PROJECTILE MOTION:

A projectile is any object that is launched, thrown, or shot.

For projectile motion, we need to think about the projectile in 2 different directions:

horizontal and Vertical

Horizontal and vertical are perpendicular and independent of each other.

Therefore, we have formulas for the horizontal direction and the vertical direction.

Horizontal Motion	Vertical Motion
$V_x = \frac{d_x}{t}$	$d_y = V_{iy}t + \frac{1}{2}gt^2$
	$V_{fy} = V_{iy} + gt$
	$V_{fy}^2 = V_{iy}^2 + 2gd_y$

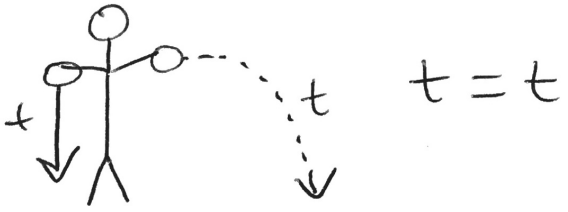
There are 2 important concepts we need to know:

1.) A horizontally thrown projectile will hit the ground at the same time a dropped projectile will.

Time is the same in vertical and horizontal formulas.

All accelerate downward at $-9.8\ m/s^2$

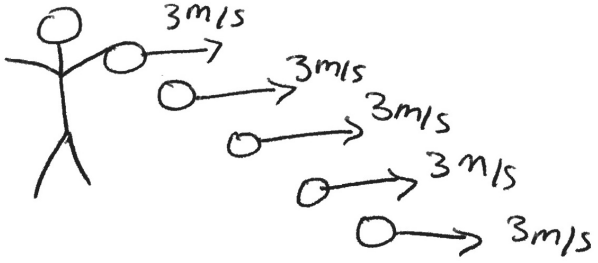
Picture:



2.) Once released, a projectile will not accelerate in the horizontal direction.

Horizontal velocity remains constant throughout the objects entire path down to the ground

Picture:



Example:

A rock is thrown horizontally from a height of 2 m with an initial velocity of 7m/s.

Picture:

Givens:

h	V
$V_x = 7 m/s$	$d_y = -2m$
$d_x = ?$	$g = -9.8 m/s^2$
$t = ?$	$V_{iy} = 0 m/s$
	$t = ?$

a. How long will it stay in the air? looking for time

Formula:

$$d_y = \frac{1}{2} g t^2$$

Plug in numbers:

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

$$\frac{-2m}{-4.9} = \frac{-4.9\, t^2}{-4.9}$$

$$\sqrt{.408} = \sqrt{t^2}$$

Answer: .64 s

b. How far did the rock travel? (horizontally)

Formula: $V_x = \frac{d_x}{t}$ or $d_x = V_x t$

Plug in numbers:

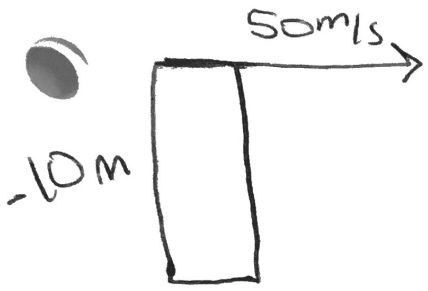
$$d_x = (7 m/s)(.64 s)$$

$$d_x = 4.48 m$$

Answer: 4.48m

2. A cannon shoots a projectile horizontally at a speed of 50m/s from a height of 10 m.

Picture:



Givens

h	v
$V_x = 50 m/s$	$d_y = -10m$
$d_x = ?$	$g = -9.8 m/s^2$
$t = ?$	$V_{iy} = 0 m/s$
	$t = ?$ (time)

a. How long will it take the cannonball to hit the ground?

Formula:

$$d_y = \frac{1}{2} g t^2$$

Plug in numbers:

$$-10m = \frac{1}{2}(-9.8 m/s^2)(t)^2$$

$$\frac{-10}{-4.9} = \frac{-4.9 t^2}{-4.9}$$

$$\sqrt{2.04} = \sqrt{t^2}$$

Answer: $1.43s = t$

b. How far did the cannonball travel in that time? (horizontally)

Formula:

$$V_x = \frac{d_x}{t} \quad \text{or} \quad d_x = V_x(t)$$

Plug in numbers:

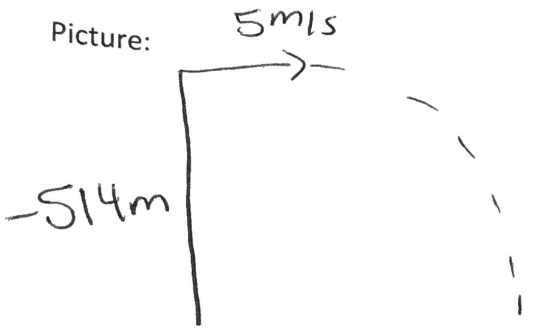
$$d_x = (50 m/s)(1.43s)$$

Answer: $d_x = 71.5m$

Horizontal Projectile Homework:

1.) A penny is thrown horizontally from the top of Stone Mountain which is 514m above sea level. If the penny's velocity is 5 m/s.

Picture:



Givens

h

$V_x = 5 m/s$

$d_x = ?$

$t = ?$

V

$d_y = -514m$

$g = -9.8 m/s^2$

$V_{iy} = 0 m/s$

$t = ?$

a. How long will the penny stay in the air? (time)

Formula: $d_y = \frac{1}{2} g t^2$

Plug in numbers:

$-514m = \frac{1}{2}(-9.8 m/s^2)(t)^2$

$\frac{-514}{-4.9} = \frac{-4.9}{-4.9} t^2$

$\sqrt{104.9} = \sqrt{t^2}$

Answer: $10.2s = t$

B. How far from the base of the mountain will the penny land? (horizontally)

Formula: $V_x = \frac{d_x}{t}$ or $d_x = V_x (t)$

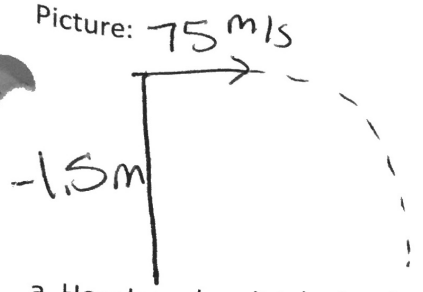
Plug in numbers: $d_x = (5 m/s)(10.2 s)$

$d_x = 51 m$

Answer:

2. A baseball is hit horizontally when the ball is 1.5m from the ground, and the ball travels at a velocity of 75 m/s.

Picture:



Givens

h

$v_x = 75\ m/s$

$d_x = ?$

$t = ?$

v

$d_y = -1.5m$

$g = -9.8\ m/s^2$

$v_{iy} = 0\ m/s$

$t = ?$

a. How long does it take for the baseball to reach the ground? (time)

Formula:

$$d_y = \frac{1}{2} g t^2$$

Plug in numbers:

$$-1.5m = \frac{1}{2}(-9.8\ m/s^2)(t)^2$$

$$-1.5 = -4.9\ t^2$$

$$\frac{-1.5}{-4.9} = \frac{-4.9\ t^2}{-4.9}$$

Answer:

$$\sqrt{.306} = \sqrt{t^2}$$

$$.55\ s = t$$

b. How far does the baseball travel before it hits the ground? (horizontally)

Formula:

$$d_x = v_x (t)$$

Plug in numbers:

$$d_x = (75\ m/s)(.55\ s)$$

Answer:

$$d_x = 41.25m$$