Tues: Discussion / quiz

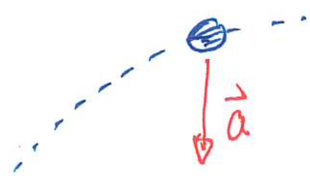
Ex: 92, 97, 99, 101, 107, 110, 111, 113

Projectile motion

Projectile motion is that where the object moves only under the influence of Earth's gravity. For a projectile the acceleration is constant and

$$a_x = 0\ m/s^2$$

$$a_y = -g = -9.80\ m/s^2$$



The fact that the vertical and horizontal components of acceleration are constant means that the vertical and horizontal components of the motion are independent. The kinematic equations reflect this

Demo: Ball vertical versus horizontal

Demo: Video – U Iowa Slo mo video

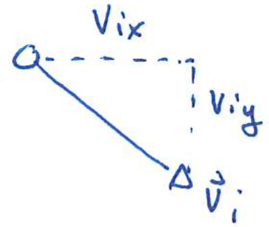
Another fact is that the horizontal component of velocity is constant. This follows from

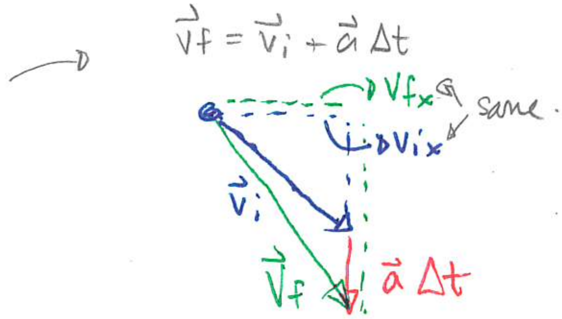
$$\vec{v}_f = \vec{v}_i + \vec{a}\,\Delta t \Rightarrow v_{fx} = v_{ix} + \cancel{a_x \Delta t} \Rightarrow v_{fx} = v_{ix}$$

~~Quiz!~~ Warm Up!

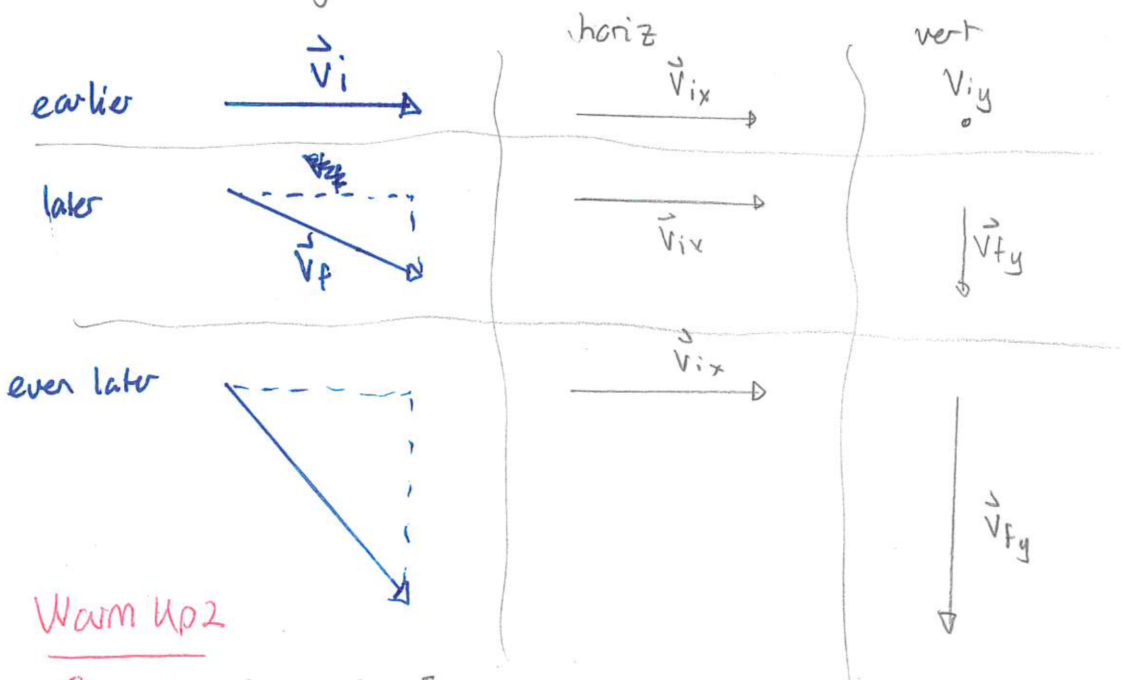
Demo: Cart and ball launcher

We can see the fact that the horizontal component is constant graphically





Consider an object launched horizontally

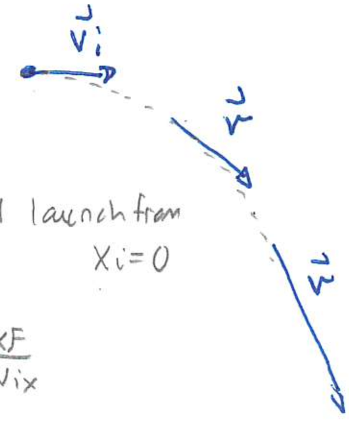


Warm Up 2

Quiz 2 80% → 80% } 50% − 20%

Quiz 3 90% } 80%

The trajectory will have to be curved since the velocity vector angles more and more steeply. The trajectory is exactly a parabola. Consider a horizontal launch from $X_i = 0$



$$X_f = \cancel{X_i} + V_{ix}\Delta t + \tfrac{1}{2}\cancel{a_x}\Delta t^2 \Rightarrow X_f = V_{ix}\Delta t$$

$$\Rightarrow \Delta t = \frac{X_F}{V_{ix}}$$

$$y_f = y_i + \cancel{V_{iy}\Delta t} + \tfrac{1}{2}a_y\Delta t^2$$

$$y_f = y_i + \tfrac{1}{2}(-g)\left(\frac{X_F}{V_{ix}}\right)^2 \Rightarrow y_f = X_f^2\left(\frac{-g}{2V_{ix}^2}\right) + y_i$$

$$\Rightarrow y = x^2(\text{const}) + \text{const} \Rightarrow \text{parabola}$$

For projectile motion

$V_{fx} = V_{ix} + a_x \Delta t$

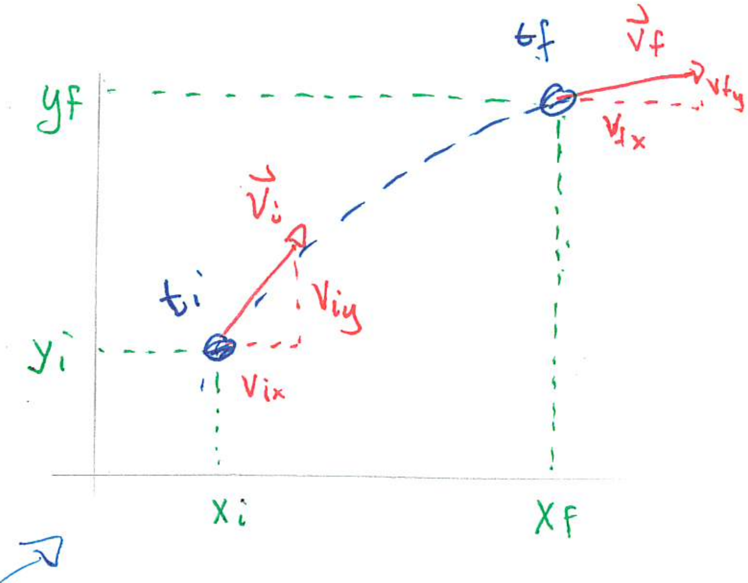
$X_f = X_i + V_{ix} \Delta t + \frac{1}{2} a_x \Delta t^2$

$V_{fx}^2 = V_{ix}^2 + 2a_x(X_f - X_i)$

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

$y_f = y_i + V_{iy} \Delta t + \frac{1}{2} a_y \Delta t^2$

$V_{fy}^2 = V_{iy}^2 + 2a_y(y_f - y_i)$



Demo: PhET projectile