop the ray at the point of incidence with the mirror. Draw the second ray such that it travels exactly parallel to the principal axis. Place arrowheads upon the rays to indicate their direction of travel.

2. The ray that travels towards the focal point will reflect and travel parallel to the principal axis. Use a straight edge to accurately draw its path. The ray that traveled parallel to the principal axis on the way to the mirror will reflect and travel in a direction such that its extension passes through the focal point. Align a straight edge with the point of incidence and the focal point, and draw the second reflected ray. Place arrowheads upon the rays to indicate their direction of travel. The two rays should be diverging upon reflection.



3. The image point of the top of the object is the point where the two reflected rays intersect. Since the two reflected rays are diverging, they must be extended behind the mirror in order to intersect.





The equation for image formation by rays near the optic axis (paraxial rays) of a mirror has the same form as the thin lens equation:

$$\frac{1}{o}+\frac{1}{i}=\frac{1}{f}$$

where o = object distance, i = image distance, f = focal length.

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

f is - if the mirror is a convex mirror

i is - if the image is a virtual image and located behind the mirror.

Thus,

$$\frac{1}{i}=-\frac{1}{o}-\frac{1}{f}=-\frac{1}{10}-\frac{1}{4}=-\frac{7}{20}$$

$$i=-\frac{20}{7}=-2.86\ \text{cm}$$