

Substitute the values for  $f$  and  $p$  into the mirror equation and the magnification equation to find the image distance and magnification.

$$\frac{1}{q} = \frac{1}{10.0 \text{ cm}} - \frac{1}{30.0 \text{ cm}} = \frac{0.100}{1 \text{ cm}} - \frac{0.033}{1 \text{ cm}} = \frac{0.067}{1 \text{ cm}}$$

$$q = 15 \text{ cm}$$

$$M = -\frac{q}{p} = -\frac{15 \text{ cm}}{30.0 \text{ cm}} = -0.50$$

**6. Evaluate your answer in terms of the image location and size.**

The image appears between the focal point (10.0 cm) and the center of curvature (20.0 cm), as confirmed by the ray diagram. The image is smaller than the object and inverted ( $-1 < M < 0$ ), as is also confirmed by the ray diagram. The image is therefore real.

## PRACTICE B

### Imaging with Concave Mirrors

1. Find the image distance and magnification of the mirror in the sample problem when the object distances are 10.0 cm and 5.00 cm. Are the images real or virtual? Are the images inverted or upright? Draw a ray diagram for each case to confirm your results.
2. A concave shaving mirror has a focal length of 33 cm. Calculate the image position of a cologne bottle placed in front of the mirror at a distance of 93 cm. Calculate the magnification of the image. Is the image real or virtual? Is the image inverted or upright? Draw a ray diagram to show where the image forms and how large it is with respect to the object.
3. A concave makeup mirror is designed so that a person 25.0 cm in front of it sees an upright image at a distance of 50.0 cm behind the mirror. What is the radius of curvature of the mirror? What is the magnification of the image? Is the image real or virtual?
4. A pen placed 11.0 cm from a concave spherical mirror produces a real image 13.2 cm from the mirror. What is the focal length of the mirror? What is the magnification of the image? If the pen is placed 27.0 cm from the mirror, what is the new position of the image? What is the magnification of the new image? Is the new image real or virtual? Draw ray diagrams to confirm your results.