<u>Unit 3: Kinematics in 2D</u>

3 - Projectile Motion Types 1 and 2

Remember that the x and y-components are perpendicular and therefore totally independent.

<u>X-components</u>

There is no net force working on the projectile in the X and the acceleration is always zero. Therefore the only equation we can ever use is:

$$V_x = \frac{d_x}{t}$$

<u>Y-components</u>

In this case there is always a constant acceleration of $-9.8\ m/s^2$ (downwards). Because of this we need to use the Big Three!.

The only value that can ever be used on both sides is time because it is a scalar.

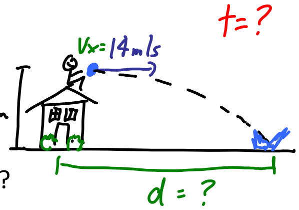
<u>Problem Type 1:</u>

A student sits on the roof of their house which is 12 m high. She can launch water-balloons from a slingshot at 14.0 m/s. If she fires a water-balloon directly horizontally:

$t = ?$

a. How long will it be airborne?

This depends on: d_y



b. How far forward will it travel?

This depends on: V_x, t

X	Y
$V_x = 14\ m/s$	$V_y =$
$d_x =$	$V_{yo} = 0$
$t = 1.565\ s$	$a_y = -9.8\ m/s^2$
	$d_y = -12\ m$
	$t = ?$

$V_x = \frac{d_x}{t}$

$d_x = V_x \cdot t$

$= (14\ m/s)(1.565\ s)$

$= \boxed{22\ m}$

$d = V_o t + \frac{1}{2}at^2$ ($V_o = 0$)

$2 \cdot d = (\frac{1}{2}at^2)2$

$\frac{2d}{a} = \frac{at^2}{a}$

$\frac{2d}{a} = t^2$

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(-12)}{-9.8}}$

$= 1.565\ s$

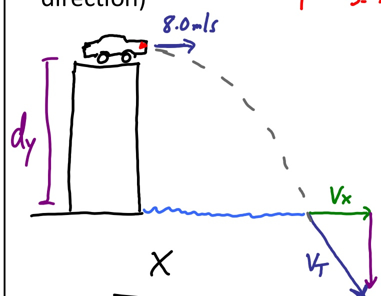
$= \boxed{1.6\ s}$

<u>Example</u>: A Cutlass Supreme drives straight out of a parking garage at 8.0 m/s and hits the water 3.4 s later.

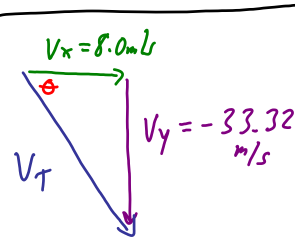
a. How far did the car fall? downwards

b. What was his **total** impact velocity? (magnitude and direction)

$t = 3.4\ s$



X	Y
$V_x = 8.0\ m/s$	$V_y =$
$d_x =$	$V_{yo} = 0\ m/s$
$t = 3.4\ s$	$a_y = -9.8\ m/s^2$
	$d_y = ? = -56.64\ m/s$
	$t = 3.4\ s$



$V_y = V_{yo} + at$ ($V_{yo} = 0$)

$= (-9.8\ m/s^2)(3.4\ s)$

$= -33.32\ m/s$

$d = V_o t + \frac{1}{2}at^2$ ($V_o = 0$)

$d = \frac{1}{2}at^2$

$= \frac{1}{2}(-9.8\ m/s^2)(3.4\ s)^2$

$= -56.64\ m$

$= \boxed{-57\ m}$

$V_T^2 = V_x^2 + V_y^2$

$V_T = \sqrt{(8.0)^2 + (-33.32)^2}$

$= 34.27\ m/s$

$\tan\theta = \frac{33.32}{8.0}$

$\theta = \tan^{-1}(\frac{33.32}{8.0})$

$= 76.499°$

34 m/s 77° below horizontal