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2.4 Projectile Motion

Review: Last class we looked at adding vectors in 2D using the North, South, East, West direction. What happens if we look at this type of motion in the up and down direction?

What are some characteristics of projectile motion?

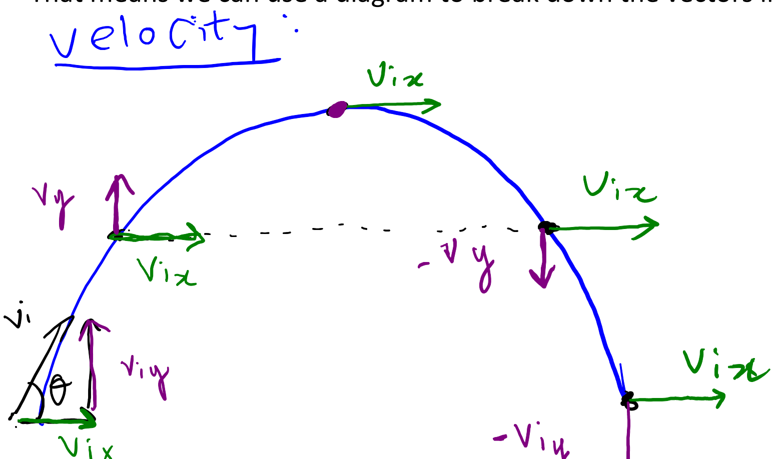
- parabolic + symmetrical
- slows down going up
- speeds up going down
- seems to stop @ the top

Key point: Gravity only works in the vertical (up and down) direction, NOT in the horizontal (left and right) direction.

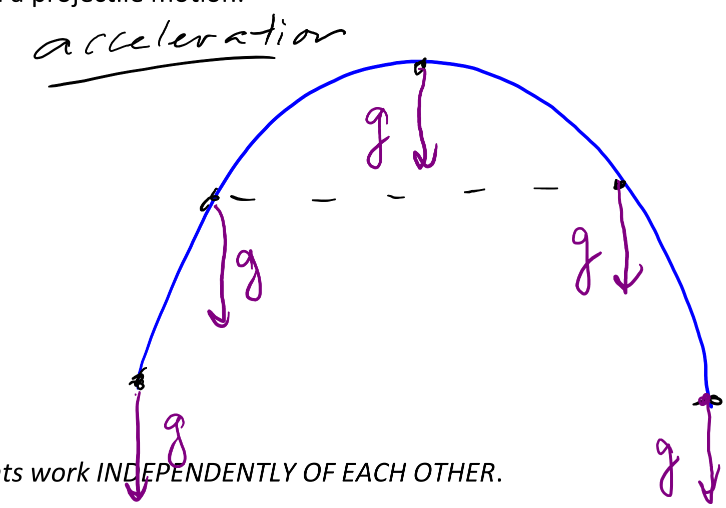
When dealing with projectile motion, we usually assume there is no air resistance meaning we assume that there is no acceleration in the horizontal direction.

That means we can use a diagram to break down the vectors in a projectile motion:

velocity:



acceleration



Recall from last class: *the horizontal and the vertical components work INDEPENDENTLY OF EACH OTHER.*

Example: Watch the video on the same two objects; one is dropped and the other one is fired horizontally.

Write down your prediction:	Write down what you observed:

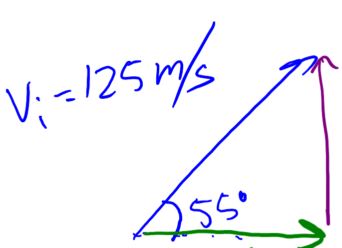
Why does that happen?

vector components work independently of each other & v_y in both cases were the same.

How do we apply this concept to a projectile motion problem?

Ex. 1: A cannon fired Ms. Li's spoon at 125m/s at 55° above the horizontal.

a) What are the horizontal and vertical components of spoon's initial velocity?



$v_y = 125 \sin 55 = 102.394..\,m/s \rightarrow \boxed{1.0 \times 10^2\,m/s}$

$v_x = 125\,m/s \cos 55 = 71.697..\,m/s \rightarrow \boxed{72\,m/s}$

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b) How long does it take the spoon to reach its maximum height?

Start a projectile motion problem with a table of horizontal (x) and vertical (y) values

$t = ?$ $\quad v_{fy} = 0\,m/s$

$v_{fy} = v_{iy} + at \rightarrow t = \frac{v_{fy} - v_{iy}}{a} = \frac{0 - 102.394..\,m/s}{-9.8\,m/s^2} = \boxed{10.s}$

x	y
$\vec{a}_x = 0\,m/s^2$	$\vec{a}_y = -9.8\,m/s^2$
$v_x = 71.697\,m/s$	$v_{iy} = 102.394..\,m/s$
	$h_{max} = ?$
$t_x =$	t_y

c) What is the velocity of the spoon when it's at this maximum height?

$v_y = 0$ but

v_x is constant throughout the motion $\therefore v = \boxed{72\,m/s}$

*Notice how the horizontal velocity _stayed constant_ since there is no acceleration in the x direction.

d) What is the time of flight of Ms. Li's spoon?

x	y
	$\Delta h = 0\,m$
	$a = -9.8\,m/s^2$
$t_x =$	t_y

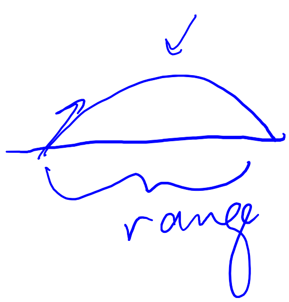
$d = v_i t + \frac{1}{2}at^2 = 0\,m$

$v_{iy} + \frac{1}{2}at = 0$

$t = -\frac{2v_{iy}}{a} = -\frac{2(102.394..)\,m/s}{-9.8\,m/s^2} = \boxed{21\,s}$

* you can also find t going up and double it for the whole journey.

e) What is the horizontal range covered by the spoon? (a.k.a. How far did the spoon travel horizontally?)



x	y
$v_{ix} = 71.697..\,m/s$	
$x = ?$	
$t =$	$20.89..\,s$

$x = v_{ix} t$

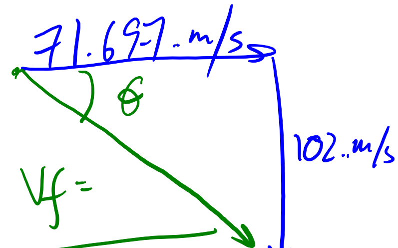
$= 71.697..\,m/s\,(20.89\,s)$

$= 1498\,m \rightarrow \boxed{1500\,m}$

f) What is the final velocity of the spoon before it hits the ground?

$v_{ix} = v_{fx} = 71..\,m/s$

$v_{iy} = -v_{fy}$ due to symmetry $= -102..\,m/s$



$\sqrt{71.697..\,m/s^2 + 102..\,m/s^2}$

$= \boxed{125\,m/s \rightarrow 130\,m/s\ 55^\circ \text{ below the horizontal}}$

HW: Projectiles #1-4, 7-8, 13