Name: _____ Date: _____ Course: _____ Professor: _____

M9a Prelab: Gravitational Free-Fall Acceleration and Projectile Motion

Read the lab instructions, the appropriate sections from your textbook and watch the videos before answering the questions.

In Lab M9a you will be investigating free fall in one dimension and the projectile motion (free fall in two dimensions). You will collect data, and use these data to calculate experimental value of free fall acceleration, g. Then you'll make conclusion on whether your experimental value of g depended on mass of an object, initial height, initial velocity, and the angle of launch. You will have to construct a graph of time of flight as a function of initial height, fit your experimental curve and conclude on whether your data were in agreement or disagreement with theoretical predictions.

You need to come to the lab ready, and know how to do the calculations and analysis, including which equations to use. The purpose of this pre-lab assignment is to help you in your preparation for the lab. You have to bring your completed pre-lab to the lab, and show it to the lab instructor. Otherwise you will not be allowed to start the lab.

Physics principles related to experiment are described in Chapters 2&3 of the Essential Physics by Wolfson, 4th edition.

I. In Part I of the lab you will be measuring time of free fall of small spheres released from rest at different heights above the ground.
   a) Write down the equation describing vertical position of an object in one dimensional free-fall as a function of time.

   b) Use the equation you wrote above and derive the equation which will allow you to calculate free fall acceleration using initial height and time of flight. You will be using this equation to calculate experimental value of the acceleration for the tables on page 6 of the lab handout.

c) Use the equation you wrote in a) and derive the equation for the time of flight as a function of initial height. You will be using this equation to choose the appropriate trendline for the graph you are required to construct in step 4 of the "Analysis" on page 4 of the lab handout and to conclude on whether your results are in agreement with theoretical predictions.

II. In Part II of the lab, you are going to measure time of flight and horizontal distance traveled by a small ball launched with initial velocity (which will be provided by a computer) at different angles above the horizontal. Then you will perform a number of calculations.

a) Write down the equation describing vertical position of an object in two dimensional free-fall as a function of initial position, time, initial velocity, and initial angle of the velocity above the horizontal.

b) Use the equation you wrote above and derive the equation which will allow you to calculate free fall acceleration using initial height, initial velocity, angle of flight, and time of flight. You will be using this equation to calculate experimental value of the acceleration for the "Analysis" table on page 8 of the lab handout. (Step 6 of the Analysis on page 4 of the lab handout)

c) Write down the equation describing horizontal distance traveled by an object in 2-dimensional free-fall as a function of initial velocity, angle of launch, and time of flight. You will be using this equation to calculate the expected value for the horizontal distance traveled by your ball for the "Analysis" table on page 8 of the lab handout. (Step 7 of the Analysis on page 4 of the lab handout)

d) Combine equations you wrote in a) and c) and derive the equation which will allow you to calculate time of flight using initial height, horizontal distance traveled by the object, angle of launch, and accepted value of the free-fall acceleration. You will be using this equation to calculate time of flight for the "Analysis" table on page 8 of the lab handout. (Step 9 of the Analysis on page 4 of the lab handout)