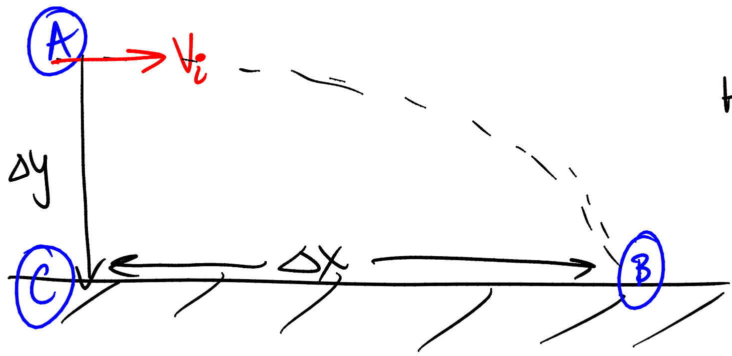
1. The fastest recorded pitch in Major League Baseball, thrown by Nolan Ryan in 1974, was clocked at 162.3 km/h (100.8 mi/h). If a pitch were thrown horizontally with this velocity, how far would the ball fall vertically by the time it reached home plate, 18.3 m (60.0 ft) away?



Given

Horizontal projectile, so

$V_{y,i} = 0$

$V_{x,i} = V_i = 162.3\ km/h$

$a = 9.81\ m/s^2$

looking for Δy

$\Delta x = 18.3\ m$

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

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

$$\boxed{V_i = 45.08\ m/s = V_x}$$

② $\Delta x = V_x \Delta t$

$$\Delta t = \frac{\Delta x}{V_x} = \frac{18.3}{45.08} = \boxed{.406\ s}$$

(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

$V_{i,y} = 0$

$\Delta t = .405\ s$

$a = 9.81$

~~$V_{f,y}$~~

$\Delta y =$

Δy
V_i
V_x
a
Δt

no V_f

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

0

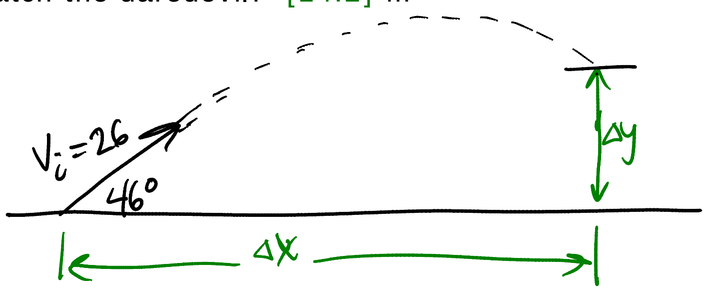
$$\Delta y = \frac{1}{2}a(\Delta t)^2$$

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

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

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] m



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

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

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

$a =$ $\quad$ $a =$

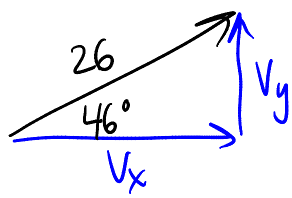
Δt ═══ $\Delta t =$

1) find time in air

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

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

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



$V_x = 18.06$

$V_y = 18.70$

2) Find Δy

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

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

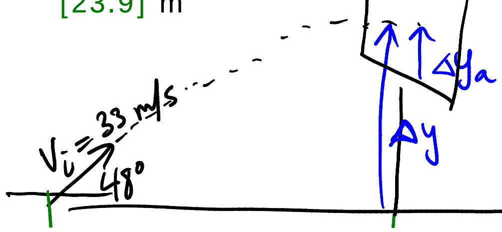
$$\boxed{\Delta y = 14.2\ m}$$

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.)

✗ [23.9] m

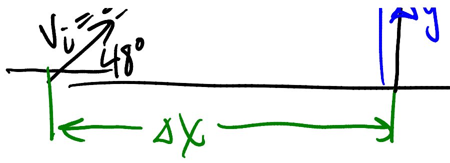
Looking for $\Delta y_a = \Delta y - \Delta y_{crossbar}$



$\Delta x = 36$ m $\quad$ $\Delta y = ?$

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

$V_{fx} = 22.08$ $\quad$ $V_f =$



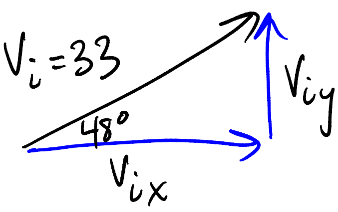
$V_{ix} = 22.08$ $\quad V_{iy} =$
$V_{fx} = 22.08$ $\quad V_{fy} =$
$a = 0$ $\quad a = -9.81$
$\Delta t = \Delta t =$

Find time

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

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

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



$V_{ix} = 22.08$
$V_{iy} = 24.52$

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

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

$$\Delta y_a = 26.97 - 3.05$$

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

(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.)
✗
[rising]

is $V_{f,y}$ pos or neg?

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

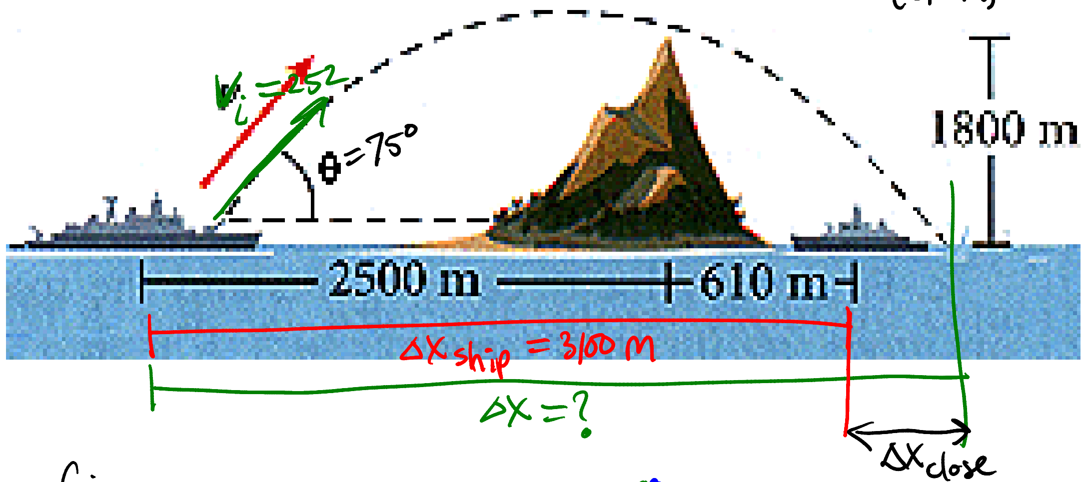
$$= 33 \sin 48 - (9.81)(1.63)$$

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

What is the vertical component of velocity of the ball at this time? (Assume the positive direction is upward.)
✗
[8.53] m/s

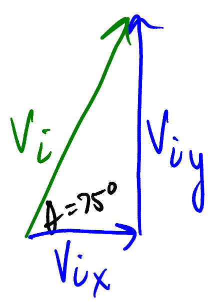
3. A ship maneuvers to within 2500 m of an island's 1800 m high mountain peak and fires a projectile at an enemy ship 610 m on the other side of the peak, as illustrated in Figure 3-29. If the ship shoots the projectile with an initial velocity of v = 252 m/s at an angle of θ = 75°, how close to the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

trying to find $\Delta x_{close} = \Delta x - \Delta x_{ship}$ (3100 m)



Given

$\Delta x = ?$	$\Delta y = 0$
$V_{ix} = 65.22$	$V_{iy} = 243.4$
$V_{fx} =$	$V_{fy} =$
$a = 0$	$a = -9.81$
$\Delta t =$	$\Delta t =$



$V_{ix} = V_i \cos\theta$

$V_{ix} = 65.22$

$V_{iy} = V_i \sin\theta$

$V_{iy} = 243.41$

find time

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

$$0 = V_{iy}\Delta t + \frac{1}{2}a\Delta t^2$$

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

$$-\frac{2V_{iy}}{a} = \boxed{\Delta t = 49.625}$$

find Δx

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

$$\Delta x = (65.22)(49.625)$$

$$\boxed{\Delta x = 3236 \text{ m}}$$

find Δx_{close}

find Δx_{close}

$$\Delta x_{close} = \Delta x - \Delta x_{ship}$$
$$= 3236 - 3100$$
$$\boxed{\Delta x_{close} = 136 \text{ m}}$$

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

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

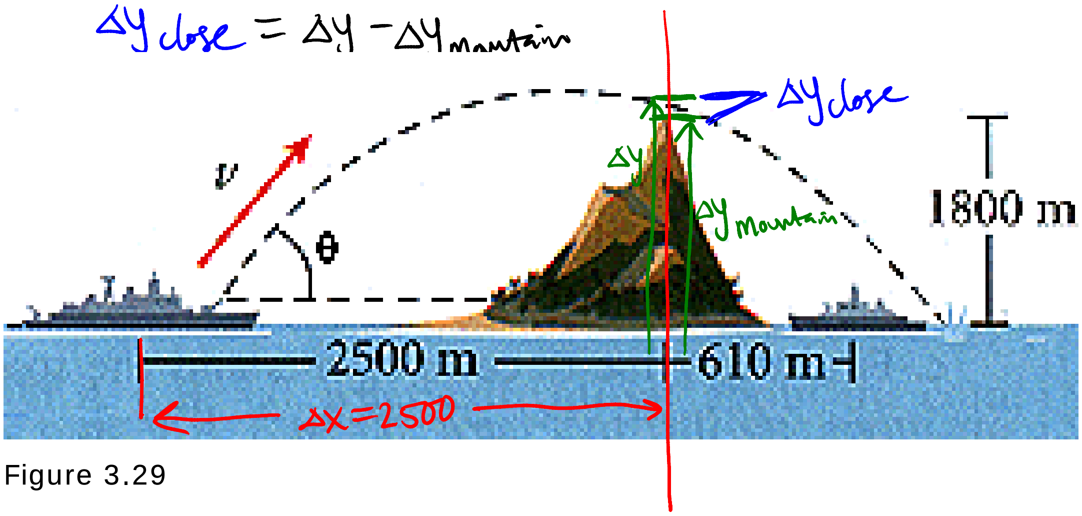


Figure 3.29

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

$$\Delta y = V_{iy}\Delta t + \frac{1}{2} a \Delta t^2$$
$$\Delta y = (243.21)(38.33) + \frac{1}{2}(-9.81)(38.33)^2$$
$$\boxed{\Delta y = 2116 \text{ m}}$$

find Δy_{close}

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