Lab #03: Kinematics #2 “Motion in Two Dimensions”

Pre-lab exercises:

1. A 100-gram ball freely falls from the top of a tower that is 50 m high (H). How long does it take to hit the ground? What is the final speed \( v_f \) of the ball when it hits the ground?

   Does the time or the final velocity depend on the mass of the ball?

2. If the ball has an initial velocity \( v_0 = 10 \text{ m/s} \) in the horizontal direction, write the displacement D of the ball when it hits the ground?

3. In problem 2, if the initial velocity \( v_0 = 10 \text{ m/s} \) has the directional angle \( \theta = 15^\circ \) as shown in the plot below, what is the displacement D when the ball hit the ground?
Physics 111L: University Physics Laboratory
Kinematics #2: Motion in Two Dimensions

A. Introduction:

In the class, important concepts, such as displacement, velocity, and acceleration were introduced. Students learned how to use them in describing the motion of an object. In this experiment, students will have the opportunity to study the motion in two dimensions with a constant acceleration. By this experiment, students will learn:

(1) How to simplify a two-dimensional motion problem into a combination of two separate motions,
(2) How to determine the initial velocity by measuring the final displacement,
(3) How to derive the final displacement under different initial conditions

The equipment used in this experiment is a spring driven launcher that can shoot a “bullet” at a certain speed. The same launcher will be used in other lab such as “Ballistic Pendulum”.

WARNING:
1. Never look into the barrel of the launcher. Observe the status of the launcher through the slots in the top of the barrel.
2. Keep your fingers away from the barrel of the launcher when firing it.
3. Make sure no one is positioned in the path of the steel ball.

B. Procedure:
1. Level the launcher horizontally. Measure the height of the launcher from the floor. This height is the $H$ as shown in the plots in the pre-lab exercises.

2. Place the steel ball in the launcher and cock it using the ram provided. Use the medium range of the cocking position. Fire the ball horizontally and let it fall onto the floor. Measure how far (the displacement $D$) the ball moves in horizontal direction from the initial position projected on the floor.

3. Repeat Step 2 five times and record the displacement for each of them. Find the mean value of the five displacement values.

4. Based on the numbers (use the mean value of $D$) to find out the initial velocity of the ball $v_0$.

5. Tilt the launcher at 30 degrees to shoot the ball upward, and measure the displacement $D$ five times.

Calculate the mean value of these five values. Then, compare with the calculation using the initial speed measured in Step 4.
6. Tilt the launcher at 15 degrees to shoot the ball downward, and repeat what in Step 5.

C. Questions and Discussions:

1. Do all five numbers in Step 3 agree with each other within 10%?

2. Does your data agree with your calculations in Step 5 and 6? What could cause the discrepancy?

3. (Credit question) In Step 5 and 6, what is the percentage of the change in the initial speed of the ball due to the gravitational force over the displacement of the spring in the launcher?