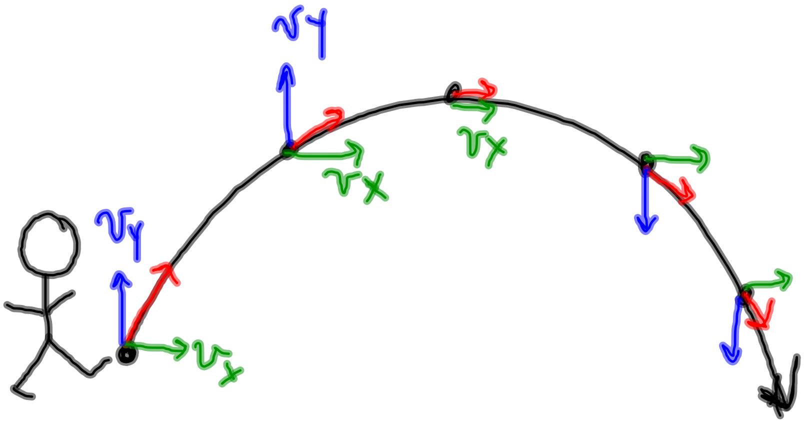
Projectile Motion



v_x = horizontal velocity

v_y = vertical velocity

* v_x is constant!
It does NOT change.

* v_y will change during flight.

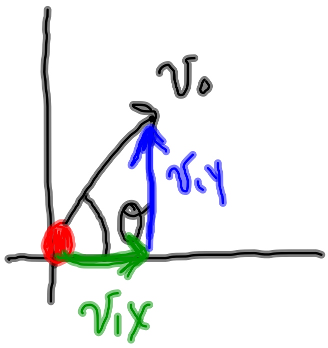
initial resultant velocity

$$v_{ix} = \boxed{v_0} \cos\theta$$

$$v_{fx} = v_{ix}$$

True b/c v_x is constant!

$$\Delta x = v_{ix} \Delta t$$



$$v_{iy} = v_0 \sin\theta$$

$$v_{fy} = v_{iy} + a_y \Delta t$$

$$\Delta y = \left(\frac{v_{iy} + v_{fy}}{2}\right)\Delta t$$

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

$$\Delta y = v_{iy}\Delta t - \frac{1}{2} a_y \Delta t^2$$

$$v_{fy}^2 = v_{iy}^2 + 2a_y \Delta y$$

A ball is kicked with a speed of 15 m/s at an angle of 30° above the horizontal.

v_0 θ

a) Find the x and y coordinates at t = 1.5 s

Δx	v_{ix}	t	Δy	v_{iy}	v_{fy}	a_y	Δt
?	$v_0 \cos\theta$ $15\cos 30$ $\boxed{13\,m/s}$	1.5 s	?	$v_0 \sin\theta$ $15\sin 30$ $\boxed{7.5\,m/s}$		$-9.81\ m/s^2$	1.5 s

$\Delta x)$

$$\Delta x = v_{ix}\Delta t$$
$$= 13\,m/s\,(1.5\,s)$$

$$\boxed{\Delta x = 19.5\,m}$$

$\Delta y)$

$$\Delta y = v_{iy}\Delta t + \frac{1}{2}a_y\Delta t^2$$
$$= (7.5)(1.5) + \frac{1}{2}(-9.81)(1.5)^2$$

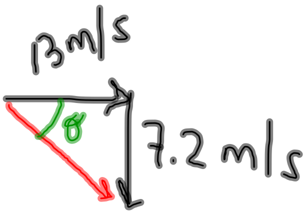
$$\boxed{\Delta y = 0.225\,m}$$

b) Find the speed of the ball @ 1.5s

** We first must find v_{fx} and v_{fy}**

$$v_{fx} = v_{ix} = 13 \text{ m/s}$$

$$v_{fy} = v_{iy} + a_y \Delta t$$
$$= 7.5 + (-9.81)(1.5)$$
$$= -7.2 \text{ m/s}$$



$$v = \sqrt{v_{fx}^2 + v_{fy}^2}$$
$$= \sqrt{13^2 + (-7.2)^2}$$
$$\boxed{v = 14.86 \text{ m/s}}$$

c) Find the direction of the motion @ 1.5 s

$$\theta = \tan^{-1}\left(\frac{opp}{adj}\right)$$
$$= \tan^{-1}\left(\frac{-7.2}{13}\right)$$

$\boxed{\theta = 29^\circ \text{ below the horizontal}}$