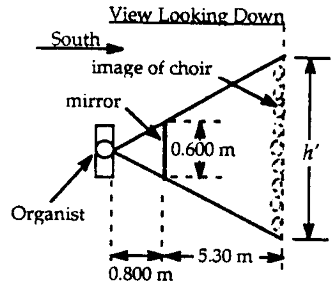
Homework 8 Solutions

***36.2** The virtual image is as far behind the mirror as the choir is in front of the mirror. Thus, the image is 5.30 m behind the mirror.



The image of the choir is $0.800\text{ m} + 5.30\text{ m} = 6.10\text{ m}$ from the organist. Using similar triangles:

$$\frac{h'}{0.600\text{ m}} = \frac{6.10\text{ m}}{0.800\text{ m}} \quad \text{or} \quad h' = (0.600\text{ m})\left(\frac{6.10\text{ m}}{0.800\text{ m}}\right) = \boxed{4.58\text{ m}}$$

36.12 For a concave mirror, R and f are positive. Also, for an erect image, M is positive. Therefore, $M = -\frac{q}{p} = 4$ and $q = -4p$.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} \quad \text{becomes} \quad \frac{1}{40.0\text{ cm}} = \frac{1}{p} - \frac{1}{4p} = \frac{3}{4p}; \quad \text{from which,} \quad p = \boxed{30.0\text{ cm}}$$

36.23 $\frac{n_1}{p} + \frac{n_2}{q} = \frac{(n_2 - n_1)}{R}$ because $\frac{1.00}{p} + \frac{1.50}{q} = \frac{1.50 - 1.00}{6.00\text{ cm}} = \frac{1.00}{12.0\text{ cm}}$

(a) $$\frac{1}{20.0\text{ cm}} + \frac{1.50}{q} = \frac{1.00}{12.0\text{ cm}} \quad \text{or} \quad q = \frac{1.50}{\left[\frac{1.00}{12.0\text{ cm}} - \frac{1.00}{20.0\text{ cm}}\right]} = \boxed{45.0\text{ cm}}$$

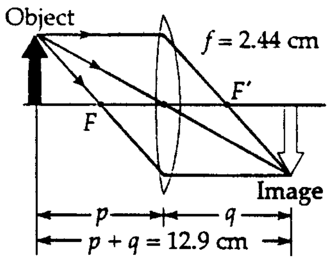
(b) $$\frac{1.00}{10.0\text{ cm}} + \frac{1.50}{q} = \frac{1.00}{12.0\text{ cm}} \quad \text{or} \quad q = \frac{1.50}{\left[\frac{1.00}{12.0\text{ cm}} - \frac{1.00}{10.0\text{ cm}}\right]} = \boxed{-90.0\text{ cm}}$$

(c) $$\frac{1.00}{3.00\text{ cm}} + \frac{1.50}{q} = \frac{1.00}{12.0\text{ cm}} \quad \text{or} \quad q = \frac{1.50}{\left[\frac{1.00}{12.0\text{ cm}} - \frac{1.00}{3.00\text{ cm}}\right]} = \boxed{-6.00\text{ cm}}$$

36.25 $\frac{n_1}{p} + \frac{n_2}{q} = \frac{n_2 - n_1}{R}$ $\quad n_1 = 1.33 \quad n_2 = 1.00 \quad p = +10.0\text{ cm} \quad R = -15.0\text{ cm}$

$q = -9.01\text{ cm}$, or the fish appears to be $\boxed{9.01\text{ cm inside the bowl}}$

36.33 (a) Note that $q = 12.9\text{ cm} - p$



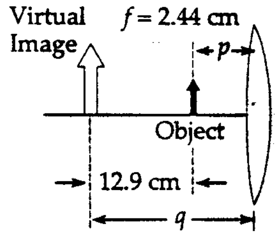
so $$\frac{1}{p} + \frac{1}{12.9 - p} = \frac{1}{2.44}$$

which yields a quadratic in p: $-p^2 + 12.9p = 31.5$

which has solutions $\boxed{p = 9.63\text{ cm or } p = 3.27\text{ cm}}$

Both solutions are valid.

(b) For a virtual image, $-q = p + 12.9\text{ cm}$



$$\frac{1}{p} - \frac{1}{12.9 + p} = \frac{1}{2.44}$$

or $p^2 + 12.9p = 31.8$

from which $\boxed{p = 2.10\text{ cm}}$ or $p = -15.0$ cm.

We must have a real object so the −15.0 cm solution must be rejected.

*36.41 To properly focus the image of a distant object, the lens must be at a distance equal to the focal length from the film ($q_1 = 65.0$ mm). For the closer object:

$$\frac{1}{p_2} + \frac{1}{q_2} = \frac{1}{f} \text{ becomes } \frac{1}{2000\text{ mm}} + \frac{1}{q_2} = \frac{1}{65.0\text{ mm}} \quad \text{and} \quad q_2 = (65.0\text{ mm})\left(\frac{2000}{2000 - 65.0}\right)$$

The lens must be moved $\boxed{\text{away from the film}}$ by a distance

$$D = q_2 - q_1 = (65.0\text{ mm})\left(\frac{2000}{2000 - 65.0}\right) - 65.0\text{ mm} = \boxed{2.18\text{ mm}}$$

36.45 $$P = \frac{1}{f} = \frac{1}{p} + \frac{1}{q} = \frac{1}{\infty} - \frac{1}{0.250\text{ m}} = -4.00\text{ diopters} = \boxed{-4.00\text{ diopters, a diverging lens}}$$