

Acceleration of Gravity

Introduction:

All objects that fall under the influence of gravity alone (“free fall”) accelerate at the same rate, namely

$$\text{Acceleration of gravity, } g = 9.8 \text{ m/s}^2$$

This value of g represents an average value measured by a number of different laboratories throughout the world. On the average, objects pick up 9.8 m/s of downward velocity during each second of free fall. So, when you drop any object, its initial velocity is exactly zero. One second later, its downward velocity is 9.8 m/s. Two seconds after the drop, its velocity is $9.8 \text{ m/s} + 9.8 \text{ m/s} = 19.6 \text{ m/s}$, and so forth. (Note that your textbook uses the less accurate value for $g = 10 \text{ m/s}^2$.)

The displacement of any object in free fall requires a more complicated formula. All dropped objects in free fall obey the formula

$$\text{Height} = \frac{1}{2}gt^2 \text{ in meters}$$

where g is the acceleration of gravity and t is the time (in seconds) it takes the object to fall to the ground.

The purpose of this experiment is to measure the “local” value of the acceleration of gravity which differs typically from the worldwide average of 9.8 m/s^2 . Make sure your group has a tape measure, a stopwatch, a scientific calculator, and a ball to drop.

Data Collection:

- 1) Open Excel.
- 2) Measure a height of 1.5 meters along a wall. Make a small mark at this level.
- 3) Align the bottom of the ball with this mark and drop it. Measure its time to reach the floor and type it in Column A of the spreadsheet. Type in the height in Column B.
- 4) Repeat Step 3 for heights 2.0 m, 2.5 m, 3.0 m, 3.5 m, and 4.0 m. You may stand on your lab table in order to drop – be careful! If you are having difficulties dropping the ball from last three heights, you are permitted to leave the laboratory and perform your measurements along a staircase.

Plotting the Data:

- 1) Highlight Columns A and B. Pull down the Insert menu and pick Chart.
- 2) Select chart type XY (Scatter) then click Next > twice.
- 3) Fill in the chart title as “Drop Height vs. Time”. The X axis value is “seconds” and the Y axis value is “meters”.
- 4) Click the Gridlines tab and remove the check mark.



- 5) Click the Legends tab and remove the check mark, then click Next > and Finish. Your graph has been inserted into your spreadsheet. Ask your instructor to inspect your graph before you proceed to curve fitting.

Curve Fitting:

- 1) Select your graph. Little black boxes will appear in the corners.
- 2) Pull down the Chart menu and pick Add Trendline. Select chart type Polynomial, Order 2.
- 3) Click the Options tab and place a check next to *Display equation on chart*. Click OK. Be sure that your graph resembles the sample shown below.

To finish this experiment, print out your graph and write your names at the top. On the reverse side of your graph, answer the following questions in complete sentences:

1. Use your formula to find the local value of the acceleration of gravity by simply multiplying the coefficient of the x^2 term by 2. Write your answer as " $g = \text{_____ m/s}^2$ ". (For the sample data below, $g = 2 \times 5.3859 = 10.7718 \text{ m/s}^2$.)
2. Describe at least two ways to improve the accuracy of your height measurements.
3. Describe at least two ways to improve the accuracy of your time measurements.

**TURN IN YOUR GRAPH AND THE ANSWERS TO THE QUESTIONS
BEFORE YOU LEAVE THE LAB.**

