

Projectile Notes

Friday, November 12, 2010 10:00 AM

Projectiles combine the kinematic formulas with **vectors**.
 A projectile is any object launched into the air regardless of direction or initial velocity.
 It accelerates downward at -9.8 m/s^2 due to gravity.
 Note that object dropped and objects fired HORIZONTALLY from the same height strike the ground at the same time.

I promise not to mix X's & Y's

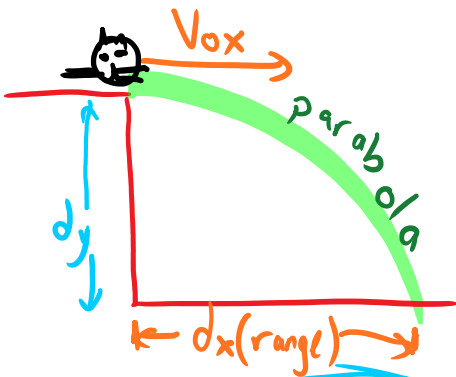
The motion in the Y-direction is independent of the motion in the X-direction.

Both directions follow the kinematic equations (most commonly used is $d = v_0t + \frac{1}{2}at^2$)

DO NOT MIX THE X AND Y VALUES!

Type I projectiles: always shot horizontally, always raised some height off a lower surface

USE t in X direction!

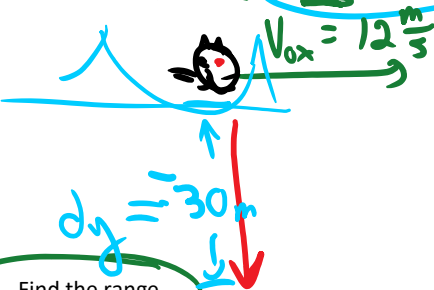


$a_y = -9.8 \frac{m}{s^2}$
 $d_y = -$
 $v_{0y} = 0$
 $t = ?$
 $d = v_0t + \frac{1}{2}at^2$

$a_x = 0$
 $d_x = \text{unknown}$
 $v_{0x} = \text{given}$
 $t = \text{found}$

~~$d = v_0t + \frac{1}{2}at^2$~~

A cat is shot horizontally off a 30m high bridge at 12 m/s, how long does it take to hit the railroad below?



$t = ?$
 $a_y = -9.8 \frac{m}{s^2}$
 $d_y = -30 \text{ m}$
 $v_{0y} = 0$

~~$d_y = v_0t + \frac{1}{2}at^2$~~
 $-30 = \frac{1}{2}(-9.8)t^2$
 $+30 = +4.9t^2$
 $\frac{30}{4.9} = t^2$
 $\sqrt{6.1} = t$
 $2.47 = t$

Find the range

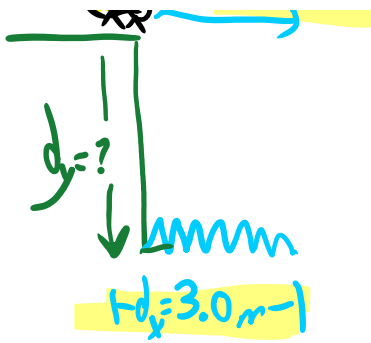
$d_x = ?$ $v_{0x} = 12 \frac{m}{s}$ $a_x = 0$ $t = 2.47$
 ~~$d_x = v_{0x}t + \frac{1}{2}a_x t^2$~~
 $= (12)(2.47) = 30 \text{ m}$

A cat on fire runs 2.0 m/s off a cliff that is unknown height if rock extend from the base 3.0 m outward will the cat clear the rocks making a perfect dive into the lake or suffer a debilitating neck injury while burning?



RARE ← Start in X
 $v_{0x} = 2 \frac{m}{s}$

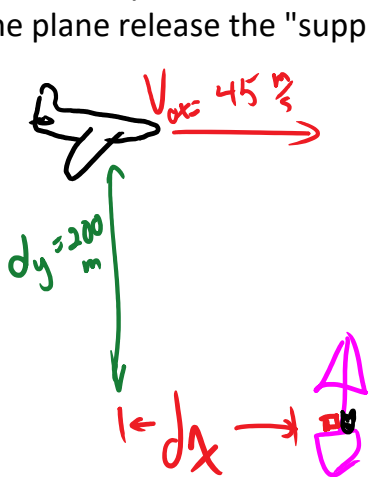
$d_y = -5 \text{ m}$
 $a_y = -9.8 \frac{m}{s^2}$



$V_{ox} = 2 \frac{m}{s}$
 $d_x = 3 m$
 $a_x = 0$
 $t = ?$
 $d_x = V_{ox}t + \frac{1}{2}a_x t^2$
 $\frac{3}{2} = 2t$
 $t = 1.5 s$

$a_y = -9.8 \frac{m}{s^2}$
 $V_{oy} = 0$
 $t = 1.5 s$
 ~~$d = V_{oy}t + \frac{1}{2}a_y t^2$~~
 $d_y = \frac{1}{2}(-9.8)(1.5)^2$
 $d_y = -4.9(1.5)^2$
 $= -11 m$

A bomber aircraft flying at height 200 m above the deck of a cruise ship full of cats is moving horizontally at 45 m/s. If it drops "food" to the disabled ship how far in front of the ship must the plane release the "supplies"?



$d_y = -200$
 $a_y = -9.8$
 $V_{oy} = 0$
 $t = ?$

~~$d_y = V_{oy}t + \frac{1}{2}a_y t^2$~~
 $-200 = \frac{1}{2}(-9.8)t^2$
 $400 = 4.9 t^2$
 $\sqrt{40.4} = t = 6.4 s$

$d_x = ?$
 $V_{ox} = 45$
 $a_x = 0$
 $t = 6.4$
 ~~$d_x = V_{ox}t + \frac{1}{2}a_x t^2$~~
 $= 45(6.4)$
 $= 288 m$

The only time you can use the X-direction to find time t is when you are given both d_x and v_{ox}. Then you're usually asked to find the height of the projectile...

A cat is thrown horizontally at 4.0 m/s off a building into a flaming barrel which is 18.0 m from the base of the building, how high was the building?

