Big Picture – How to Handle Projectile Motion

Key Concept: The curved path a projectile takes through space is the result of two basic motions - a constant velocity sideways and a constant acceleration up & down.

Position: Use only **X** or **Y** for distances. We have to be specific in the equations.

x is the horizontal component of its position.

y is the vertical component of its position.

X & Y are just the coordinates of its location.

Velocity! Again, we have to be specific and ALWAYS label the components.

V_x is the horizontal component of its velocity and it NEVER changes

V_y is the vertical component of its velocity. This DOES change - at the constant rate of $-10\ m/s^2$ because of gravity.

[V_{y_i} is the initial vertical velocity. That means it the V_y the projectile has at the start of the problem]

ORIGINAL EQUATION

$v = \frac{d}{t}$ ⟶ $(d = vt)$

$d = \frac{1}{2}at^2 + v_i t$

$a = \frac{v_f - v_i}{t}$ ⟶ $(v = at + v_i)$

WRITTEN FOR PROJECTILE MOTION

$X = v_x t$

$Y = \frac{1}{2}at^2 + v_{y_i} t$

$v_y = at + v_{y_i}$

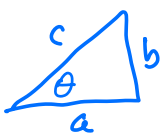
Note: a is just gravity!

$a = -10\ m/s^2$

(unless not on the Earth.)

$c^2 = a^2 + b^2$

(Pythagorean Theorem)



c is the magnitude of the vector

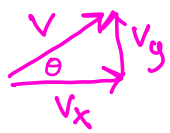
$\cos\theta = \frac{a}{c}$

$\sin\theta = \frac{b}{c}$

to find components given magnitude and direction.

$v^2 = v_x^2 + v_y^2$

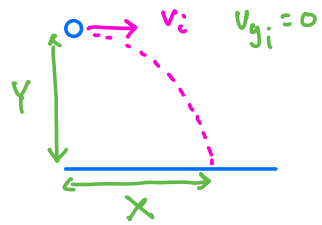
↑ overall speed of projectile



$\cos\theta = \frac{v_x}{v}$

$\sin\theta = \frac{v_y}{v}$

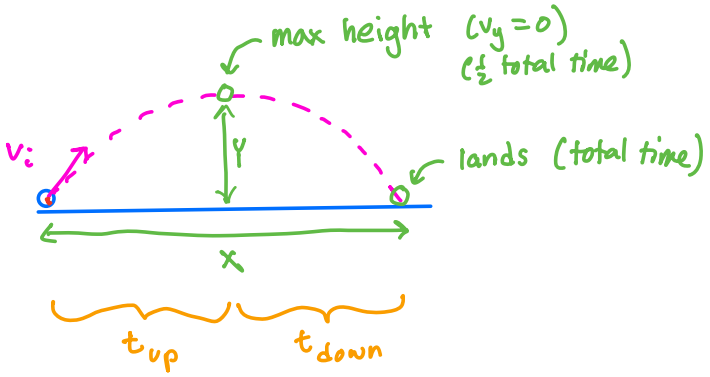
Things to Remember



$\vec{V}_i \begin{cases} V_x \\ V_{y_i} = 0 \text{ m/s} \end{cases}$

$a = -10 \text{ m/s}^2$

Y is negative
(it ends lower than where it started)



$\vec{V}_i \begin{cases} V_x \\ V_{y_i} \end{cases}$ ← this is NOT zero!

$a = -10 \text{ m/s}^2$

Y is positive
(Its higher than initial position)

* @ Maximum Height: $V_y = 0$ m/s

* $t_{up} = t_{down}$

  Time to Max Height = Half of Total Time

* X → use total time in air

* Y (max height) → use t_{up} ($\frac{1}{2}$ total time)

[$Y = 0$ when it lands (total time)]

[$V_{y_f} = -V_{y_i}$ when it lands (total time)]