Answer on Question 77615, Physics, Optics

Question:

An object placed in front of a convex mirror of radius $20\ cm$ produces an erect image which is one-fifth 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).

Let's first find the focal length of the convex mirror. By the definition, the focal length of the curved mirror is half a radius of curvature:

$$f=\frac{R}{2}=\frac{20\ cm}{2}=10\ cm.$$

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

$$h_i=\frac{1}{5}h_o.$$

Also, we know that:

$$\frac{h_i}{h_o}=\frac{-d_i}{d_o}=\frac{1}{5}.$$

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

$$d_o=-5d_i.$$

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

$$-\frac{1}{5d_i}+\frac{1}{d_i}=-\frac{1}{10\ cm},$$

$$\frac{4}{5d_i}=-\frac{1}{10\ cm},$$

$$d_i=-\frac{4\cdot 10\ cm}{5}=-8\ cm.$$

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

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

$$d_o = -5d_i = -5 \cdot (-8\ cm) = 40\ cm.$$

Answer:

$d_o = 40\ cm.$