

Acceleration of Gravity

Purpose:

1. To determine the acceleration of gravity for a freely falling object
2. To gain experience using the computer as a data collector.

Equipment: windows based computer, Lab Pro interface, Logger Pro software, motion detector, rubber ball, wire basket

Introduction: In this laboratory you will use the computer to collect some position (x) vs time (t) data for a rubber ball tossed into the air. Since the **velocity of an object is equal to the slope of the x vs t curve**, the computer can also construct the graph of v vs t by calculating the slope of x vs t at each point in time. We will use both the x vs. t graph and the v vs. t graph to find the free fall acceleration of the ball.

Procedure:

1. Connect the lab pro to computer and motion detector to DIG/SONIC2 port on lab pro. Turn on the computer and load the **Logger Pro** software by double clicking on its icon located within the **Physics Apps** folder. A file named graphlab will be used to set up the computer for collecting the data needed for this experiment. To open this file first 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 **graphlab** to open the file.
2. You should see a blank position vs time graph. 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 on **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?
5. Select the data in the interval that corresponds to the ball in free fall by clicking and dragging the mouse across the parabolic portion of the graph. Release the mouse button at the end of this data range. Any later data analysis done by the program will use only the data from this range. Choose **Analyze/ Curve Fit** from the menu at the top of the window. Choose **a t²+ b t + c (Quadratic)** and let the computer find the values of **a**, **b**, and **c** that best fit the data. If the fitted curve matches the data curve, select **Try Fit**. Click on **OK** if the fit looks good. A box should appear on the graph that contains the values of **a**, **b**, and **c**. Give a physical interpretation and the proper units for each of these quantities. Find the

acceleration, g_{exp} , of the ball from this data and calculate the percent difference between this value and the accepted value, g_{acc} , (9.80 m/s^2).

6. Look at a graph of velocity vs time for this motion by double clicking on the y-axis label and select “velocity” and deselect “position”. Examine this graph carefully. Explain (relate them to the actual motion of the ball) the regions where the velocity is negative, positive, and where it reaches zero. Why does the curve have a negative slope? What does the slope of this graph represent? Determine the slope by choosing **Analyze/ Curve Fit** from the menu at the top of the window. Choose **$y = m t + b$ (Linear)** and let the computer find the values of **m** and **b** that best fit the data. Give a physical interpretation and the proper units for each of these quantities. When satisfied, choose **Try Fit**. Click on **OK** if the fit looks good. Find the acceleration of the ball, g_{exp} , from this data and calculate the percent difference between this value and the accepted value, g_{acc} . Place your data (from step 5 and 6) in the first row of a data table like the one shown below. Finally, select **Experiment/Store Latest Run** to prepare for the next trial.
7. Repeat steps 4 - 6 for at least five more trials. Obtain an average value for the acceleration of gravity and a percent difference between this value and the accepted value.
8. Obtain a printout of one representative graph for position vs time and velocity vs time and include this in your lab report. Ask your instructor to show you how to put both graphs on a single page.

Results from Falling Body Experiment				
	Data For Step 5		Data For Step 6	
Trial	$g_{\text{exp}} (= 2a)$ (m/s^2)	% diff from g_{acc}	$g_{\text{exp}} (= m)$ (m/s^2)	% diff from g_{acc}
1				
2				
3				
4				
5				