Laboratory Activity: Unit 1, Measuring g

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1 The Acceleration of Gravity, First Measurement

The goal of this laboratory activity is to measure g, the acceleration due to gravity. Let g be the acceleration downward, and assume it is constant. Let $v_{i,y}$ be the initial velocity in the y-axis, and assume the y-axis is vertical. Let y_i be the initial vertical position. The position of a vertically accelerating object, in general, is given by

$$y(t) = -\frac{1}{2}gt^2 + v_{i,y}t + y_i \tag{1}$$

In Eq. 1, $-g$ is the acceleration. The vector form of acceleration points down, so we give g a minus sign. We begin to observe the system at time $t = 0$. If a stationary marble is dropped and Eq. 1 is used to predict the position $y(t)$, then $v_{i,y} = 0$. Let the change in height be $h = y(t) - y_i$. Show that

$$h = -\frac{1}{2}gt^2 \tag{2}$$

Use this equation to solve for g. The result should be

$$g = \frac{-2h}{t^2} \tag{3}$$

Use the following procedure to measure g:

1. Use the ruler to measure the vertical displacement of the marble.
2. Use a stopwatch to time the descent of the marble.
3. Insert the measured values of h and t into Eq. 3 to calculate g.
4. Repeat 10 times and compute the average for $g = g_{ave}$.
5. Calculate the *percent error* of g, using the $g = 9.81$ m s^{-2}.

$$\Delta g\ (\%) = \frac{g_{ave} - g}{g} \times 100 \tag{4}$$

2 The Acceleration of Gravity, Second Measurement

Now measure g using a pendulum, constructed in the same fashion as the previous lab activity. Let T be the period of the pendulum, and L be the length. The relationship between T, L, and g is

$$T = 2\pi\sqrt{L/g} \tag{5}$$

Solve Eq. 5 for g, and repeat the above procedure to obtain g_{ave} and the percent error using the pendulum. Compare the results for g_{ave} from each technique.