9. **REASONING** Since the woman runs for a known distance at a known constant speed, we can find the time it takes for her to reach the water from Equation 2.1. We can then use Equation 2.1 to determine the total distance traveled by the dog in this time.

**SOLUTION** The time required for the woman to reach the water is
\[
\text{Elapsed time} = \frac{d_{\text{woman}}}{v_{\text{woman}}} = \left( \frac{4.0 \text{ km}}{2.5 \text{ m/s}} \right) \left( \frac{1000 \text{ m}}{1.0 \text{ km}} \right) = 1600 \text{ s}
\]

In 1600 s, the dog travels a total distance of
\[
d_{\text{dog}} = v_{\text{dog}} t = (4.5 \text{ m/s})(1600 \text{ s}) = 7.2 \times 10^3 \text{ m}
\]

27. **REASONING** Since the belt is moving with constant velocity, the displacement \((x_0 = 0 \text{ m})\) covered by the belt in a time \(t_{\text{belt}}\) is giving by Equation 2.2 (with \(x_0\) assumed to be zero) as

\[
x = v_{\text{belt}} t_{\text{belt}}
\]

(1)

Since Clifford moves with constant acceleration, the displacement covered by Clifford in a time \(t_{\text{Cliff}}\) is, from Equation 2.8,

\[
x = v_0 t_{\text{Cliff}} + \frac{1}{2} a t_{\text{Cliff}}^2 = \frac{1}{2} a t_{\text{Cliff}}^2
\]

(2)

The speed \(v_{\text{belt}}\) with which the belt of the ramp is moving can be found by eliminating \(x\) between Equations (1) and (2).

**SOLUTION** Equating the right hand sides of Equations (1) and (2), and noting that \(t_{\text{Cliff}} = \frac{1}{4} t_{\text{belt}}\), we have

\[
v_{\text{belt}} t_{\text{belt}} = \frac{1}{2} a \left( \frac{1}{4} t_{\text{belt}} \right)^2
\]

\[
v_{\text{belt}} = \frac{1}{32} a t_{\text{belt}} = \frac{1}{32} (0.37 \text{ m/s}^2)(64 \text{ s}) = 0.74 \text{ m/s}
\]

53. **REASONING AND SOLUTION** The stone requires a time, \(t_1\), to reach the bottom of the hole, a distance \(y\) below the ground. Assuming downward to be the positive direction, the variables are related by Equation 2.8 with \(v_0 = 0 \text{ m/s}:\)
\[ y = \frac{1}{2} at_1^2 \]  

The sound travels the distance \( y \) from the bottom to the top of the hole in a time \( t_2 \). Since the sound does not experience any acceleration, the variables \( y \) and \( t_2 \) are related by Equation 2.8 with \( a = 0 \) m/s\(^2\) and \( v_{\text{sound}} \) denoting the speed of sound:

\[ y = v_{\text{sound}} t_2 \]  

Equating the right hand sides of Equations (1) and (2) and using the fact that the total elapsed time is \( t = t_1 + t_2 \), we have

\[ \frac{1}{2} a t_1^2 = v_{\text{sound}} t_2 \quad \text{or} \quad \frac{1}{2} a t_1^2 = v_{\text{sound}} (t - t_1) \]

Rearranging gives

\[ \frac{1}{2} a t_1^2 + v_{\text{sound}} t_1 - v_{\text{sound}} t = 0 \]

Substituting values and suppressing units for brevity, we obtain the following quadratic equation for \( t_1 \):

\[ 4.90 t_1^2 + 343 t_1 - 514 = 0 \]

From the quadratic formula, we obtain

\[ t_1 = \frac{-343 \pm \sqrt{(343)^2 - 4(4.90)(-514)}}{2(4.90)} = 1.47 \text{ s} \quad \text{or} \quad -71.5 \text{ s} \]

The negative time corresponds to a nonphysical result and is rejected. The depth of the hole is then found using Equation 2.8 with the value of \( t_1 \) obtained above:

\[ y = v_0 t_1 + \frac{1}{2} a t_1^2 = (0 \text{ m/s})(1.47 \text{ s}) + \frac{1}{2}(9.80 \text{ m/s}^2)(1.47 \text{ s})^2 = 10.6 \text{ m} \]

**67. REASONING AND SOLUTION**

a. The magnitude of the acceleration can be found from Equation 2.4 \((v = v_0 + at)\) as

\[ a = \frac{v - v_0}{t} = \frac{3.0 \text{ m/s} - 0 \text{ m/s}}{2.0 \text{ s}} = 1.5 \text{ m/s}^2 \]

b. Similarly the magnitude of the acceleration of the car is

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\[ a = \frac{v - v_0}{t} = \frac{41.0 \text{ m/s} - 38.0 \text{ m/s}}{2.0 \text{ s}} = 1.5 \text{ m/s}^2 \]

c. Assuming that the acceleration is constant, the displacement covered by the car can be found from Equation 2.9 \((v^2 = v_0^2 + 2ax)\):

\[ x = \frac{v^2 - v_0^2}{2a} = \frac{(41.0 \text{ m/s})^2 - (38.0 \text{ m/s})^2}{2(1.5 \text{ m/s}^2)} = 79 \text{ m} \]

Similarly, the displacement traveled by the jogger is

\[ x = \frac{v^2 - v_0^2}{2a} = \frac{(3.0 \text{ m/s})^2 - (0 \text{ m/s})^2}{2(1.5 \text{ m/s}^2)} = 3.0 \text{ m} \]

Therefore, the car travels \(79 \text{ m} - 3.0 \text{ m} = 76 \text{ m}\) further than the jogger.