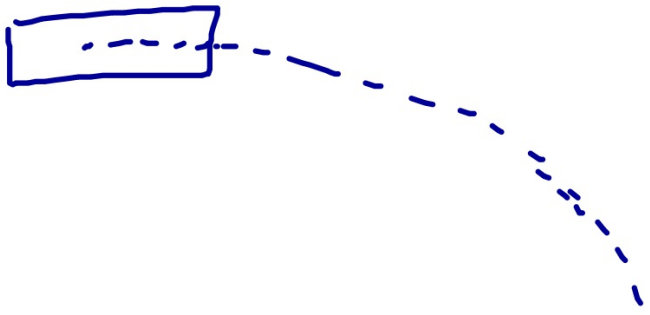
Bellwork 4/11

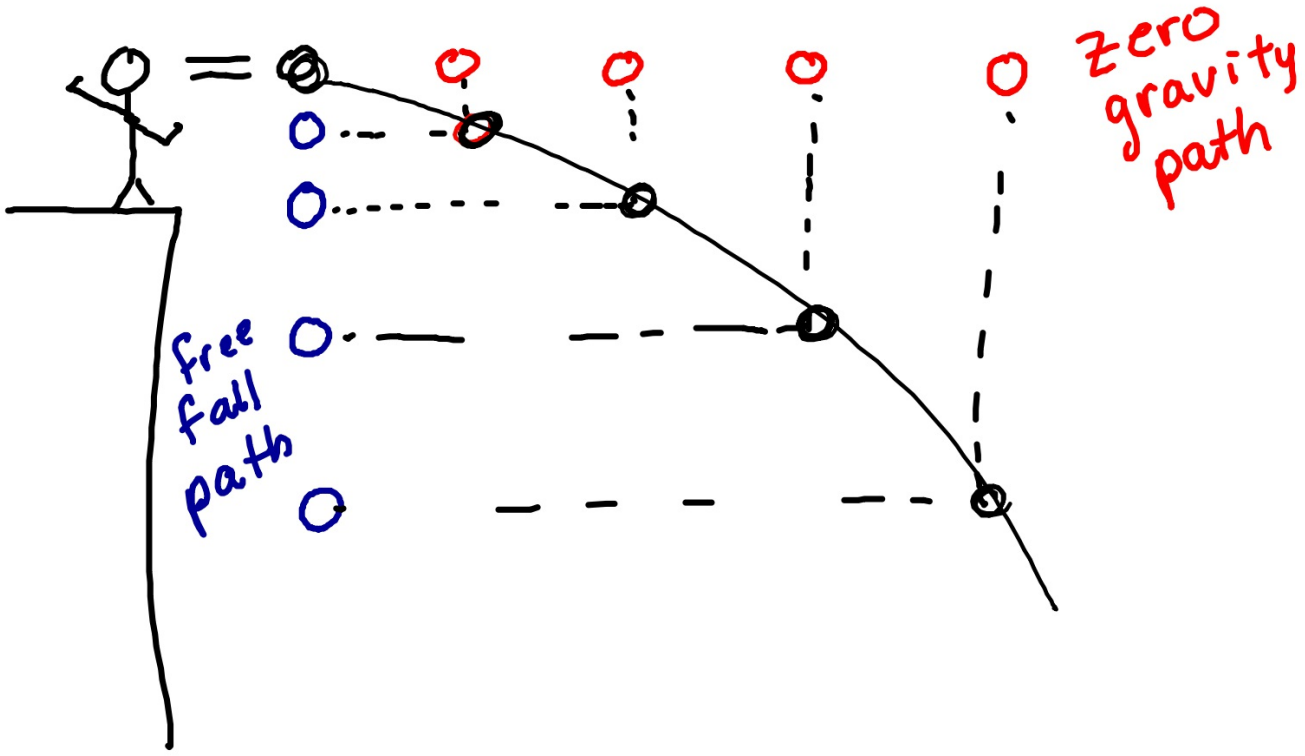
Suppose you drop your notebook out the window of a moving car. Describe its trajectory

Parabola



Projectile Motion

- An object flying thru a vacuum.
  - Only force acting on it gravity (ignore air resistance)
  - Parabolic Trajectory


zero gravity path
free fall path

When solving Problems, separate the x and y direction variables:

x = horizontal

y = vertical

x-direction

$a_x = 0 \frac{m}{s^2}$

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

(need to know 2 of 3 variables)

V_x does not change

y-direction

$a_y = -9.8 \frac{m}{s^2} = -g$

$\Delta \vec{y} = \vec{V}_{iy} \Delta t + \frac{a_y \Delta t^2}{2}$

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

$V_{fy}^2 = V_{iy}^2 + 2 a_y (\Delta y)$

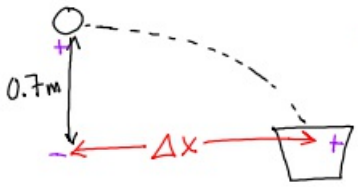
$a_y = \frac{V_{fy} - V_{iy}}{\Delta t}$

If you know 3 variables, you can find the other 2

Δt is the same in x or y direction because it is a scalar.

Example 1) A car is moving at 10 $\frac{mi}{hr}$ when a water balloon is dropped out the window from a height of 0.7m above a bucket. How far behind the bucket should the balloon be dropped?

$\Delta x = ?$ goal



x-direction

$\Delta \vec{x} = ?$

$\vec{V}_x = 10 \frac{mi}{hr} \times \frac{1\ hr}{3600 s} \times \frac{1609 m}{1\ mi} = 4.47 \frac{m}{s}$

$\Delta t = 0.38 s$ $\quad V_x = \frac{\Delta \vec{x}}{\Delta t}$

y direction $\quad 4.47 \frac{m}{s} = \frac{\Delta \vec{x}}{0.38 s}$

$\Delta \vec{x} = 1.7 m$

$\Delta \vec{y} = -0.7 m$

$\vec{V}_{iy} = 0 \frac{m}{s}$

$\vec{V}_{fy} =$ NOT ZERO (unknown)

$\vec{a}_y = -9.8 \frac{m}{s^2}$

$\Delta t =$ Find Δt

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

$-0.7 m = (0) \Delta t + \frac{1}{2} (-9.8 \frac{m}{s^2}) \Delta t^2$

$2(-0.7 m) = (\frac{1}{2} (-9.8 \frac{m}{s^2}) \Delta t^2) 2$

$\frac{2(-0.7 m)}{-9.8 \frac{m}{s^2}} = \frac{(-9.8 \frac{m}{s^2}) \Delta t^2}{-9.8 \frac{m}{s^2}}$

$\sqrt{\frac{2(-0.7 m)}{-9.8 \frac{m}{s^2}}} = \sqrt{\Delta t^2}$

$0.38 s = \Delta t$