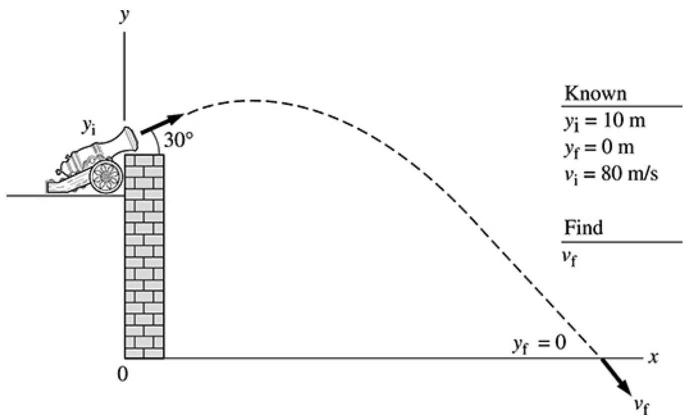
10.34. Model: This is case of free fall, so the sum of the kinetic and gravitational potential energy does not change as the cannon ball falls.

Visualize:



The figure shows a before-and-after pictorial representation. To express the gravitational potential energy, we put the origin of our coordinate system on the ground below the fortress.

Solve: Using $y_f = 0$ and the equation $K_i + U_{gi} = K_f + U_{gf}$ we get

$$\frac{1}{2}mv_i^2 + mgy_i = \frac{1}{2}mv_f^2 + mgy_f \Rightarrow v_i^2 + 2gy_i = v_f^2$$

$$v_f = \sqrt{v_i^2 + 2gy_i} = \sqrt{(80\text{ m/s})^2 + 2(9.8\text{ m/s}^2)(10\text{ m})} = 81\text{ m/s}$$

Assess: Note that we did not need to use the tilt angle of the cannon, because kinetic energy is a scalar. Also note that using the energy conservation equation, we can find only the magnitude of the final velocity, not the direction of the velocity vector.