

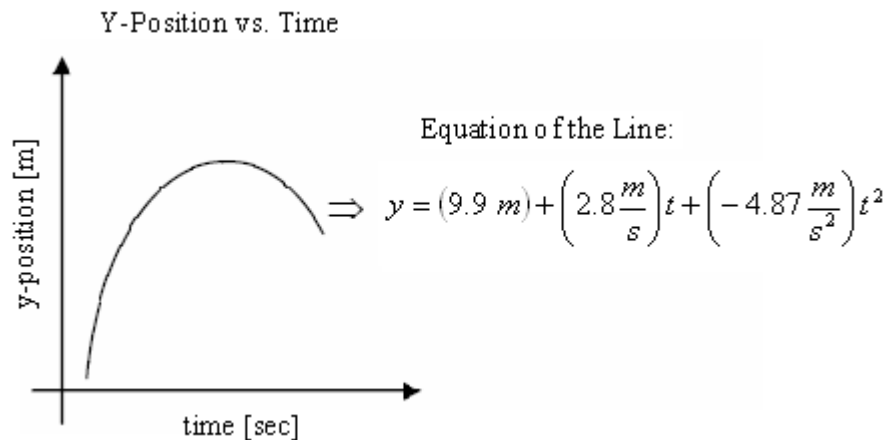
## Experiment #3 Projectile Motion Pre-lab Hints

The following are some hints for this pre-lab, since a few of these questions can be a little difficult. Note that these are not necessarily the answers to the questions, but merely a means to get to the answer. The hints are written in RED below the question for which the hint is given.

- What are the kinematic equations in two dimensions? List expressions for:  
 $x, v_x, a_x, y, v_y, a_y$

Look these up in your physics book if you can't remember them off hand.

- From this graph find  $g, v_{oy}$  and  $y_o$ .

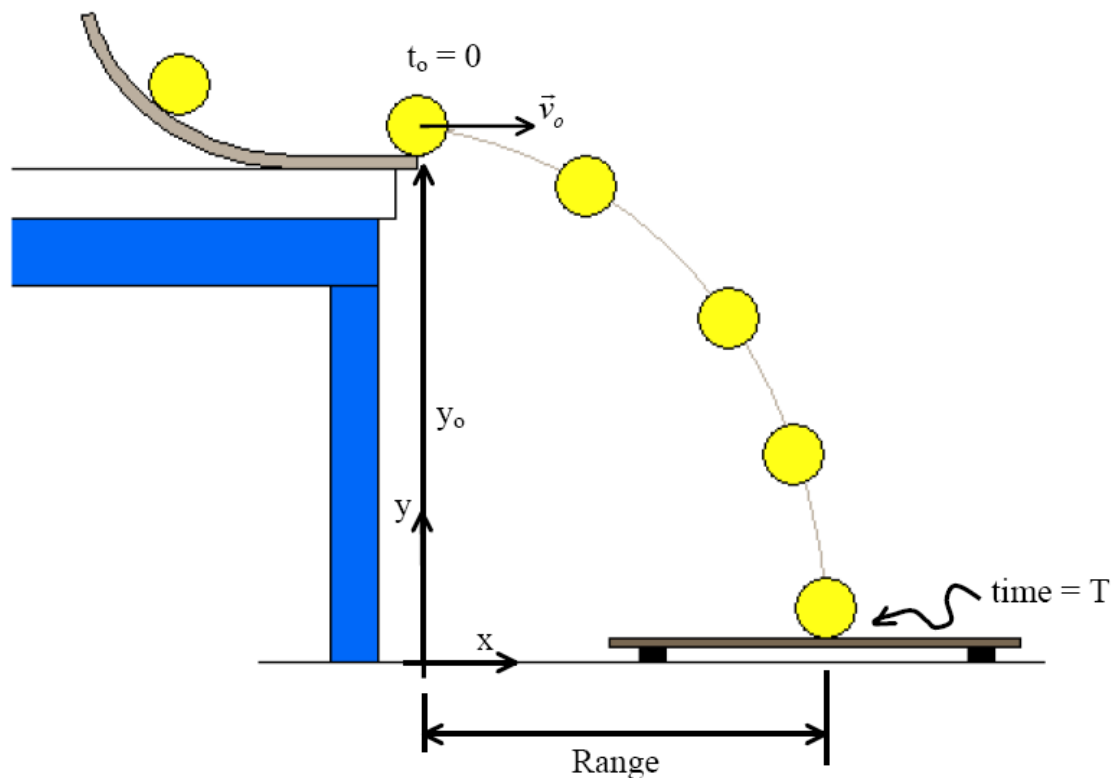


Notice that the equation given above is identical to the kinematic equation in two dimensions for “y” displacement. If we compare this given equation of the line to the “y” displacement kinematic equation, we can see the similarities. Match coefficients on the powers of time ... note that one of them contains a  $\frac{1}{2}$  in addition to the variable you're looking for (hence it'll be double the value shown in the best fit line).

- What should  $a_x$  and  $a_y$  be on earth for all projectile motion (no external forces)?

On Earth, for all projectile motion with no external forces, the acceleration for the x-direction and acceleration for the y-direction are given constants (at zero latitude and sea-level)..

- Find the expressions for the Range (R) and the Time of Flight (T) for the following situation in terms of  $v_{0,x}, x_o, y_o$ , and  $g$ .



Notice that the location of the coordinate system is on the floor. By placing our coordinate system at the location show above, we can get the following initial conditions:

|                         |                                      |
|-------------------------|--------------------------------------|
| $x_o = 0 \text{ m}$     | $y_o = y_o$                          |
| $v_{o,x} = v_o$         | $v_{o,y} = 0 \text{ m/s}$            |
| $a_x = 0 \text{ m/s}^2$ | $v_{o,y} = -g = -9.81 \text{ m/s}^2$ |

We can use the Equations of Motion [which you should have written down from the first question] and the given initial conditions to plug-in the “knowns” to effectively “re-write” the Equations of Motion.

If we use the equation for x-displacement, we can solve for time, and then plug it into time in the equation for y-displacement. This will give us an equation of y [the final height] in terms of y-not (because ☺) [the initial height of the ramp] and g, x [the final range] and v-not [the initial velocity in the x-direction].

Notice that the final height of the ball is  $y = 0$ , and the final range of the ball is told to be R. Change just the x to R and plug in 0 for y (not the y-not). Use this to solve for R After some work, I came up with the following for the range:

$$R = \sqrt{\frac{2y_o v_o^2}{g}} = v_o \sqrt{\frac{2y_o}{g}}$$

YOU MUST SHOW YOUR WORK HOW YOU GOT TO THIS STEP! IF YOU JUST WRITE DOWN THE ANSWER YOU WILL BE MARKED OFF!

Once you got the equation for Range, set R back to x and then plug that back into the kinematic equation for x-displacement and solve for time. Change the little t to big T to represent the time of flight to reach the final range distance of displacement. After some work, I came up with the following for the time of flight:

$$T = \sqrt{\frac{2y_o}{g}}$$

AGAIN, YOU MUST SHOW YOUR WORK HOW YOU GOT TO THIS STEP! IF YOU JUST WRITE DOWN THE ANSWER YOU WILL BE MARKED OFF!