PHYS101 Lab: Gravity
Instructor: James Cutright

Materials:

Lab Station Computer	PASCO 850 Universal Interface
Rod Stand (on desk)	Metal Right-Angle Clamp (on desk)
Small Rod (on desk)	Plastic Right-Angle Clamp
13 mm and 19 mm steel balls	Free Fall Adaptor
Metric Tap Measure	

Purpose
The purpose of this lab is to measure the acceleration of a falling object assuming that the only force acting on the object is the gravitational force.

Theory
In class we learned about a kinematic equation that can describe the location of an object in time based upon its initial velocity, acceleration, and initial position:

$$y = y_0 + v_0 t + \frac{1}{2}at^2$$

In this lab we want to verify that the acceleration of gravity is in fact $-9.8\ {}^{m}/_{s^2}$. To do this, we will drop a small ball from rest from a known height. If we can accurately measure how long it takes for the ball to hit the ground we can calculate the acceleration of gravity in the following way.

$$0 = y_0 + 0 + \frac{1}{2}at^2$$

$$a = \frac{-2y_0}{t^2}$$

Procedure
1. Assemble the rod stand with the small rod and the metal right-angle clamp. Take a look at Diagram 1 to see how the system is assembled.
2. Use the plastic right-angle clamp to attach the free-fall adaptor to the small metal rod. Make sure that the free fall adaptor is hanging over the edge of the table. Position the pad on the adaptor under the spring-loaded clamp on the adaptor. Use the tape measure as a plumb bob if needed.
3. Connect the free fall adaptors large audio jack to digital port 1 on your PASCO 850 Universal Interface.
4. Find the document titled “PHYS101_Gravity Lab.cap”. You will need to download the file onto your desktop to use it. It is in the Google Drive under “Labs\Lab3”.
5. Place the larger ball in the release mechanism. Press the spring-loaded rod inward to hold the ball in the mechanism and tighten the thumbscrew to hold the rod in place.

6. Position the ball 1.5 meters over the black pad. Press the Record button (Figure 3).
7. Loosen the thumbscrew to release the ball. Do not touch any metal when you do this. The time for the drop will be displayed on the screen. Hit stop when you are done.
8. Take two more trials and record the average of the three times.
9. Repeat this process for heights of 1.25 m, 1.00 m, 0.75 m, and 0.50 m. You do not have to use these heights, they are only suggestions. You are welcome to use others, but they must all be different. You cannot take the same data point multiple times for an object.
10. A suggested data table is given below. Make this table on your paper and fill it out with your data.
11. Repeat for the 13 mm ball. Notice that you can do both objects data runs in parallel, so that you do not waste too much time moving the free fall adaptor around.

Figure 1: Set up for the Gravity Lab

Figure 2: The PASCO 850 Universal Interface. Digital Port 1 is circled.

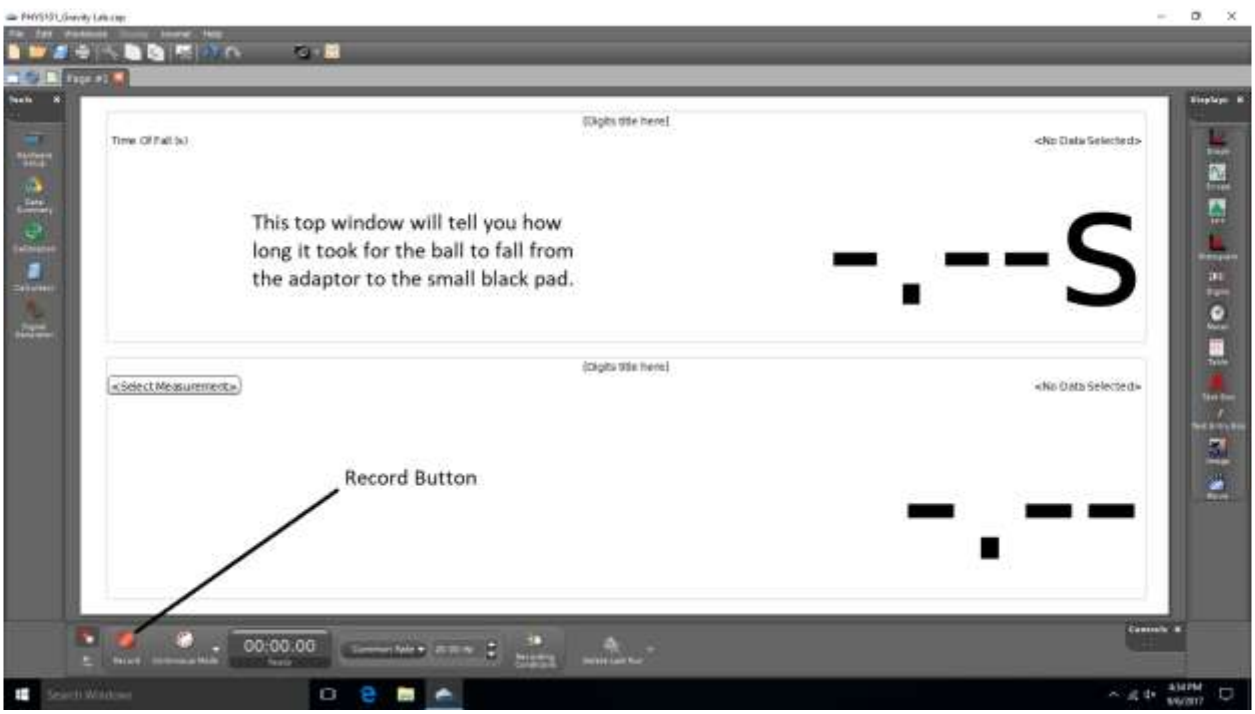

Figure 3: The data acquisition window. The record button is in the lower left hand corner. Data will be taken from the top window.

Suggested Data Table (you need 1 table for each object):

Object: 19 mm Ball

Trial	**1**	**2**	**3**	**4**	**5**
$\boldsymbol{y_0\ (m)}$	**0.5**	**0.75**	**1.0**	**1.25**	**1.5**
$\boldsymbol{t_1\ (s)}$					
$\boldsymbol{t_2\ (s)}$					
$\boldsymbol{t_3\ (s)}$					
$\boldsymbol{t_{ave}\ (s)}$					
$\boldsymbol{2y_0\ (m)}$					
$\boldsymbol{t_{ave}^2 (s)}$					
$\boldsymbol{g = \frac{2y_0}{t_{ave}^2} \frac{m}{s^2}}$					

Average value for g = ___________ m/s^2

% error = ___________ %

Data Analysis

1. Make sure that you have a data table for the 19 mm ball and the 13 mm ball.
2. Compute the appropriate averages for both objects along with the % error for each average. The accepted value for the acceleration of gravity is $g = -9.81\ {}^{m}/_{s^2}$.
3. Graph all the data together on the same piece of paper. You need to graph $2y_0\ (m)\ vs\ \ t_{ave}^2(s)$. Use a square to represent the data from the 19 mm ball. Use a circle to indicate the data from the 13 mm ball.
4. Find the slope of the line that goes through your data, and compare that to the accepted value of g.

Questions

1. The graph that you created very nicely shows that all objects fall at the same rate. Explain how you can reach that conclusion with the graph.
2. The slope of the graph is another way to compute the acceleration of gravity. Is that number a better or worse average than the other two that you calculated. Why do you think this is?
3. What are the sources of error in this experiment? Note: there is no such thing as human error.