

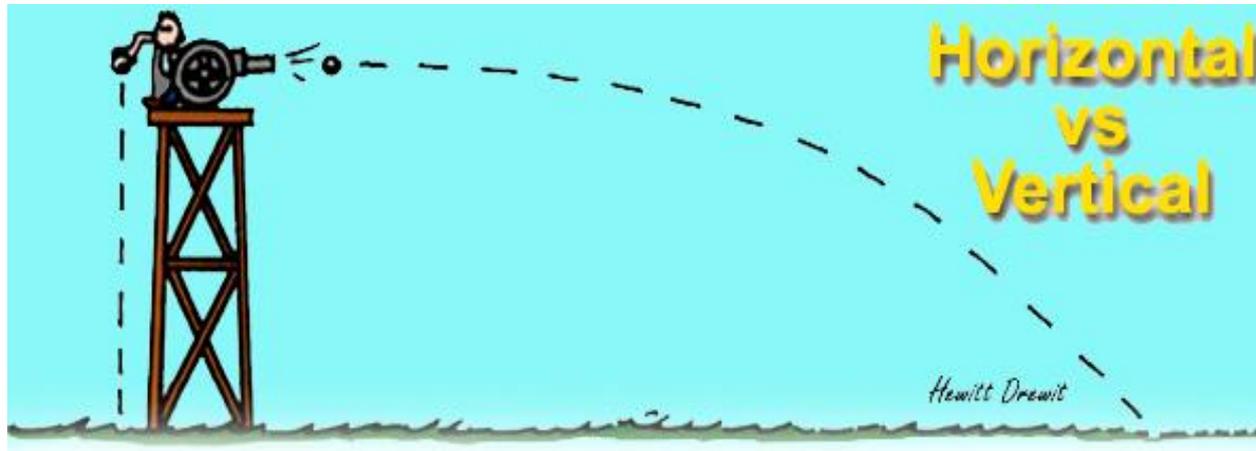


Projectile Motion

Motion in Two Dimensions

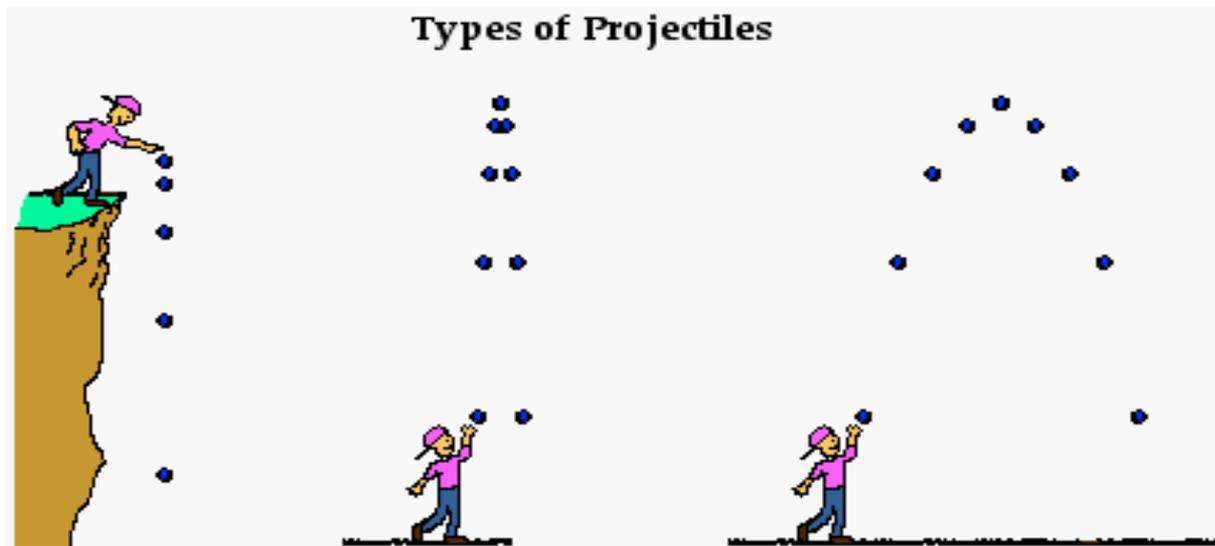
A Question to Begin

- At the instant a horizontally pointed cannon ball is fired, a cannonball held at the cannon's side is released and drops to the ground. Which cannonball strikes the ground first, the one fired from the cannon or the one dropped?



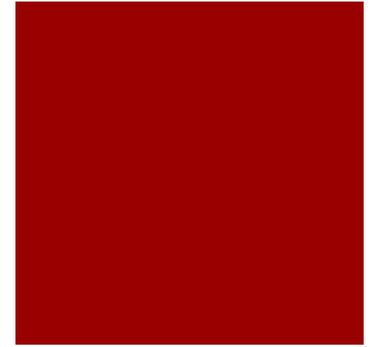
What is a Projectile?

- Any object that continues in motion by its own inertia and is influenced only by the downward force of gravity (and air resistance)
 - an object dropped from rest is a projectile
 - an object thrown straight upward is a projectile
 - an object thrown upward at an angle to the horizontal



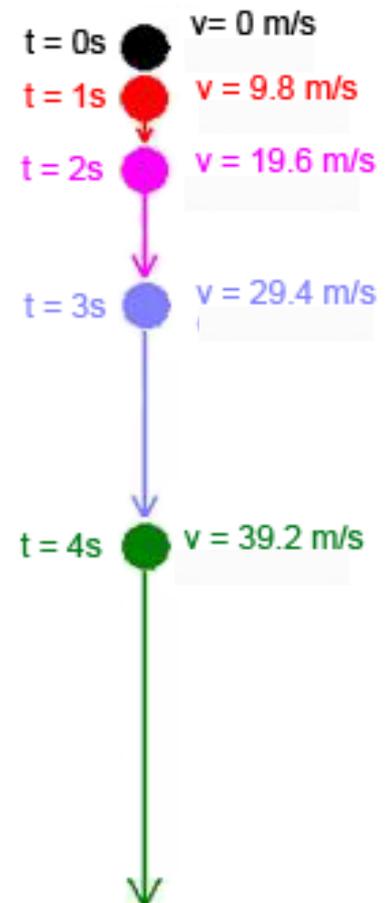
The path that the projectile follows is a parabola...

- the path is called its trajectory



Lets look at the Vertical component first

- An object in free fall is only acted on by gravity
 - Acceleration due to gravity is 9.8 m/s^2
 - distance covered increases with each second

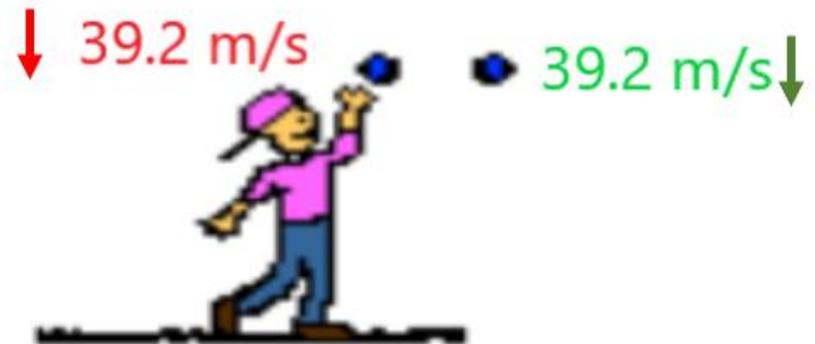
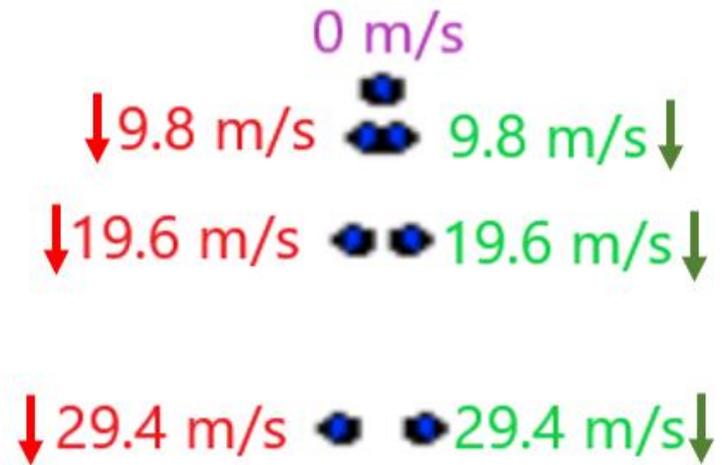


Throw it straight Up

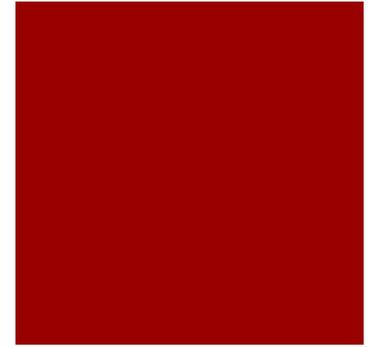


$$\downarrow = -g$$

$$\downarrow = g$$



Kinematic Equations



$$d = V_i t + \frac{1}{2} a t^2$$

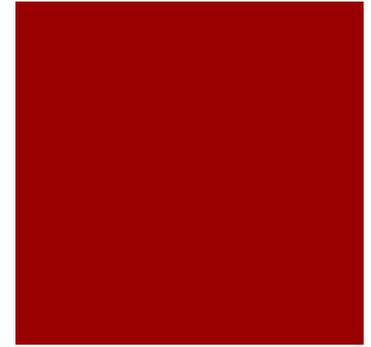
$$V_f = V_i + a t$$

$$V_f^2 = V_i^2 + 2 a d$$

$$d = \frac{V_i + V_f}{2} * t$$

- ✓ **D** = displacement, (Δx)
- ✓ **t** = time
- ✓ **a** = acceleration
- ✓ **V_i = V₀** = Initial Velocity
- ✓ **V_f** = Final Velocity

Vertical Practice

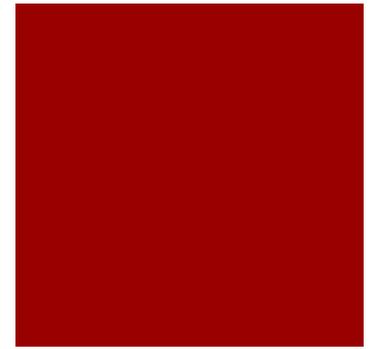


- 1. Emily threw a ball straight up in the air with a velocity of 23 m/s. How high will the ball be after 3.2 seconds?

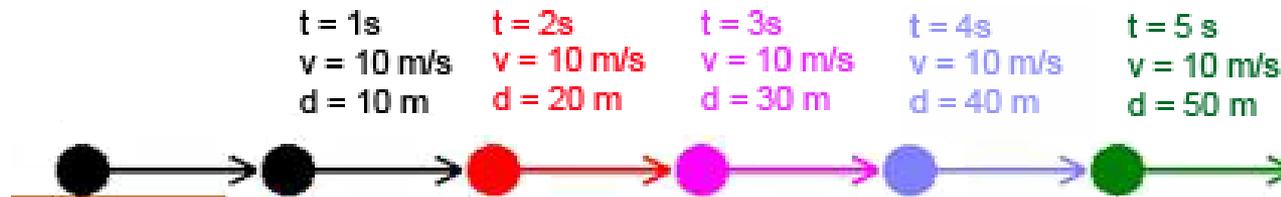
- 2. Marshall shot an arrow straight up in the air and it came down and hit him in the head (luckily he was wearing a helmet!) in 8.5 seconds. What velocity did the arrow have when it hit him in the head?

- 3. Hanna was shot out of a cannon with a velocity of 32 m/s. How high will she be when her velocity is -5.4 m/s?

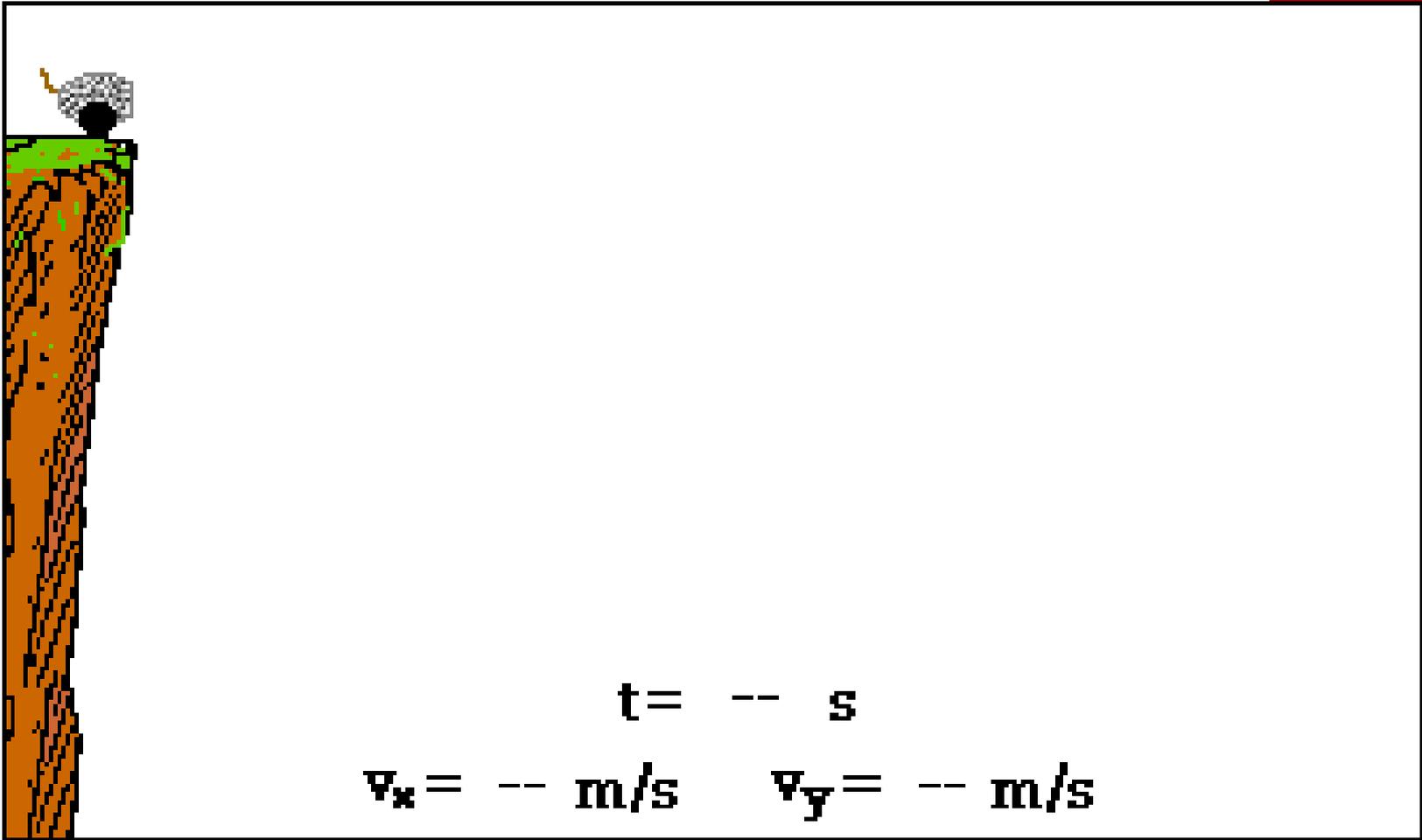
Now On To Horizontal Motion



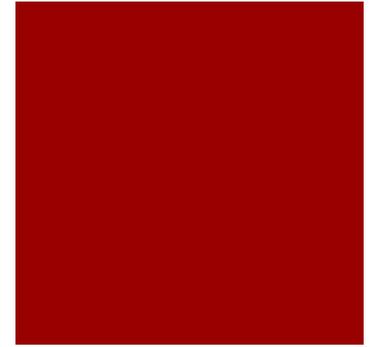
- If there is no force acting on an object, then it will continue moving at a constant speed in the same direction.
 - there will be no change in its velocity



- distance will increase the same amount with each second

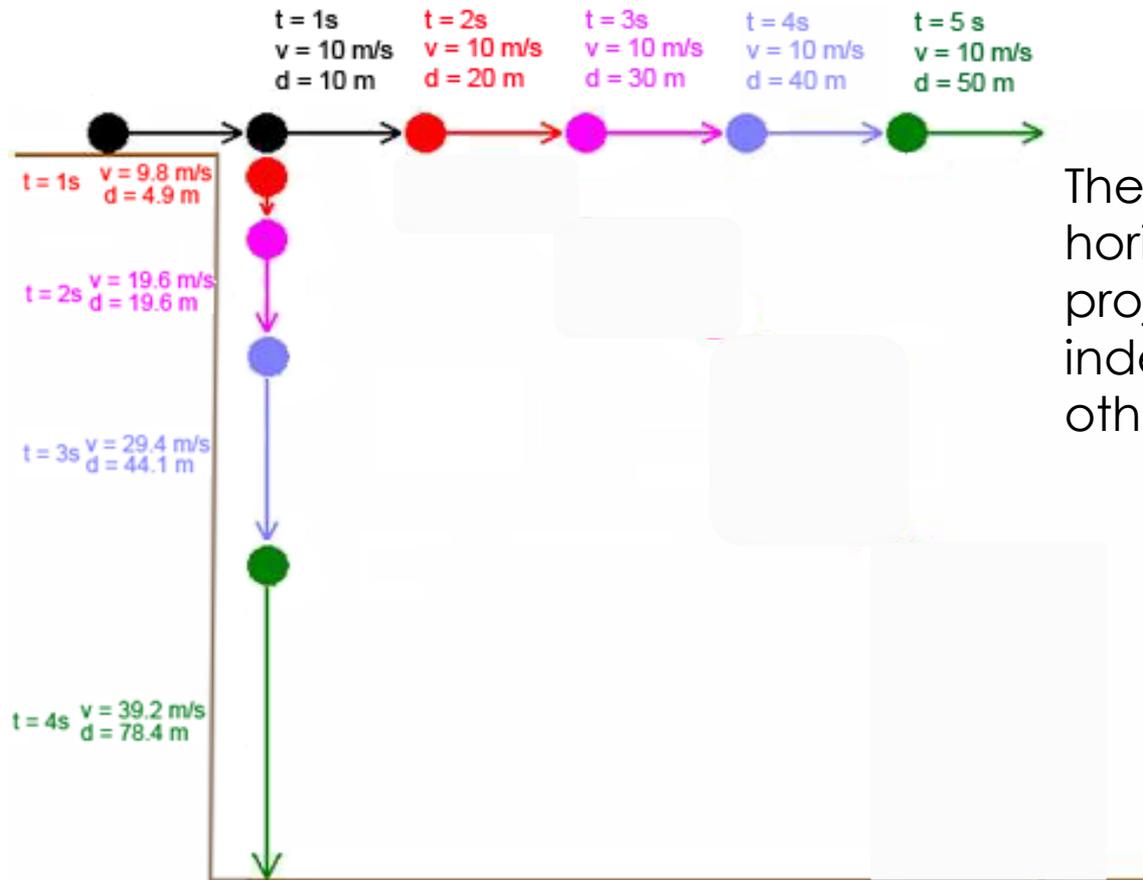


Horizontal Practice... kinda



- A ball rolls with a speed of 2.0 m/s across a level table that is 1.0 m above the floor. Upon reaching the edge of the table, it follows a parabolic path to the floor. How far along the floor is the landing spot from the table?
- A rifle is fired horizontally and travels 200.0 m [E] . The rifle barrel is 1.90 m from the ground. What speed must the bullet have been travelling at?
- A skier leaves the horizontal end of a ramp with a velocity of 25.0 m/s [E] and lands 70.0 m from the base of the ramp. How high is the end of the ramp from the ground?

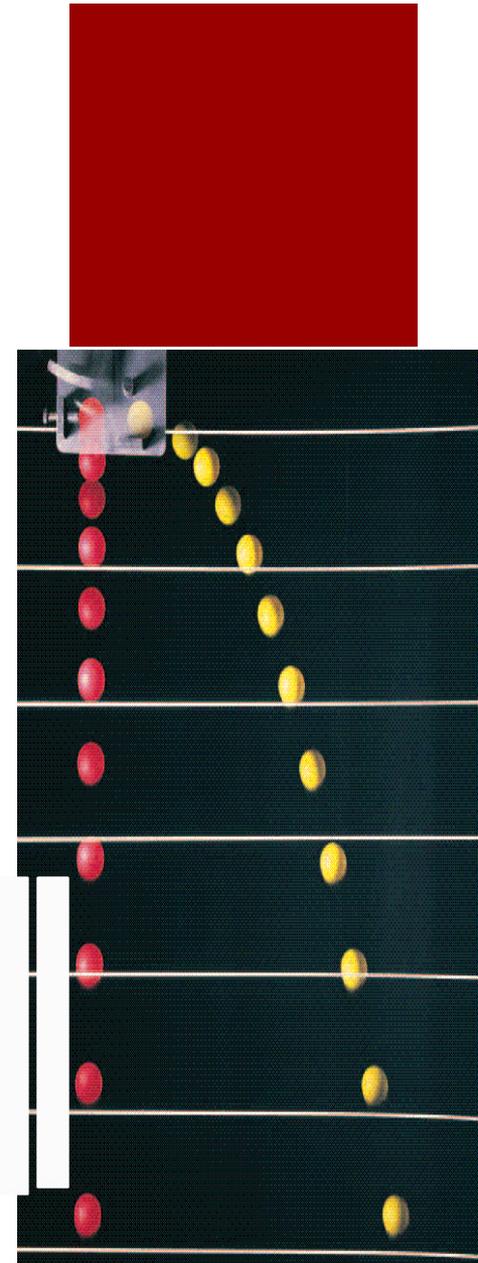
Projectile Motion Combines Horizontal Motion and Vertical Motion



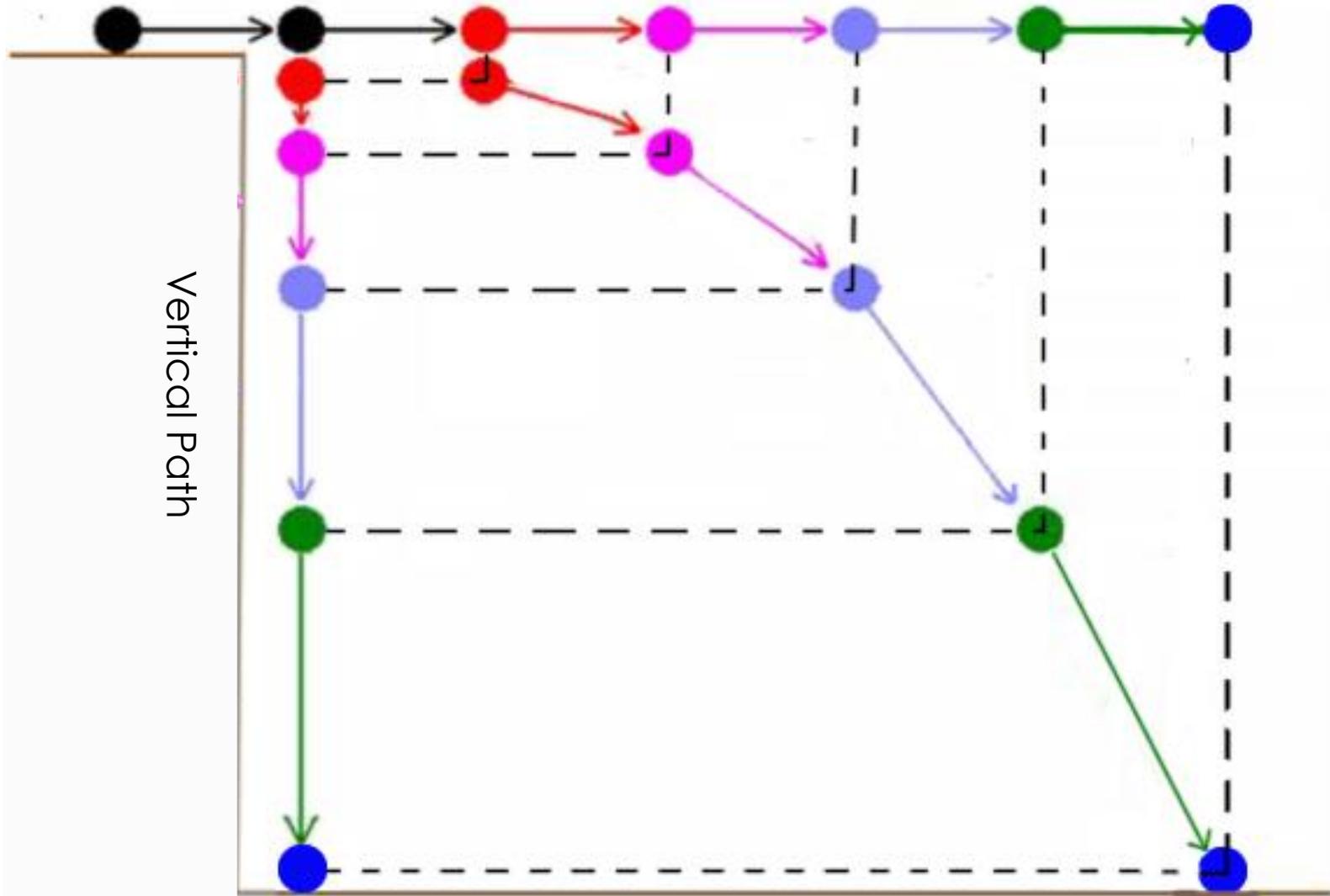
The vertical and horizontal motion of a projectile are independent of each other

Projectile Motion Combines Vertical Motion and Horizontal Motion

- The vertical motion of a projectile is not affected by its horizontal motion
 - meaning: The vertical motion of a projectile is identical to an object in free fall
- The horizontal motion of a projectile is not affected by its vertical motion
 - meaning the projectile will travel the same horizontal distance as it would if it were simply rolling on a flat surface in the absence of friction

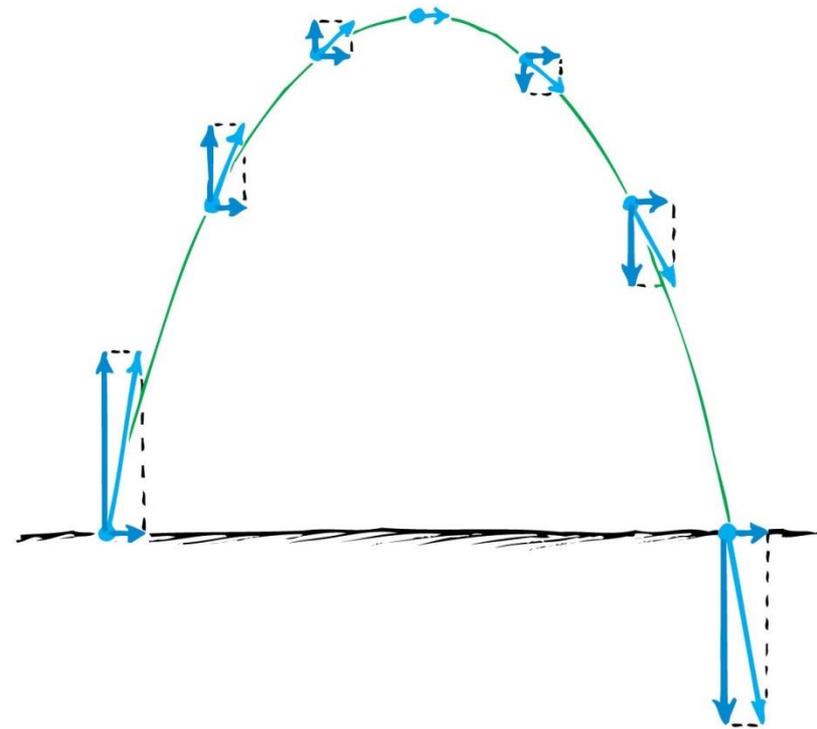


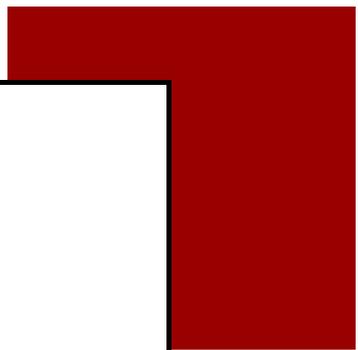
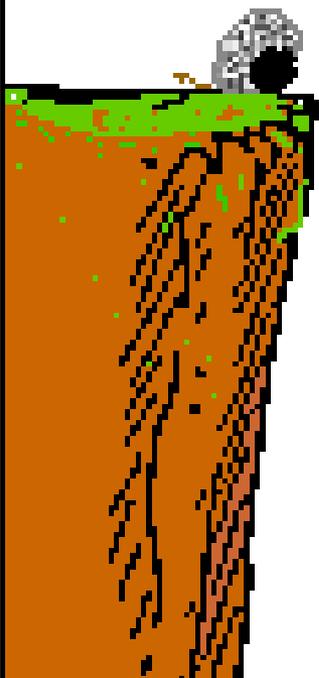
Horizontal Path Without Gravity



Projectile Motion

- Projectiles follow a parabolic trajectory
- Horizontal component along trajectory remains unchanged.
- Acceleration only occurs in the vertical component

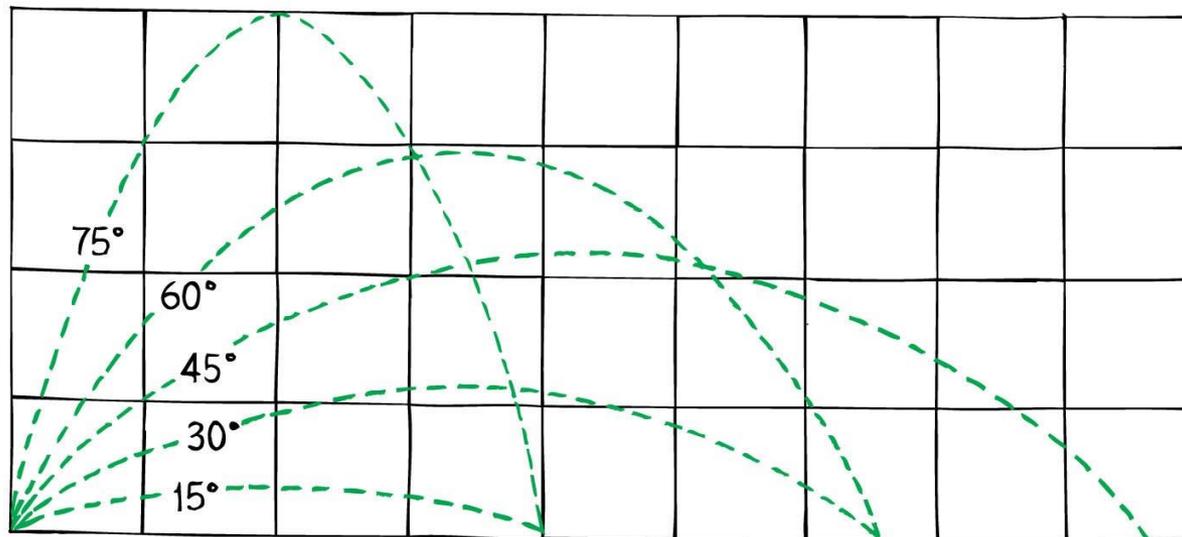




$$t = \text{--} \text{ s}$$
$$v_x = \text{--} \text{ m/s} \quad v_y = \text{--} \text{ m/s}$$

Projectile Motion and Complementary Angles

- Different launch angles result in different horizontal distances traveled by the projectile
 - Same range is obtained from two different launching angles when the angles add up to 90° .
 - Object launched at an angle of 60° has the same range as if it were thrown at an angle of 30° .
 - What launch angle would have the same range as a projectile launched at 20° ?



Angled Projectile Practice

- 1. A baseball player leads off the game and hits a long home run. The ball leaves the bat at an angle of 30.0° from the horizontal with a velocity of 40.0 m/s. How far will it travel in the air?**
- 2. A golfer is teeing off on a 170.0 m long par 3 hole. The ball leaves with a velocity of 40.0 m/s at 50.0° to the horizontal. Assuming that she hits the ball on a direct path to the hole, how far from the hole will the ball land (no bounces or rolls)?**
- 3. A punter in a football game kicks a ball from the goal line at 60.0° from the horizontal at 25.0 m/s.
What is the hang time of the punt?
How far down field does the ball land?**

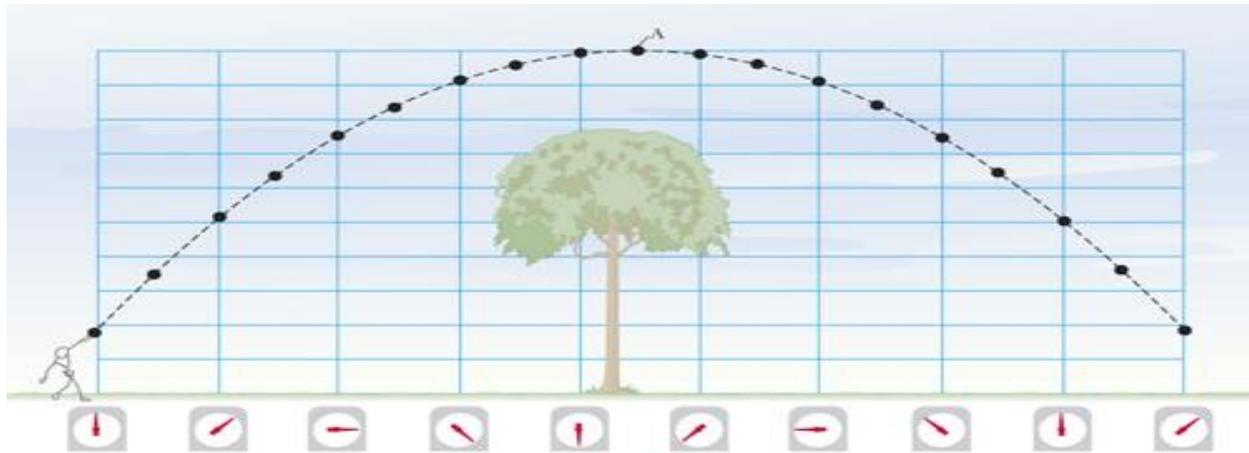
Angled Projectile Practice

At the SMHS vs. Judson football game, the cheerleading squad launches a Rattler t-shirt with the t-shirt shooter into the bleachers from the football field with an initial velocity of 50 m/s at an angle of 40° ?

1. What is the initial velocity of the shirt?
Horizontal
Vertical
2. How long will it take to reach max height?
3. What is the max height?
4. What is the range (how far did it go?)

Review

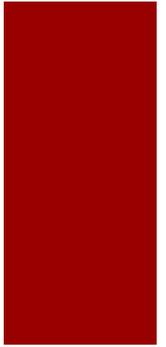
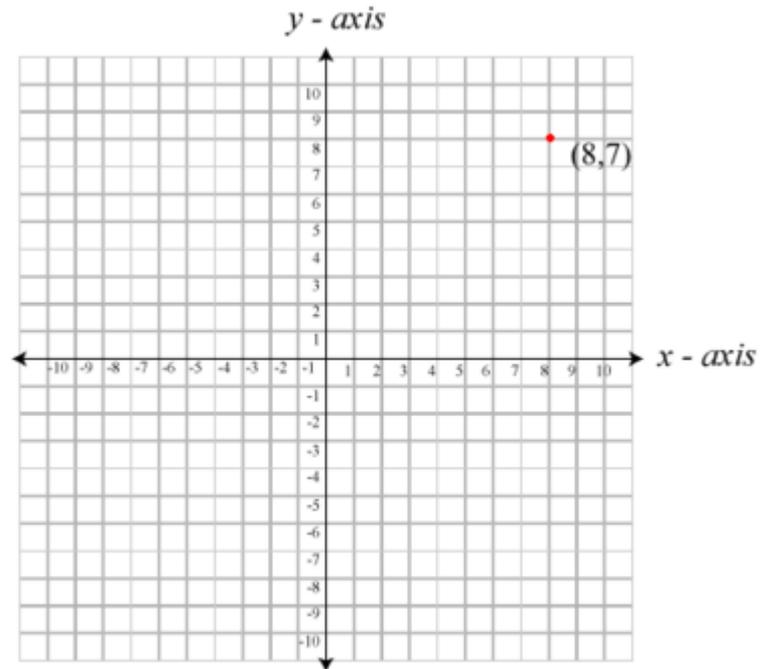
- What is the path of a projectile called?



- Trajectory

Review

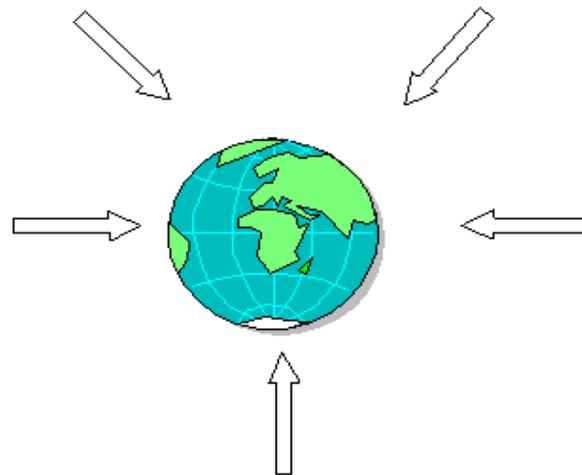
- Is projectile motion one dimensional?



Review

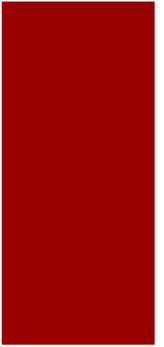
- What force (s) is acting on the projectile?

- Gravity only



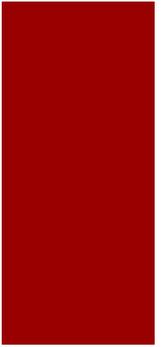
Review

- Which direction, horizontal or vertical has acceleration?
- Vertical
- Which direction, horizontal or vertical has constant speed?
- Horizontal



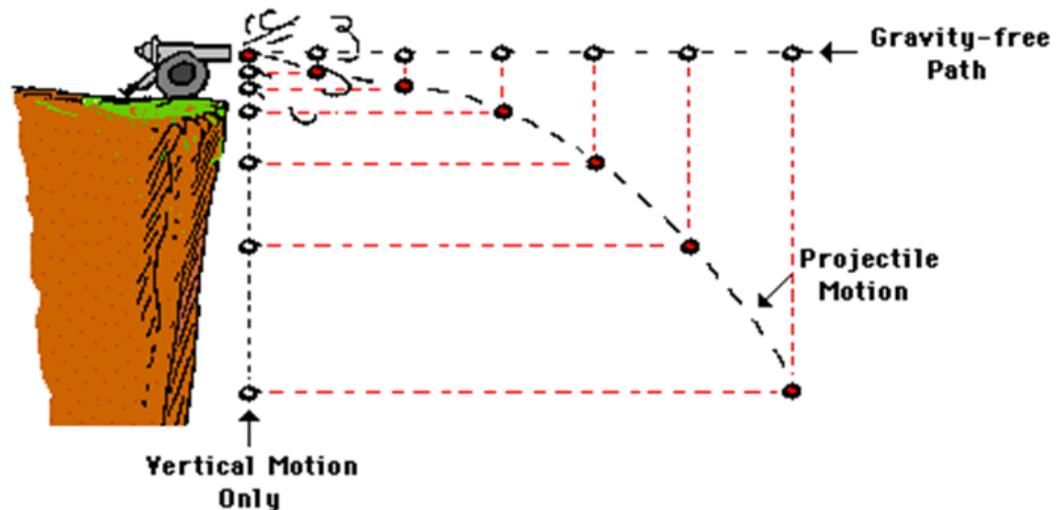
Review

- Two identical balls roll off the edge of a table. One leaves the table travelling twice the speed of the other. Which ball hits the floor first?
- Both hit the ground at the same time. The difference in horizontal velocity does not affect the vertical time.

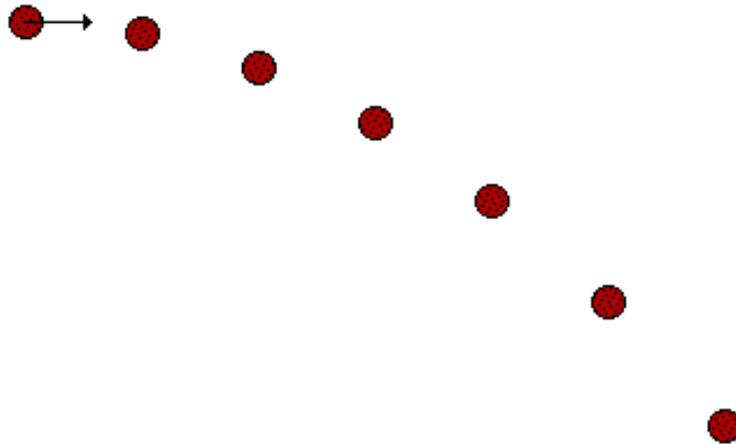
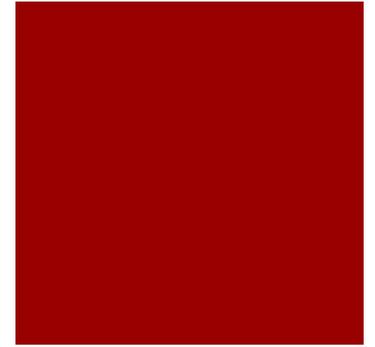


Review

- At the instant a horizontally pointed cannon ball is fired, a cannonball held at the cannon's side is released and drops to the ground. Which cannonball strikes the ground first, the one fired from the cannon or the one dropped?
- They hit at the exact same time



Draw vector arrows representing the \mathbf{v}_x and \mathbf{v}_y velocity components during the course of the motion. The length of the arrows should represent the magnitude of the velocity components.



Draw vector arrows representing the \mathbf{v}_x and \mathbf{v}_y velocity components during the course of the motion.

