

PHY 1033C - Lab 7
Falling Bodies and Acceleration due to Gravity

In today's lab, we will measure the acceleration due to gravity directly by timing falling objects. Steps marked with an asterisk (*) are steps in which data is collected, and so should be completed before lab time ends. Read each step, and any notes that follow, completely before performing the step.

- *1. Stand by the wall and drop a ball from a height of two meters. Time how long it takes to hit the floor. The best way to do this is for one person to drop the ball and also to do the timing. Practice it a few times until you can get reproducible results. Then make about five measurements for recording, and have a second student make five further measurements. Then take the average of all 10 to find the one value for the time at this height.

Note: It is important to have at least two students repeat the timing for each height so that systematic errors caused by reaction times can be abated. Also, you don't need to report all of the individual times measured for each height. You may record them on scratch paper and simply record the average in your lab notebook.

- *2. Now repeat this same procedure for different heights, 0.5 m intervals from 0.5 to 2.5 m. Doing the last point may require standing on a desk.
- *3. You should collect the data of height and average time in a table. Add an extra column for the average time squared (t^2). Also note that if the ball were dropped from a height of 0.0m it would take 0.0s to reach the floor and so you can consider this as one of your data points.
- 4. Recall the equation of motion for constant acceleration

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

Since the ball is dropped, $v_0 = 0$ m/s and $a = g$. The change in height, $y - y_0$, is simply equal to the initial height that the ball is dropped from, thus the equation we are investigating is

$$h = \frac{1}{2} g t^2$$

and we can see that $h \propto t^2$ with proportionality constant $\frac{1}{2}g$. Since gravitational acceleration, g , is part of the proportionality constant, we can estimate g with our data. Create a plot of h (vertical axis) versus t^2 (horizontal axis), and make it plenty **big**. The data should be close to a straight line because the ball ought to fall with constant acceleration. Eyeball a best fit line through the data and measure the slope of this line,

$$\text{slope} = \frac{\text{change in height}}{\text{change in time squared}} = \frac{\Delta h}{\Delta(t^2)}$$

- 5. The acceleration due to gravity, g , is just twice the slope,

$$g = 2 \times \text{slope}$$

So, what is your estimate of g ? Does it seem reasonable? How close is it to the g you measured previously during the Simple Pendulum lab? (If you were absent for the previous lab, get a measurement of g from a lab partner who did the pendulum lab.)