2. The image is 10 cm behind the mirror and you are 30 cm in front of the mirror. You must focus your eyes for a distance of $10 \text{ cm} + 30 \text{ cm} = 40 \text{ cm}$. 
7. We use Eqs. 34-3 and 34-4, and note that \( m = -i/p \). Thus,

\[
\frac{1}{p} - \frac{1}{pm} = \frac{1}{f} = \frac{2}{r}.
\]

We solve for \( p \):

\[
p = \frac{r}{2} \sqrt{1 - \frac{1}{m}} = \frac{35.0 \text{ cm}}{2} \sqrt{1 - \frac{1}{2.50}} = 10.5 \text{ cm}.
\]
43. We solve Eq. 34-9 for the image distance:

\[ i = \left( \frac{1}{f} - \frac{1}{p} \right)^{-1} = \frac{fp}{p-f}. \]

The height of the image is

\[ h_i = mh_p = \left( \frac{i}{p} \right) h_p = \frac{fh_p}{p-f} = \frac{(75 \text{ mm})(1.80 \text{ m})}{27 \text{ m} - 0.075 \text{ m}} = 5.0 \text{ mm}. \]
68. (a) A convex (converging) lens, since a real image is formed.

(b) Since \( i = d - p \) and \( i/p = 1/2 \),

\[
p = \frac{2d}{3} = \frac{2 \times 40.0 \text{ cm}}{3} = 26.7 \text{ cm}
\]

(c) The focal length is

\[
f = \left( \frac{1}{i} + \frac{1}{p} \right)^{-1} = \left( \frac{1}{d/3} + \frac{1}{2d/3} \right)^{-1} = \frac{2d}{9} = \frac{2(40.0 \text{ cm})}{9} = 8.89 \text{ cm}
\]
In this problem we convert the Gaussian form of the thin-lens formula to the Newtonian form.

For a thin lens, the Gaussian form of the thin-lens formula gives $(1/p) + (1/i) = (1/f)$, where $p$ is the object distance, $i$ is the image distance, and $f$ is the focal length. To convert the formula to the Newtonian form, let $p = f + x$, where $x$ is positive if the object is outside the focal point and negative if it is inside. In addition, let $i = f + x'$, where $x'$ is positive if the image is outside the focal point and negative if it is inside.

From the Gaussian form, we solve for $I$ and obtain:

$$i = \frac{fp}{p-f}.$$ 

Substituting $p = f + x$ gives

$$i = \frac{f(f+x)}{x}.$$ 

With $i = f + x'$, we have

$$x' = i - f = \frac{f(f+x)}{x} - f = \frac{f^2}{x}.$$ 

which leads to $xx' = f^2$.

The Newtonian form is equivalent to the Gaussian form, and it provides another convenient way to analyze problems involving thin lenses.
The water is medium 1, so \( n_1 = n_w \), which we simply write as \( n \). The air is medium 2, for which \( n_2 \approx 1 \). We refer to points where the light rays strike the water surface as \( A \) (on the left side of Fig. 34-56) and \( B \) (on the right side of the picture). The point midway between \( A \) and \( B \) (the center point in the picture) is \( C \). The penny \( P \) is directly below \( C \), and the location of the “apparent” or virtual penny is \( V \). We note that the angle \( \angle CVB \) (the same as \( \angle CV_A \)) is equal to \( \theta_2 \), and the angle \( \angle CPB \) (the same as \( \angle CPA \)) is equal to \( \theta_1 \). The triangles \( CVB \) and \( CPB \) share a common side, the horizontal distance from \( C \) to \( B \) (which we refer to as \( x \)). Therefore,

\[
\tan \theta_2 = \frac{x}{d_a} \quad \text{and} \quad \tan \theta_1 = \frac{x}{d}.
\]

Using the small angle approximation (so a ratio of tangents is nearly equal to a ratio of sines) and the law of refraction, we obtain

\[
\frac{\tan \theta_2}{\tan \theta_1} \approx \frac{\sin \theta_2}{\sin \theta_1} \quad \Rightarrow \quad \frac{x}{d_a} \approx \frac{n_1}{n_2} \quad \Rightarrow \quad \frac{d}{d_a} \approx n
\]

which yields the desired relation: \( d_a = d/n \).