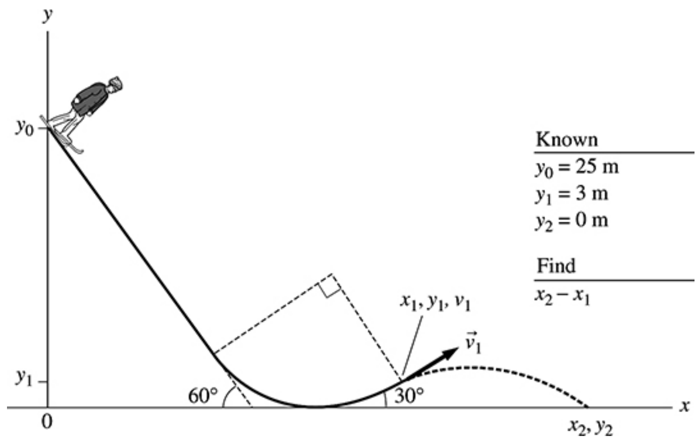
10.49. Model: Since there is no friction, the sum of the kinetic and gravitational potential energy does not change. Model Julie as a particle.

Visualize:



We place the coordinate system at the bottom of the ramp directly below Julie's starting position. From geometry, Julie launches off the end of the ramp at a 30º angle.

Solve: Energy conservation: $K_1 + U_{g1} = K_0 + U_{g0} \Rightarrow \frac{1}{2}mv_1^2 + mgy_1 = \frac{1}{2}mv_0^2 + mgy_0$

Using $v_0 = 0$ m/s, $y_0 = 25$ m, and $y_1 = 3$ m, the above equation simplifies to

$$\frac{1}{2}mv_1^2 + mgy_1 = mgy_0 \Rightarrow v_1 = \sqrt{2g(y_0 - y_1)} = \sqrt{2(9.8\text{ m/s}^2)(25\text{ m} - 3\text{ m})} = 20.77\text{ m/s}$$

We can now use kinematic equations to find the touchdown point from the base of the ramp. First we'll consider the vertical motion:

$$y_2 = y_1 + v_{1y}(t_2 - t_1) + \frac{1}{2}a_y(t_2 - t_1)^2 \quad 0\text{ m} = 3\text{ m} + (v_1 \sin 30°)(t_2 - t_1) + \frac{1}{2}(-9.8\text{ m/s}^2)(t_2 - t_1)^2$$

$$\Rightarrow (t_2 - t_1)^2 - \frac{(20.77\text{ m/s})\sin 30°}{(4.9\text{ m/s}^2)}(t_2 - t_1) - \frac{(3\text{ m})}{(4.9\text{ m/s}^2)} = 0$$

$$(t_2 - t_1)^2 - (2.119\text{ s})(t_2 - t_1) - (0.6122\text{ s}^2) = 0 \Rightarrow (t_2 - t_1) = 2.377\text{ s}$$

For the horizontal motion:

$$x_2 = x_1 + v_{1x}(t_2 - t_1) + \frac{1}{2}a_x(t_2 - t_1)^2$$

$$x_2 - x_1 = (v_1 \cos 30°)(t_2 - t_1) + 0\text{ m} = (20.77\text{ m/s})(\cos 30°)(2.377\text{ s}) = 43\text{ m}$$

Assess: Note that we did not have to make use of the information about the circular arc at the bottom that carries Julie through a 90° turn.