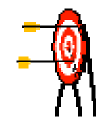
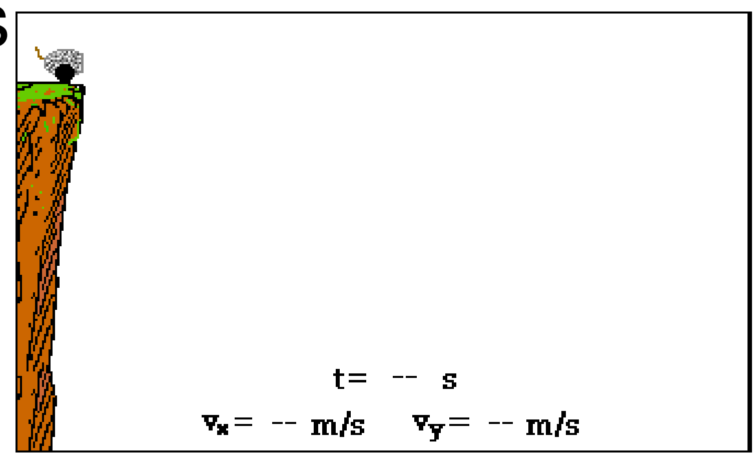
Projectile Motion

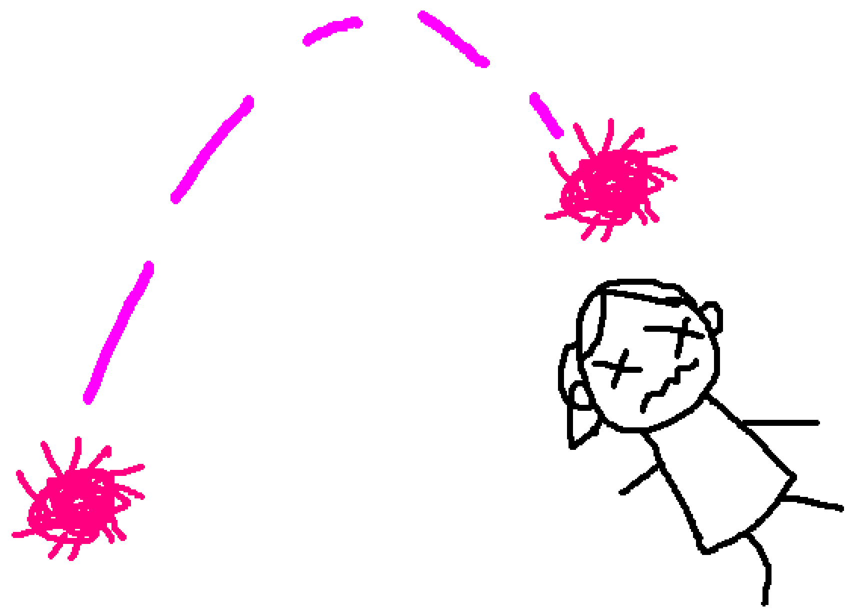


Honors Physics



What is projectile?

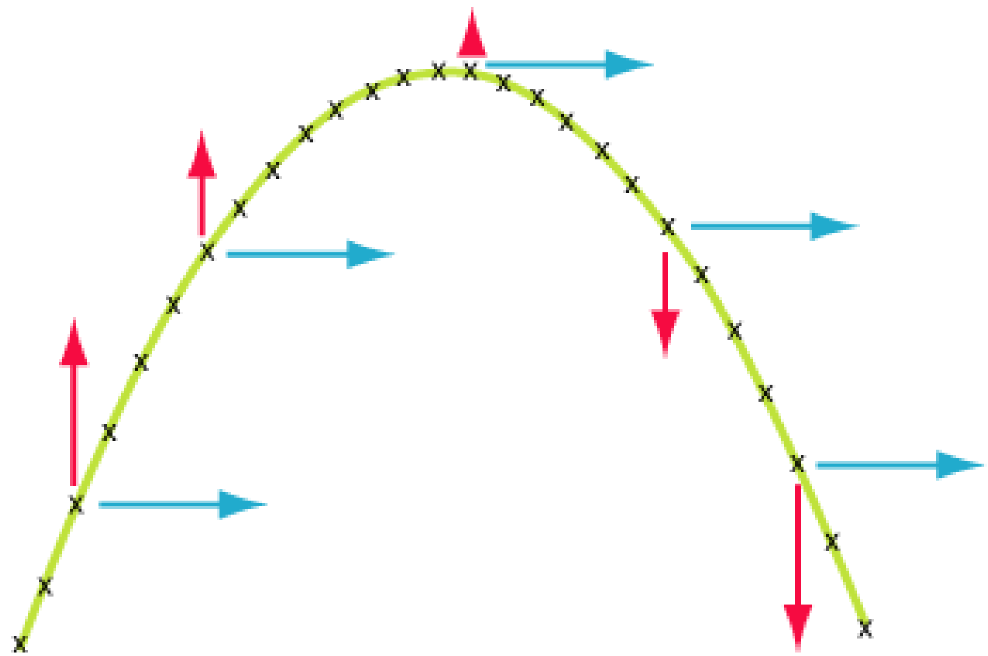
Projectile -Any object which projected by some means and continues to move due to its own inertia (mass).



Projectiles move in TWO dimensions

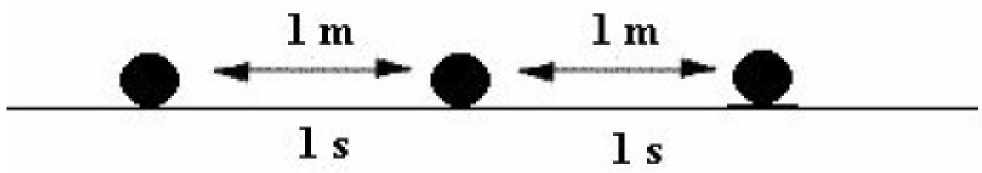
Since a projectile moves in 2-dimensions, it therefore has 2 components just like a resultant vector.

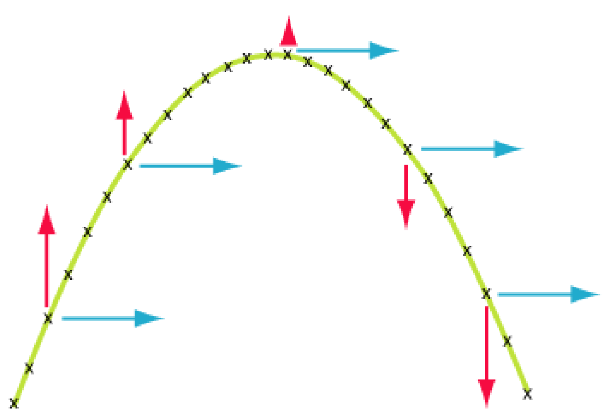
- **Horizontal and Vertical**



Horizontal "Velocity" Component

- **NEVER** changes, covers equal displacements in equal time periods. This means the initial horizontal velocity equals the final horizontal velocity



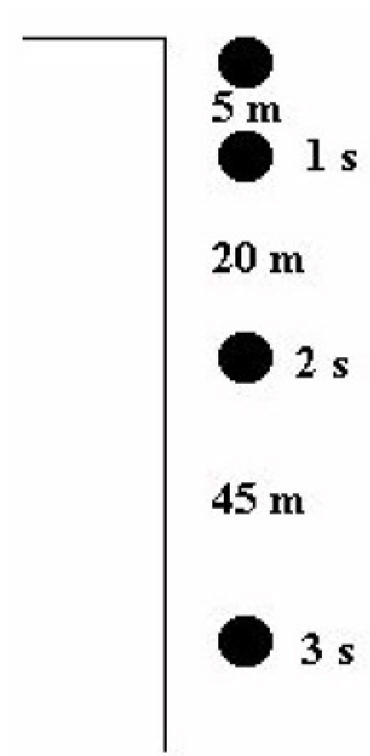


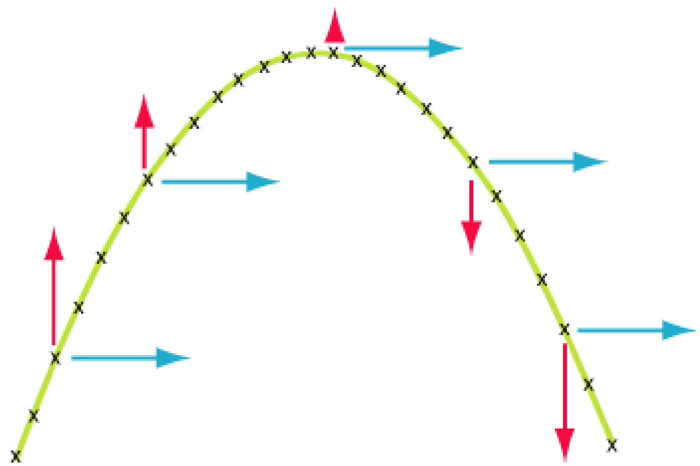
In other words, the horizontal velocity is CONSTANT. BUT WHY?

Gravity DOES NOT work horizontally to increase or decrease the velocity.

Vertical "Velocity" Component

- Changes (due to gravity), does **NOT** cover equal displacements in equal time periods.

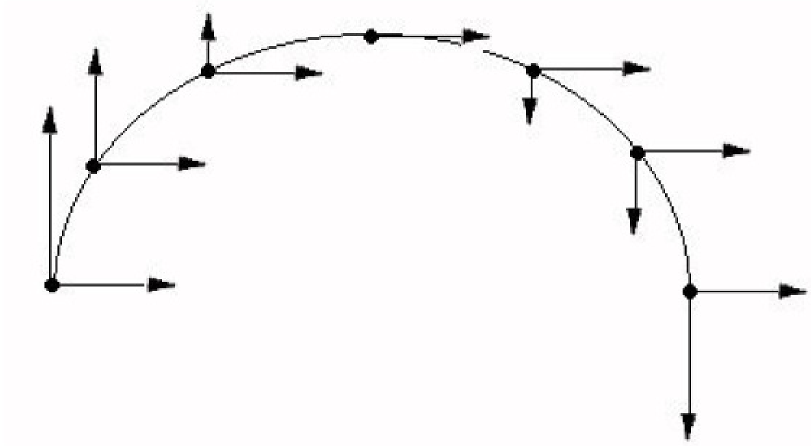




Both the MAGNITUDE and DIRECTION change. As the projectile moves up the MAGNITUDE DECREASES and its direction is UPWARD. As it moves down the MAGNITUDE INCREASES and the direction is DOWNWARD.

Combining the Components

Together, these components produce what is called a **trajectory** or path. This path is **parabolic** in nature.

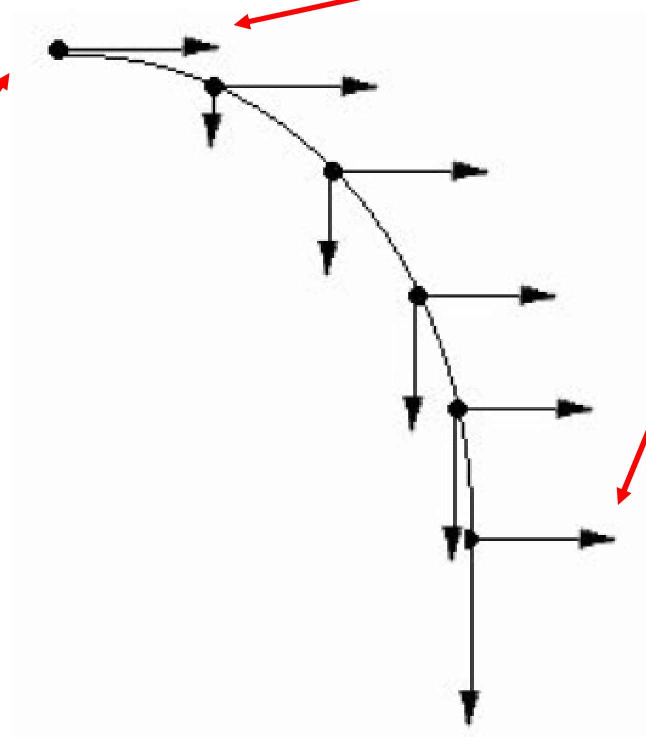


Component	Magnitude	Direction
Horizontal	Constant	Constant
Vertical	Changes	Changes

Horizontally Launched Projectiles

Projectiles which have NO upward trajectory and NO initial VERTICAL velocity.

$$v_{ox} = v_x = \text{constant}$$



$$v_{oy} = 0\, m/s$$

Horizontally Launched Projectiles

To analyze a projectile in 2 dimensions we need 2 equations. One for the "x" direction and one for the "y" direction. And for this we use kinematic #2.

$$x = v_{ox}t + \tfrac{1}{2}at^2$$

$x = v_{ox}t$	$y = \tfrac{1}{2}gt^2$

Remember, the velocity is CONSTANT horizontally, so that means the acceleration is ZERO!

Remember that since the projectile is launched horizontally, the INITIAL VERTICAL VELOCITY is equal to ZERO.

Horizontally Launched Projectiles

Example: **A plane traveling with a horizontal velocity of 100 m/s is 500 m above the ground. At some point the pilot decides to drop some supplies to designated target below. (a) How long is the drop in the air? (b) How far away from point where it was launched will it land?**

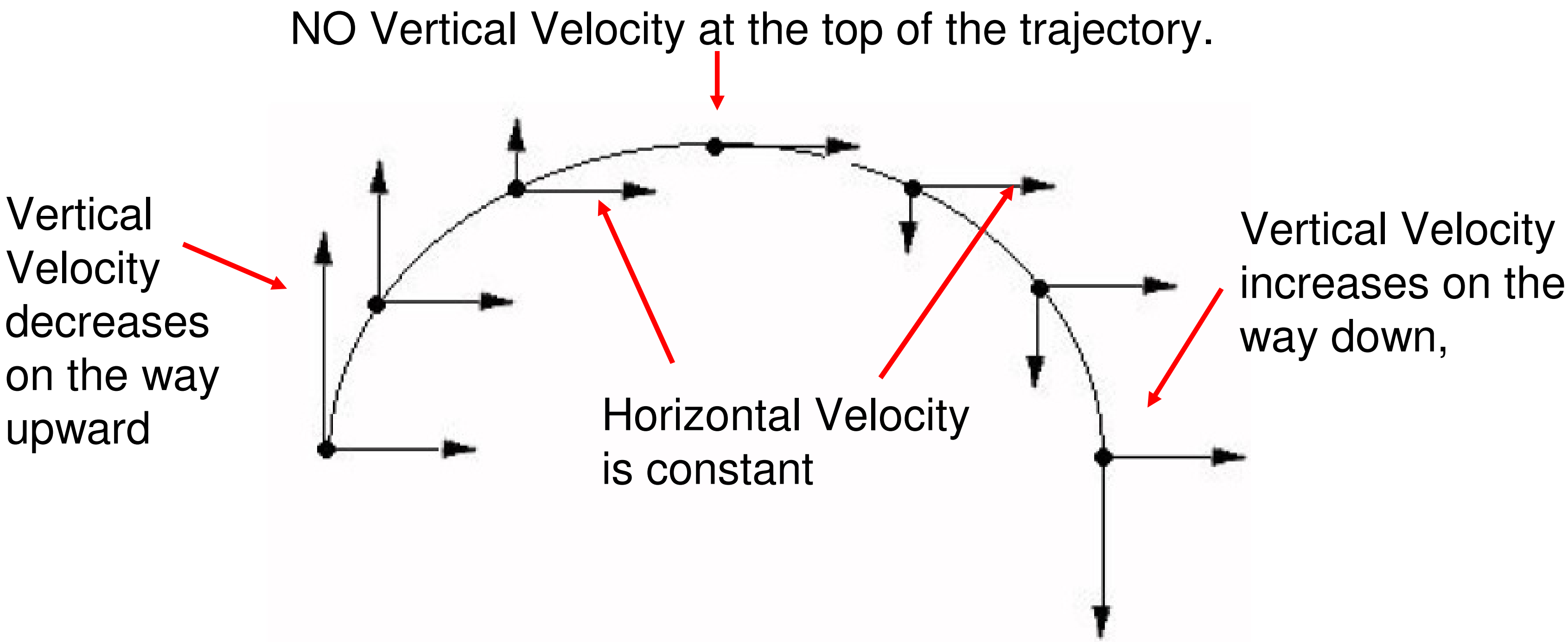
What do I know?	What I want to know?
v_{ox}=100 m/s	t = ?
y = 500 m	x = ?
v_{oy}= 0 m/s	
g = -9.8 m/s/s	

$$y = \tfrac{1}{2} g t^2 \rightarrow -500 = \tfrac{1}{2}(-9.8) t^2$$

$$102.04 = t^2 \rightarrow t = $$ **10.1 seconds**

$$x = v_{ox} t = (100)(10.1) = $$ 1010 m

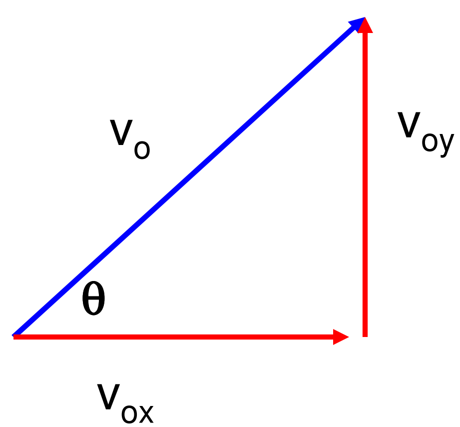
Vertically Launched Projectiles



Component	Magnitude	Direction
Horizontal	Constant	Constant
Vertical	Decreases up, 0 @ top, Increases down	Changes

Vertically Launched Projectiles

Since the projectile was launched at a angle, the velocity MUST be broken into components!!!

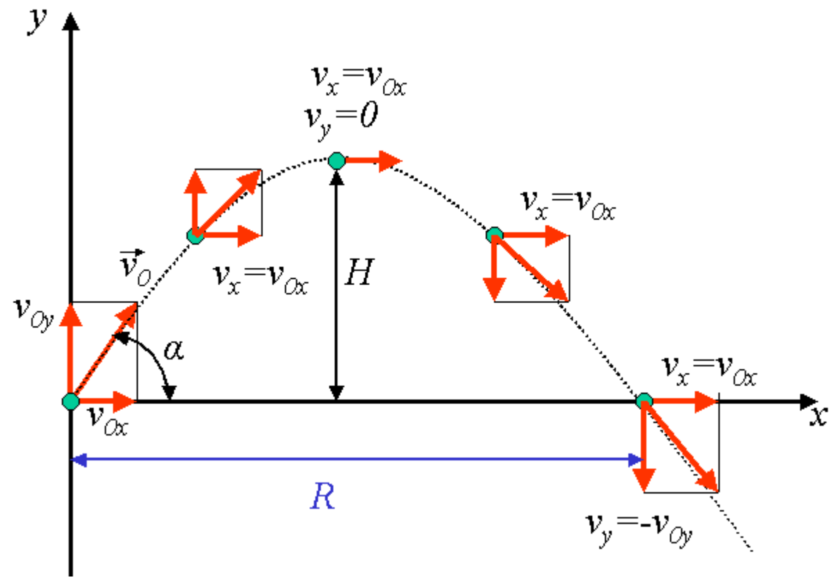


$$v_{ox} = v_o \cos\theta$$

$$v_{oy} = v_o \sin\theta$$

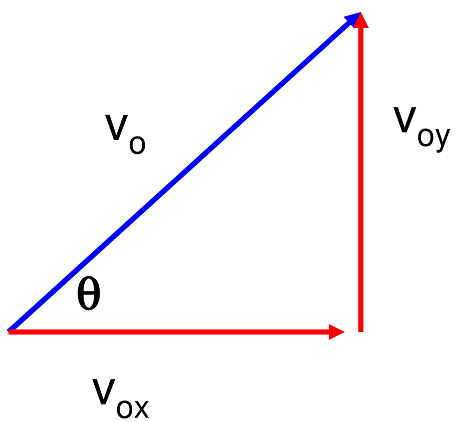
Vertically Launched Projectiles

There are several things you must consider when doing these types of projectiles besides using components. If it begins and ends at ground level, the "y" displacement is ZERO: y = 0



Vertically Launched Projectiles

You will still use kinematic #2, but YOU MUST use COMPONENTS in the equation.



$$x = v_{ox} t \qquad y = v_{oy} t + \tfrac{1}{2} g t^2$$

$$v_{ox} = v_o \cos\theta$$

$$v_{oy} = v_o \sin\theta$$

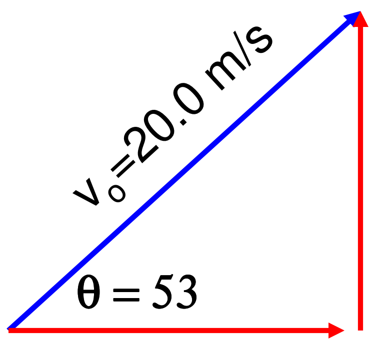
Example

A place kicker kicks a football with a velocity of 20.0 m/s and at an angle of 53 degrees.

(a) How long is the ball in the air?

(b) How far away does it land?

(c) How high does it travel?



$$v_{ox} = v_o \cos\theta$$

$$v_{ox} = 20\cos 53 = 12.04\ m/s$$

$$v_{oy} = v_o \sin\theta$$

$$v_{oy} = 20\sin 53 = 15.97\ m/s$$

Example

A place kicker kicks a football with a velocity of 20.0 m/s and at an angle of 53 degrees.

(a) How long is the ball in the air?

What I know	What I want to know
v_{ox}=12.04 m/s	t = ?
v_{oy}=15.97 m/s	x = ?
y = 0	y_{max}=?
g = - 9.8 m/s/s	

$$y = v_{oy}t + \tfrac{1}{2}gt^2 \rightarrow 0 = (15.97)t - 4.9t^2$$

$$-15.97t = -4.9t^2 \rightarrow 15.97 = 4.9t$$

$t =$ **3.26 s**

Example

A place kicker kicks a football with a velocity of 20.0 m/s and at an angle of 53 degrees.

(b) How far away does it land?

What I know	What I want to know
v_{ox}=12.04 m/s	t = 3.26 s
v_{oy}=15.97 m/s	x = ?
y = 0	y_{max}=?
g = - 9.8 m/s/s	

$$x = v_{ox}t \rightarrow (12.04)(3.26) =$$ **39.24 m**

Example

A place kicker kicks a football with a velocity of 20.0 m/s and at an angle of 53 degrees.

(c) How high does it travel?

CUT YOUR TIME IN HALF!

What I know	What I want to know
v_{ox}=12.04 m/s	t = 3.26 s
v_{oy}=15.97 m/s	x = 39.24 m
y = 0	y_{max}=?
g = - 9.8 m/s/s	

$$y = v_{oy}t + \tfrac{1}{2}gt^2$$

$$y = (15.97)(1.63) - 4.9(1.63)^2$$

$$y = \textbf{13.01 m}$$