

Nasty Ned kicks a ball at $\vec{v} = 25 \text{ m/s}$ at 28° onto the roof of the gym building, which is $H = 3 \text{ m}$ above playground.

a) find time in air

$$y_f = y_i + v_y t + \frac{1}{2} a_y t^2$$

Here $y_f = H = 3 \text{ m}$

$$y_i = 0$$

$$v_y = v \sin \theta = 11.74 \text{ m/s}$$

$$a_y = -9.8 \frac{\text{m}}{\text{s}^2} = -g$$

$$\rightarrow 0 = -H + v_y t - \frac{1}{2} g t^2$$

Quadratic eqn.

$$t = \frac{-v_y \pm \sqrt{v_y^2 - 2gH}}{-g}$$

Plug in

$$t = \left\{ \frac{-11.74 \frac{\text{m}}{\text{s}} \pm 8.89 \frac{\text{m}}{\text{s}}}{-9.8 \frac{\text{m}}{\text{s}^2}} \right\} = \left\{ \begin{array}{l} 2.10 \text{ s} \\ 0.29 \text{ s} \end{array} \right.$$

So ball lands on roof at

$$t = 2.10 \text{ s}$$

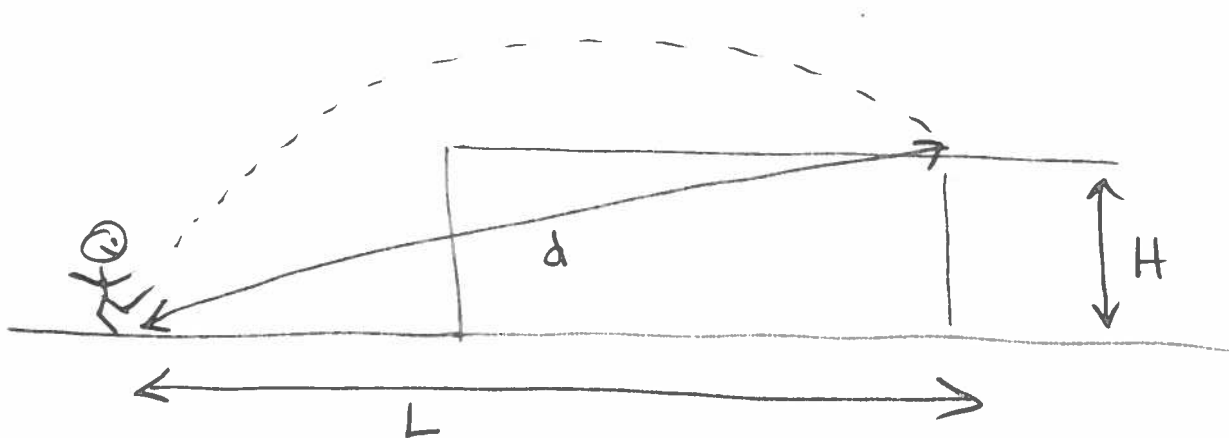
b) Velocity of ball just before it lands on roof is

$$v_x = v \cos \theta = 22.07 \text{ m/s} \quad \text{constant}$$

$$v_y = v \sin \theta - gt = -8.85 \text{ m/s}$$

$$\vec{v}_{\text{final}} = \left(22.07 \frac{\text{m}}{\text{s}}, -8.85 \frac{\text{m}}{\text{s}} \right)$$

$$= 23.78 \text{ m/s} \text{ @ } 21.8^\circ \text{ below horiz}$$



$$L = v_x t = 46.3 \text{ m}$$

$$H = 3 \text{ m}$$

$$d = \sqrt{L^2 + H^2} = 46.4 \text{ m} \quad \text{distance}$$

$$\vec{d} = (46.3 \text{ m}, 3 \text{ m}) \quad \text{displacement}$$