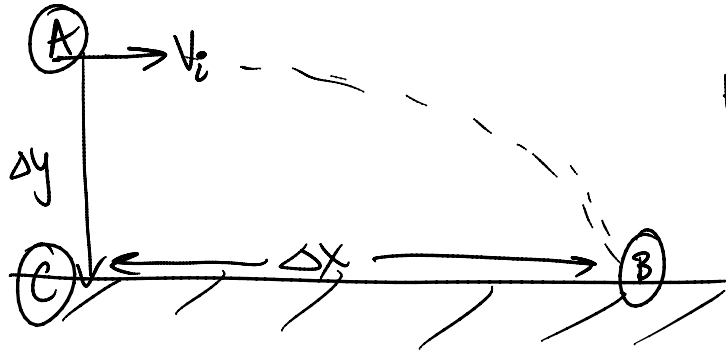


1. The fastest recorded pitch in Major League Baseball, thrown by Nolan Ryan in 1974, was clocked at 162.3 km/h (100.8 mi/h). If a pitch were thrown horizontally with this velocity, how far would the ball fall vertically by the time it reached home plate, 18.3 m (60.0 ft) away?



Given
Horizontal projectile, so
 $V_{y,i} = 0$
 $V_{x,i} = v_i = 162.3 \text{ km/h}$
 $a = 9.81 \text{ m/s}^2$
looking for Δy
 $\Delta x = 18.3 \text{ m}$

① Dimensional Analysis $\frac{\text{km}}{\text{h}} \rightarrow \frac{\text{m}}{\text{s}}$

$$\frac{162.3 \text{ km}}{\text{h}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ h}}{60 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ s}} = 45.08 \text{ m/s}$$

$$\boxed{v_i = 45.08 \text{ m/s} = v_x}$$

② $\Delta x = v_x \Delta t$

$$\Delta t = \frac{\Delta x}{v_x} = \frac{18.3}{45.08} = .406 \text{ s}$$

(time that it takes for the ball to go from the pitcher to home plate, Also the free fall time)

③ Do a free fall equation, using Δt

$$v_{i,y} = 0$$

$$\Delta t = .405 \text{ s}$$

$$a = 9.81$$

~~$v_{f,y}$~~
 $\Delta y =$

Δy
 v_i
 v_x
 a
 Δt

no v_f

$$\Delta y = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$$

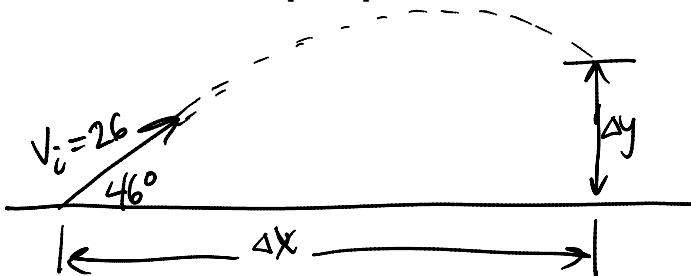
$$\Delta y = \frac{1}{2} a (\Delta t)^2$$

$$= \frac{1}{2} (9.81) (.405)^2$$

$$\boxed{\Delta y = .809 \text{ m}}$$

WA 15 (415927)

1. A daredevil is shot out of a cannon at 46.0° to the horizontal with an initial speed of 26.0 m/s . A net is positioned a horizontal distance of 50.0 m from the cannon. At what height above the cannon should the net be placed in order to catch the daredevil? $[14.2] \text{ m}$



Handwritten notes for problem 1:

$$\Delta x = 50 \quad \Delta y = ?$$

$$v_{ix} = \quad v_{iy} =$$

$$v_{fx} = \quad v_{fy} =$$

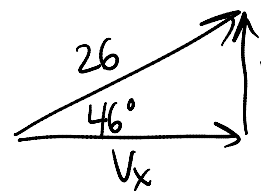
$$a = \quad a =$$

$$\Delta t = \quad \Delta t =$$

1) find time in air

$$\Delta x = v_x \Delta t$$

$$\frac{\Delta x}{v_x} = \Delta t$$

$$\frac{50}{18.06} = \Delta t = 2.769 \text{ s}$$


$$v_x = 18.06$$

$$v_y = 18.70$$

2) Find Δy

$$\Delta y = v_{iy} \Delta t + \frac{1}{2} a \Delta t^2$$

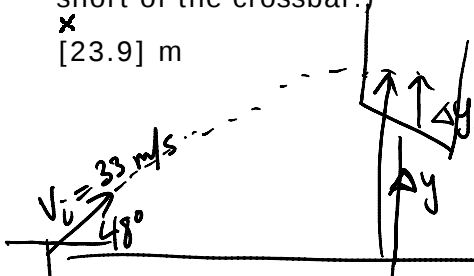
$$\Delta y = (18.7)(2.769) + \frac{1}{2} (-9.81)(2.769)^2$$

$$\Delta y = 14.2 \text{ m}$$

2. A place kicker must kick a football from a point 36.0 m (about 40.0 yd) from the goal, and the ball must clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 33.0 m/s at an angle of 48° to the horizontal.

(a) By how much does the ball clear or fall short of the crossbar? (Give a positive answer if the ball clears the crossbar, or a negative answer if it falls short of the crossbar.)

x
 $[23.9] \text{ m}$



Handwritten notes for problem 2:

looking for $\Delta y_a = \Delta y - \Delta y_{\text{crossbar}}$

$$\Delta x = 36 \text{ m} \quad \Delta y = ?$$

$$v_{ix} = 22.08 \quad v_{iy} =$$

$$v_{fx} = 22.08 \quad v_{fy} =$$



Find time

$$\Delta x = V_x \Delta t$$

$$\frac{\Delta x}{V_x} = \Delta t$$

$$\frac{36}{22.08} = 1.63 \text{ s} = \Delta t$$



Find Δy

$$\Delta y = V_{iy} \Delta t + \frac{1}{2} a \Delta t^2$$

$$\Delta y = (24.52)(1.63) + \frac{1}{2}(-9.81)(1.63)^2$$

$$\Delta y = 26.97$$

Find clearance

$$\Delta y_a = \Delta y - \Delta y_{\text{crossbar}}$$

$$\Delta y_a = 26.97 - 3.05$$

$$\Delta y_a = 23.9 \text{ m}$$

(b) Does the ball approach the crossbar while still rising or while falling?
(Type 'rising' or 'falling', or 'neither' if it falls short of the crossbar.)

x
[rising] is $V_{f,y}$ pos or neg?

$$V_{f,y} = (V_i \sin \theta) - g \Delta t$$

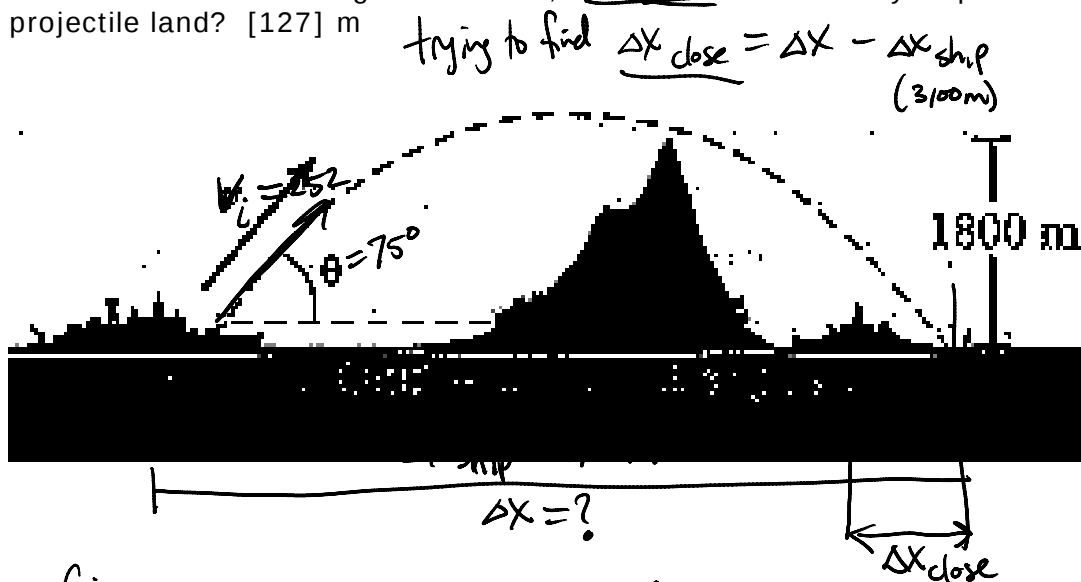
$$= 33 \sin 48 - (9.81)(1.63)$$

$$V_{fy} = 8.53 \quad \text{positive} = \text{rising}$$

What is the vertical component of velocity of the ball at this time? (Assume the positive direction is upward.)

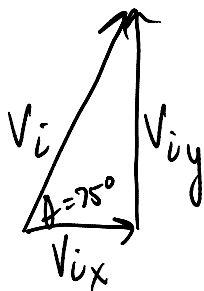
x
[8.53] m/s

3. A ship maneuvers to within 2500 m of an island's 1800 m high mountain peak and fires a projectile at an enemy ship 610 m on the other side of the peak, as illustrated in Figure 3-29. If the ship shoots the projectile with an initial velocity of $v = 252$ m/s at an angle of $\theta = 75^\circ$, how close to the enemy ship does the projectile land? [127] m



Given

$$\begin{array}{ll} \Delta x = ? & \Delta y = 0 \\ v_{ix} = 65.22 & v_{iy} = 243.4 \\ v_{fx} = & v_{fy} = \\ a = 0 & a = -9.81 \\ \Delta t = & \Delta t = \end{array}$$



$$\begin{array}{l} v_{ix} = v_i \cos \theta \\ v_{ix} = 65.22 \\ v_{iy} = v_i \sin \theta \\ v_{iy} = 243.41 \end{array}$$

find time

$$\begin{array}{l} \Delta y = v_{iy} \Delta t + \frac{1}{2} a \Delta t^2 \\ 0 = v_{iy} \Delta t + \frac{1}{2} a \Delta t^2 \\ -v_{iy} \Delta t = \frac{1}{2} a \Delta t^2 \\ -\frac{2 v_{iy}}{a} = \Delta t = 49.625 \end{array}$$

find Δx

$$\begin{array}{l} \Delta x = v_x \Delta t \\ \Delta x = (65.22)(49.625) \\ \Delta x = 3236 \text{ m} \end{array}$$

find Δx_{close}

find Δx_{close}

$$\Delta x_{\text{close}} = \Delta x - \Delta x_{\text{ship}}$$
$$= 3236 - 3100$$

$$\Delta x_{\text{close}} = 136 \text{ m}$$

How close (vertically) does the projectile come to the peak? [324] m

$$\Delta y_{\text{close}} = \Delta y - \Delta y_{\text{mountain}}$$

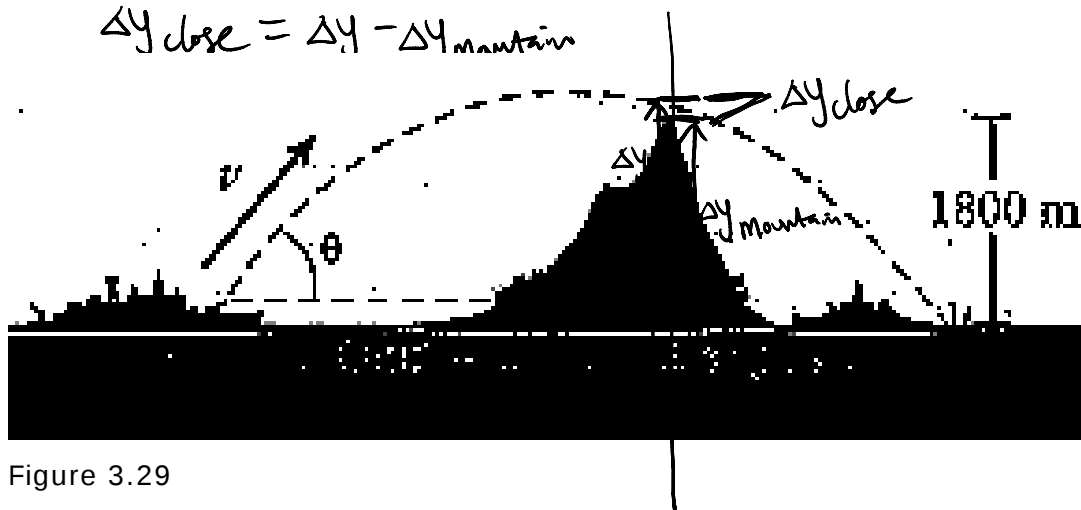


Figure 3.29

find Δt

$$\Delta x = v_x \Delta t$$

$$\frac{\Delta x}{v_x} = \Delta t$$

$$\frac{2500}{65.22} = \Delta t$$

$$38.33 \text{ s} = \Delta t$$

find Δy

$$\Delta y = v_{iy} \Delta t + \frac{1}{2} a \Delta t^2$$

$$\Delta y = (243.21)(38.33) + \frac{1}{2}(-9.81)(38.33)^2$$

$$\Delta y = 2116 \text{ m}$$

find Δy_{close}

$$\Delta y_{\text{close}} = \Delta y - \Delta y_{\text{mountain}}$$
$$= 2116 - 1800$$