

Chapter 26

1. $\theta_i = \theta_r$
 $\theta_i + \theta_r = 2\theta_i = 38^\circ + 2(5.0^\circ) = \boxed{48^\circ}$

10. (a) The distance decreases at twice the walking rate.

$$2(2.4 \frac{\text{m}}{\text{s}}) = \boxed{4.8 \text{ m/s}}$$

(b) $2(2.4 \frac{\text{m}}{\text{s}}) \cos 33^\circ = \boxed{4.0 \text{ m/s}}$

19. $\frac{1}{d_i} = \frac{1}{f} - \frac{1}{d_o}$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \left(\frac{1}{\frac{40.0 \text{ cm}}{2}} - \frac{1}{30.0 \text{ cm}}\right)^{-1} = 60.0 \text{ cm}$$

The object will be formed $\boxed{60.0 \text{ cm in front of the mirror.}}$

22. $d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \left(\frac{1}{0.50 \text{ m}} - \frac{1}{2.0 \text{ m}}\right)^{-1} = \boxed{0.67 \text{ m}}$

$$m = -\frac{d_i}{d_o} = -\frac{1}{2.0 \text{ m}} \left(\frac{1}{0.50 \text{ m}} - \frac{1}{2.0 \text{ m}}\right)^{-1} = \boxed{-0.33}$$

46. $\tan \theta_{\text{refr}} = \frac{y}{x}$

$$n_{\text{air}} \sin \theta = n_g \sin \theta_{\text{refr}}$$

$$\theta = \sin^{-1}\left(\frac{n_g}{n_{\text{air}}} \sin \theta_{\text{refr}}\right) = \sin^{-1}\left(\frac{n_g}{n_{\text{air}}} \sin \tan^{-1} \frac{y}{x}\right) = \sin^{-1}\left(\frac{1.52}{1.000} \sin \tan^{-1} \frac{5.0 \text{ cm}}{20.0 \text{ cm}}\right) = 22^\circ$$

49. The angles of incidence are both exactly 45° .

$$n = \frac{n_{\text{air}}}{\sin \theta_c} = \frac{1.000}{\sin 45^\circ} = \boxed{1.414}$$

62. $\frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = \left(\frac{1}{-32 \text{ cm}} - \frac{1}{23 \text{ cm}}\right)^{-1} = -13 \text{ cm}$$

The image is located $\boxed{13 \text{ cm in front of the lens.}}$

$$m = -\frac{d_i}{d_o} = -\frac{1}{d_o} \left(\frac{1}{f} - \frac{1}{d_o}\right)^{-1} = -\frac{1}{23 \text{ cm}} \left(\frac{1}{-32 \text{ cm}} - \frac{1}{23 \text{ cm}}\right)^{-1} = \boxed{0.58}$$

$$64. \text{ (a) } \frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{f}$$

$$d_i = \left(\frac{1}{f} - \frac{1}{d_o} \right)^{-1} = \left(\frac{1}{35.0 \text{ mm}} - \frac{1}{36.3 \text{ mm}} \right)^{-1} = 0.98 \text{ m}$$

The image is located 0.98 m to the right of the lens.

$$\text{(b) } h_i = mh_o = -\frac{d_i h_o}{d_o} = -\frac{\left(\frac{1}{35.0 \text{ mm}} - \frac{1}{36.3 \text{ mm}} \right)^{-1} (2.54 \text{ cm})}{36.3 \text{ mm}} = -68 \text{ cm}$$

The image is inverted and 68 cm tall.