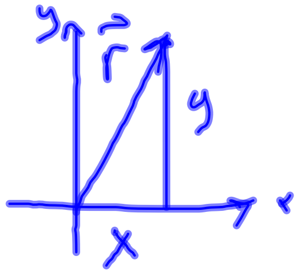
Velocity & Acceleration as Vectors

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

$\vec{r}$



$$\vec{V} = \frac{\Delta \vec{r}}{\Delta t} = \frac{\Delta x}{\Delta t}\hat{e}_x + \frac{\Delta y}{\Delta t}\hat{e}_y \qquad \vec{r} = x\hat{e}_x + y\hat{e}_y$$

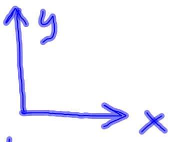
$$= V_x\hat{e}_x + V_y\hat{e}_y$$

similarly

$$\vec{a} = \frac{\Delta \vec{V}}{\Delta t} = a_x\hat{e}_x + a_y\hat{e}_y$$

Projectile Motion

horizontal motion is independent of verticle motion



$V_x = V_{x_0} + a_x t \rightarrow V_{x_0}$

$V_y = V_{y_0} + a_y t \rightarrow V_{y_0} - gt$

$x = x_0 + V_{x_0} t + \frac{1}{2} a_x t^2$

$y = y_0 + V_{y_0} t + \frac{1}{2} a_y t^2$

$\rightarrow x = x_0 + V_{x_0} t$

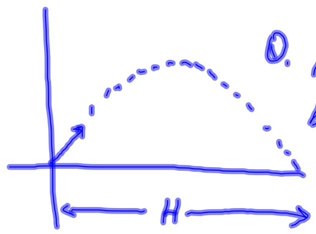
$y = y_0 + V_{y_0} t - \frac{1}{2} g t^2$

$\vec{a} \nearrow$

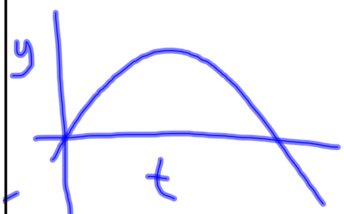
$\vec{a} = -g\hat{e}_y$

$a_x = 0$

$a_y = -g$



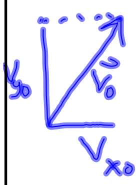
Q. How far does cannon ball travel horizontally? [what is H?]



$0 = V_{y_0} t - \frac{1}{2} g t^2$

$y_0 = 0$

$0 = V_{y_0} - \frac{1}{2} g t$



$\frac{2V_{y_0}}{g} = t_{impact}$

$H = V_{x_0} t_{impact}$

$= V_{x_0}\left(\frac{2V_{y_0}}{g}\right) = \frac{2V_{x_0}V_{y_0}}{g}$

$\frac{\left(\frac{m}{s}\right)^2}{m/s^2} = m$ ✓ correct units

Sep 4-2:50 PM

3rd Kinematic equation
Derive from 1st 2.

$$x = x_0 + v_0 t + \frac{1}{2} a t^2$$
$$v = v_0 + a t$$

$$v^2 - v_0^2 = 2a(x - x_0)$$

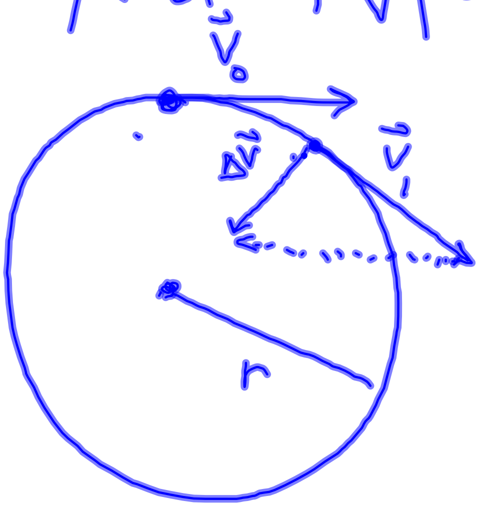
want	know
x	t
v	t
v	x

Uniform Circular Motion

object moves in circle at constant speed.

Constant speed is <u>NOT</u> the same as constant velocity.

speed $= |\vec{v}|$ = magnitude of velocity vector



$$\vec{v}_1 - \vec{v}_0 = \Delta\vec{v}$$

$$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$$

In uniform circular motion acceleration vector points toward center of circle.

$$|\vec{a}| = \frac{v^2}{r} \quad v = |\vec{v}| = |\vec{v}_0| = |\vec{v}_1|$$