Projectile Motion

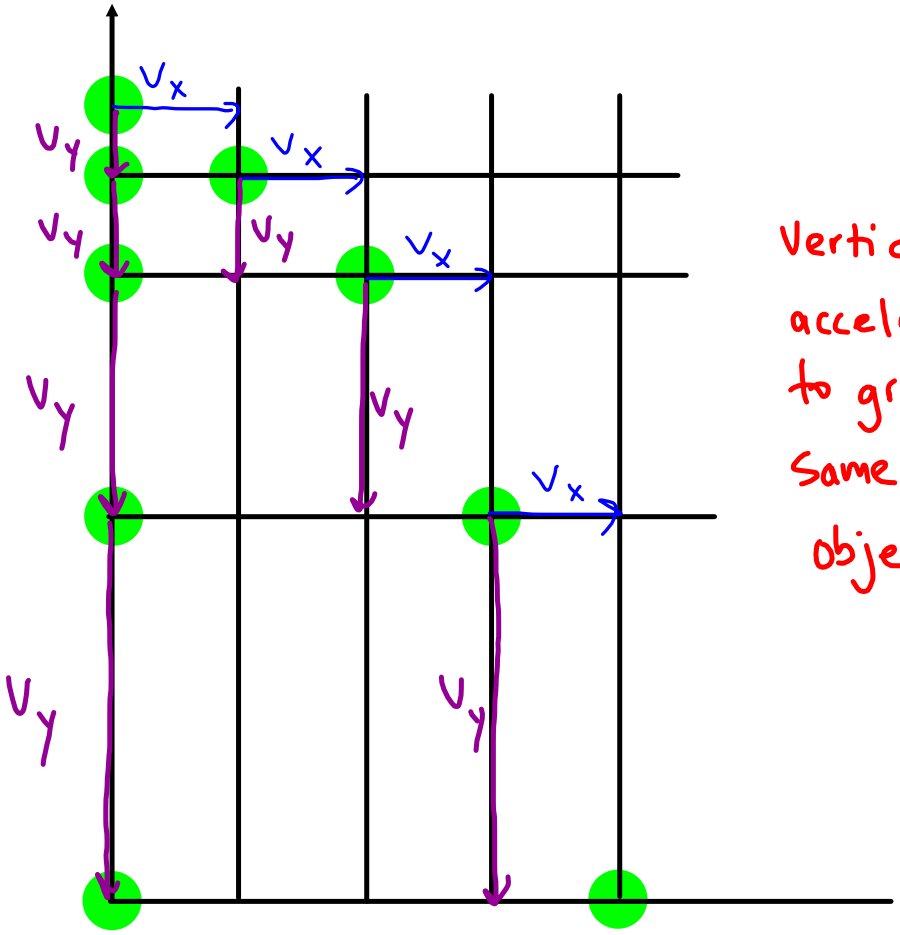
Goal:

- to solve problems with horizontally launched projectiles

Which object will hit the ground first, an arrow shot horizontally with a speed of 20 m/s or an arrow that is simply dropped?

video evidence

The horizontal and vertical components have no affect on each other.

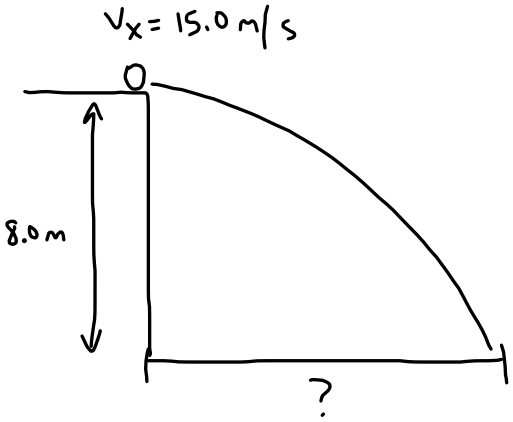


Vertically, acceleration due to gravity is the same for both objects

The connection is **time.**

The amount of time it takes the object to fall is equal to the time it travels horizontally.

A ball is thrown horizontally with a speed of 15.0 m/s from a height of 8.0 m. How far away will the ball hit the ground?



Vertical

$\vec{a}_g = 9.8\ m/s^2$ [down]

$\vec{v}_{i_y} = 0$

$\vec{\Delta y} = 8.0\ m$ [down]

$\Delta t = ?$

$\Delta d = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$

$8 = 0 + \frac{1}{2}(9.8)\Delta t^2$

$8 = 4.9\,\Delta t^2$

$\Delta t^2 = \frac{8}{4.9}$

$\Delta t = 1.28\ s$

Horizontal

$\Delta t = 1.28\ s$

$\vec{v}_x = 15.0\ m/s$

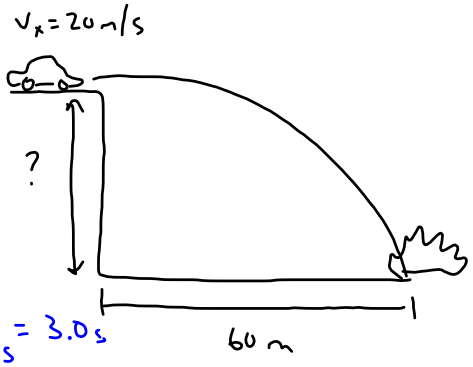
$\vec{\Delta x} =$

$\vec{v} = \frac{\vec{\Delta d}}{\Delta t}$

$15.0(1.28) = \vec{\Delta x}$

$\vec{\Delta x} = 19.2\ m$

A stunt car is driven off a cliff at 20 m/s. The car lands 60 m from the bottom of the cliff.



a) How high is the cliff?

Horizontal

$\vec{v}_x = 20$ m/s

$\Delta x = 60$ m

$\Delta t = ?$

$\vec{\Delta d} = \vec{v}\,\Delta t$

$\Delta t = \frac{\vec{\Delta d}}{\vec{v}} = \frac{60\text{ m}}{20\text{ m/s}} = 3.0\text{ s}$

Vertical

$\vec{a}_g = 9.8\text{ m/s}^2$ [down]

$\vec{v}_{iy} = 0$

$\Delta t = 3.0$ s

$\vec{\Delta y} = ?$

$\vec{\Delta d} = \vec{v}_i \Delta t + \frac{1}{2}\vec{a}(\Delta t)^2$

$= 0 + \frac{1}{2}(9.8)(3)^2$

$= 44.1$

Cliff is 44.1 m high

b) What is the velocity of the car when it strikes the ground?

Horizontal

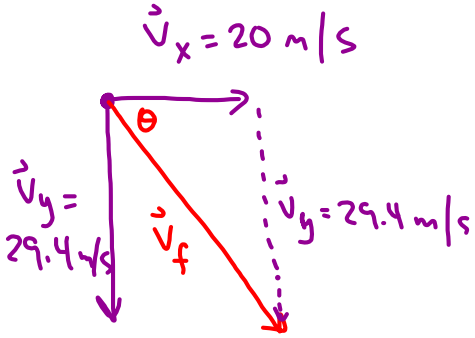
$v_x = 20$ m/s

Vertical

$v_{fy} = v_{iy} + a\Delta t$

$= 0 + 9.8(3)$

$= 29.4$ m/s [down]



$\vec{v}_f = \sqrt{20^2 + 29.4^2}$

$= 35.6$ m/s

$\theta = \tan^{-1}\left(\frac{29.4}{20}\right)$

$= 55.8°$

Final velocity is 35.6 m/s [55.8° below horizontal]

A marble is rolling along a table that is 1.2 m high. The marble lands 1.5 m away from the table. What was the speed of the marble on the table?

Attachments

http://www.youtube.com/watch?v=zMF4CD7i3hg