

25. (a) Since friction is negligible the force of the girl is the only horizontal force on the sled. The vertical forces (the force of gravity and the normal force of the ice) sum to zero. The acceleration of the sled is

$$a_s = \frac{F}{m_s} = \frac{5.2 \text{ N}}{8.4 \text{ kg}} = 0.62 \text{ m/s}^2 .$$

- (b) According to Newton's third law, the force of the sled on the girl is also 5.2 N. Her acceleration is

$$a_g = \frac{F}{m_g} = \frac{5.2 \text{ N}}{40 \text{ kg}} = 0.13 \text{ m/s}^2 .$$

- (c) The accelerations of the sled and girl are in opposite directions. Assuming the girl starts at the origin and moves in the $+x$ direction, her coordinate is given by $x_g = \frac{1}{2}a_g t^2$. The sled starts at $x_0 = 1.5 \text{ m}$ and moves in the $-x$ direction. Its coordinate is given by $x_s = x_0 - \frac{1}{2}a_s t^2$. They meet when

$$\begin{aligned} x_g &= x_s \\ \frac{1}{2}a_g t^2 &= x_0 - \frac{1}{2}a_s t^2 . \end{aligned}$$

This occurs at time

$$t = \sqrt{\frac{2x_0}{a_g + a_s}} .$$

By then, the girl has gone the distance

$$x_g = \frac{1}{2}a_g t^2 = \frac{x_0 a_g}{a_g + a_s} = \frac{(1.5)(0.13)}{0.13 + 0.62} = 2.6 \text{ m} .$$