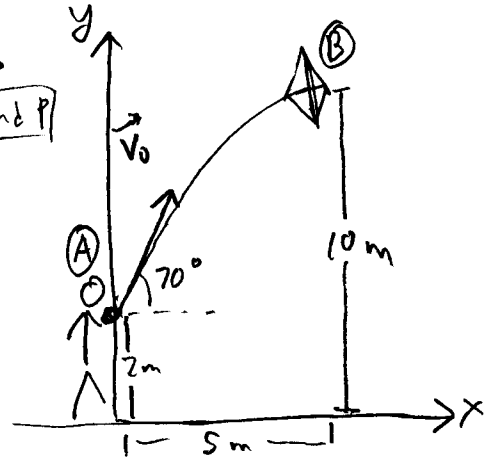
Std. Problems 3 - Additional Problems

1.

O and P



$y_A = 2\,m$ $\quad V_{Ax} = V_A \cos 70$

$y_B = 10\,m$ $\quad V_{Ay} = V_A \sin 70$

$x_A = 0\,m$ $\quad a_{ABx} = 0\ m/s^2$

$x_B = 5\,m$ $\quad a_{ABy} = -g$

I'll analyze both the x and y motion and see if I can connect the two mathematically using the shared time Δt_{AB}.

Solve

x motion: $x_B = x_A + V_{Ax}\Delta t_{AB} = V_A \cos 70\, \Delta t_{AB}$

y motion: $y_B = y_A + V_{Ay}\Delta t_{AB} + \frac{1}{2} a_{ABy} \Delta t_{AB}^2$

$y_B = y_A + V_A \sin 70\, \Delta t_{AB} + \frac{1}{2} a_{ABy} \Delta t_{AB}^2$

two eqns, two unknowns (Δt_{AB} and V_A)

Solve the x-motion eqn. for Δt_{AB}: $\Delta t_{AB} = \dfrac{x_B}{V_A \cos 70}$

Sub into the y-motion eqn:

$$y_B = y_A + V_A \sin 70 \left(\frac{x_B}{V_A \cos 70}\right) + \frac{1}{2} a_{ABy}\left(\frac{x_B}{V_A \cos 70}\right)^2$$

$$\Rightarrow \quad y_B = y_A + x_B \tan 70 + \frac{1}{2} a_{ABy} \frac{x_B^2}{V_A^2 \cos^2 70}$$ now solve for V_A

$$\Rightarrow \quad \frac{\frac{1}{2} a_{ABy} x_B^2}{V_A^2 \cos^2 70} = y_B - y_A - x_B \tan 70$$

$$\Rightarrow \quad V_A^2 \cos^2 70 = \frac{\frac{1}{2} a_{ABy} x_B^2}{y_B - y_A - x_B \tan 70}$$

$$\Rightarrow \quad V_A = \sqrt{\frac{\frac{1}{2} a_{ABy} x_B^2}{\cos^2 70\,(y_B - y_A - x_B \tan 70)}} = \sqrt{\frac{\frac{1}{2}(-9.8\,m/s^2)(5m)^2}{\cos^2 70\,(10m - 2m - 5m(\tan 70))}} = 13.5\,\frac{m}{s}$$

Reflect

This is ~30 mph, a reasonable speed to throw a rock. Here, we couldn't find numbers for V_{Ax} and V_{Ay}, but they are related by the angle so by writing the x and y equations using those variables, we are still able to relate the two directions