The Acceleration of Gravity

Purpose: To measure the acceleration of gravity of a freely falling ball

Equipment: motion detector, Windows based computer, Logger Pro Software, LabPro interface, rubber ball, wire basket, 2m meterstick

Introduction: Your instructor will explain how, using the computer and motion detector we can collect position vs time data for a falling ball. Using this data and the formula for distance (position) traveled by a object accelerating under the influence of gravity, we can calculate the acceleration of the falling object. When an object begins at rest the distance traveled, D, is given by (see your text)

$$\mathbf{D = \tfrac{1}{2}\, a\, t^2}$$

If we do a little algebra and solve for the acceleration, a, we get (go through the algebra steps to solve for a, and show your work here):

Procedure:

1. Connect the LabPro interface to the computer and the motion detector to the DIG/SONIC2 port on the LabPro. Turn on the computer (your instructor will help you log on this first time). On the desktop you should see an icon called **Physics Apps.** Double click on this icon to open the folder that contains various physics oriented software packages. Double click on the icon named **Logger Pro** to start the software that we will use for this lab. Once the Logger Pro software has started select **FILE/OPEN** (with the mouse) and then open the **Mechanics** folder by double clicking on its icon. When this folder opens, double click on **Motion Detector** to open this file.
2. You should now see, on the monitor, a graph of position vs time. The vertical scale (position axis) should be from 0 to 4 m while the horizontal scale (time axis) should be from 0 to 4 s. These values can be changed if you desire by pointing the mouse at the upper and lower limits on either scale and clicking on the number to be changed. Enter in the desired numbers and push the Enter key.
3. Place the motion detector on the floor facing upward and place the wire basket (inverted) over the detector for protection from the falling ball. Check to see that the motion detector is working properly by holding the rubber ball about 1 m above the detector. Have your lab partner click the **Collect** button to begin taking data and then move your hand up and down a few times and verify that the graph of the motion is consistent with the actual motion of your hand. After 4 s the computer will stop taking data and will be ready for another trial. If your equipment does not seem to be working properly ask for help.
4. Give the ball a gentle toss straight up from a point about 1 meter above the detector. The ball should rise 1 or 2 m above where your hand released the ball. Ideally your toss should result in the ball going straight up and down directly above the detector. It will take a few tries to perfect your toss. Be aware of what your hands are doing after the toss as they may interfere with the path of the ultrasonic waves as they travel from the detector to the ball and back. Take your time and practice until you can get a position-time graph that has a nice parabolic shape. Why should it be a parabola? Get your instructor's approval of your graph before proceeding.
5. When you have obtained a good set of data, click on the **X =** button at the top of the window so that the computer will display the position and time data that you just collected. Notice now, that when you point the mouse at a particular point on the curve you are shown the position and time for that point. Move the curser to the very top of the curve on your graph and record, in the table on the next page, the position and time for this point which represents the highest position that your ball reached. In a similar manner, locate another point at the low end of the parabola and record its position and time.

6. By subtracting the two positions and the two times that you just recorded, you will have the distance fallen and the time of fall. Do these calculations and record the results in your table. In the space below the data table show a sample calculation for each different calculation that you do.

Falling Body Data

Trial	Position at the top (m)	Time at the top (s)	Position at the low end (m)	Time at the low end (s)	Distance fallen (m)	Time of Fall (s)	Acceleration (m/s^2)	Accepted Value (m/s^2)	Percent Difference (%)
1									
2									
3									
4									
5									

Sample Calculations

Distance Fallen	Time of Fall	Acceleration

7. Repeat steps 4,5, and 6 four more times and record all of your data in the same table (five trials in all). Select **File/Print** and obtain a printout of one of your graphs to attach to your lab report.
8. Now, using the equation that you worked out for the acceleration (see the box at the start of the lab procedure), calculate the acceleration for each of the five trials. Record these in your data table and finally, find the percent difference between your values of acceleration and the accepted value for the acceleration of gravity. Calculate the average of your five values for the acceleration of gravity and write in the box below:

Average Value for the acceleration of gravity =

Questions: 1. Was there any point in the motion of the ball where the velocity was zero? Explain.

2. In this experiment you measured the acceleration of the ball when it was falling. Was there any point in the motion where the acceleration was zero? Explain.