Answer on Question 68639, Physics, Optics

Question:

An object placed in front of a convex mirror of radius $40\ cm$ produces an erect image which is one-sixth the size of the object. How far is the object from the mirror?

Solution:

We can find the position of the object from the mirror equation:

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

here, d_o is the distance from the object to the mirror, d_i is the distance from the image to the mirror and f is the focal length (since we have the convex mirror, the focal length will be with sign minus).

By the definition, the focal length of the curved mirror is half a radius of curvature:

$$f=\frac{R}{2}.$$

Substituting f into the mirror equation we get:

$$\frac{1}{d_o}+\frac{1}{d_i}=-\frac{2}{R}.$$

From the initial condition of the question we know that the size of the image is one-sixth the size of the object:

$$h_i=\frac{1}{6}h_o.$$

Also, we know that:

$$\frac{h_i}{h_o}=\frac{-d_i}{d_o}=\frac{1}{6}.$$

From this equation we can express d_o in terms of d_i:

$$d_o=-6d_i.$$

Let's first substitute d_o into the mirror equation and find the distance from the image to the mirror:

$$-\frac{1}{6d_i}+\frac{1}{d_i}=-\frac{2}{R},$$

$$\frac{5}{6d_i}=-\frac{2}{R},$$

$$d_i=-\frac{5R}{12}=-\frac{5\cdot 40\ cm}{12}=-16.6\ cm.$$

The sign minus indicates that the image is located behind the mirror.

Finally, using the same mirror equation we can find the distance from the object to the mirror:

$$\frac{1}{d_o}=-\frac{2}{R}-\frac{1}{d_i},$$

$$d_o=\frac{1}{-\frac{2}{40\ cm}-\frac{1}{-16.6\ cm}}=97.6\ cm.$$

Answer:

$d_o=97.6\ cm.$