Things to Memorize: Motion in Two Dimensions

General Ideas:

- Motion in one dimension does not effect the motion in the other dimension.
  - Thus, kinematic equations can only be applied to one dimension at a time.
  - The only variable that can be applied to each dimension is time.
- Each Dimension (X, Y) has its own set of kinematic variables. Use a subscript to distinguish them, ie: v_{fx} and v_{fy}.
- Distances, Velocities, and Accelerations can be **combined as vectors** by using the Pythagorean Theorem.
- Distances, Velocities, and Accelerations can be **decomposed** (broken down) into component vectors by using trigonometric equations.

To Solve a Two-Dimensional Problem

1. Draw a diagram.
2. Define a positive X direction and a positive Y direction. Label those directions clearly with arrows: $\longrightarrow X$ and $\uparrow Y$
   - X and Y directions must be 90°to each other.
   - X and Y don't have to be right and up. Instead, choose directions that correspond with the motion described in the problem.
3. Indicate in words what portion of motion your are considering, (like "motion from launch to the peak of the flight.)
4. Fill out a chart, including signs and units, of the five kinematics variables for each direction. Remember time is the only varible that can be used in any dimension.

$d_x =$	$d_y =$
$v_{ix} =$	$v_{iy} =$
$v_{fx} =$	$v_{fy} =$
$a_x =$	$a_y =$
$t =$	

5. Pick an dimension (X, Y) that will allow you to use a kinematic equation that has only **ONE** unknown variable.
   - Remember: **Do not mix X and Y variables in the same equation!**
6. Manipulate the equation to isolate the unknown variable (if needed).

7. Plug in the numbers.
8. Write your answer with units. Add it to the table above.
9. Continue to solve for variables until you have determined the variable you want.

Projectiles Launched Horizontally

- A projectile launched horizontally has an initial vertical velocity of zero: $v_{iy} = 0$ m/s.
- Since gravity is the only force acting on the object while it is in free-fall, $a_y = 9.8\ m/s^2$ downward, and $a_x = 0\ m/s^2$
- Be sure to double-check your positive and negative signs to make sure they correspond with the diagram you drew.

Projectiles Launched at an Angle

- Use trigonometry to determine the initial X and Y velocities.
- Since gravity is the only force acting on the object while it is in free-fall, $a_y = 9.8\ m/s^2$ downward, and $a_x = 0\ m/s^2$
- Be sure to double-check your positive and negative signs to make sure they correspond with the diagram you drew.
- Determine the time to the top of the path first. At the top of a projectile's path, $v_y = 0$ m/s.
- Rarely, you will need to solve the equation $d = v_i t + \frac{1}{2}at^2$ for t when neither v_i nor a are zero.
  - This can be done by using the quadratic equation.
  - Alternately, the problem can be broken into a rising component and a falling component and the times can be added.