

HW3-6 Soln)

Let the origin be at the player's forward foot (right under the ball at release) and let up be +y and to the right be +x.

$$x_i = 0 \text{ m} \quad y_i = 2.5 \text{ m}$$

$$x_f = 12 \text{ m} \quad y_f = 6 \text{ m}$$

$$v_{xi} = v_0 \cos \theta_o = 16 \cos \theta_o \quad v_{yi} = v_0 \sin \theta_o = 16 \sin \theta_o$$

$$v_{xf} = 16 \cos \theta_o \quad v_{yf} = ?$$

$$a_x = 0 \text{ m/s}^2 \quad a_y = -10 \text{ m/s}^2$$

$$t = ?$$

(3)

$$x = x_i + v_{xi}t + \frac{1}{2}a_x t^2 \rightarrow x = 0 + v_0 \cos \theta_o t + 0$$

$$t = \frac{x}{v_0 \cos \theta_o}$$

(3)

$$y = y_i + v_{yi}t + \frac{1}{2}a_y t^2 = y_i + v_0 \sin \theta_o t + \frac{1}{2}a_y t^2 = y_i + v_0 \sin \theta_o \frac{x}{v_0 \cos \theta_o} + \frac{1}{2}a_y \left( \frac{x}{v_0 \cos \theta_o} \right)^2$$

$$\begin{aligned} y &= y_i + x \tan \theta_o + \frac{a_y x^2}{2v_0^2} \left( \frac{1}{\cos \theta_o} \right)^2 = y_i + x \tan \theta_o + \frac{a_y x^2}{2v_0^2} (\tan^2 \theta_o + 1) \\ &= \left( y_i + \frac{a_y x^2}{2v_0^2} \right) + x \tan \theta_o + \left( \frac{a_y x^2}{2v_0^2} \right) \tan^2 \theta_o \end{aligned}$$

This is quadratic in the tangent. Re-arrange.

$$\left( \frac{a_y x^2}{2v_0^2} \right) \tan^2 \theta_o + (x) \tan \theta_o + \left( y_i - y + \frac{a_y x^2}{2v_0^2} \right) = 0$$

$$\left( \frac{(-10)12^2}{2(16^2)} \right) \tan^2 \theta_o + (12) \tan \theta_o + \left( 2.5 - 6 + \frac{(-10)12^2}{2(16^2)} \right) = 0$$

$$(-2.8125) \tan^2 \theta_o + (12) \tan \theta_o + (-6.0125) = 0$$

$$\tan \theta_o = \frac{-12 \pm \sqrt{12^2 - 4(-2.8125)(-6.0125)}}{2(-2.8125)} = \frac{3.687}{0.580}$$

$$\theta_{o1} = \arctan(0.580) = 30.1^\circ$$

$$\theta_{o2} = \arctan(3.687) = 74.8^\circ$$