EXPERIMENT: The Acceleration of Gravity

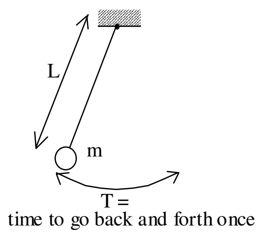
The standard Physics textbook gives the value of the acceleration of gravity as

$$\mathbf{g} = 9.8 \text{ ms}^{-2}$$

You will measure the acceleration of gravity by two completely different methods.

Method 1: You will determine **g** by measuring the period (**T**) of a simple pendulum. A simple pendulum consists of a mass at the end of a (nearly) massless string. The period **T** of such a pendulum of length **L** is given approximately by:

$$T = 2\pi\sqrt{\frac{L}{g}} \qquad (1)$$



Notice that T does not depend on the mass of the pendulum. This expression for T is only accurate if the amplitude of the swing is small. For big swings, T is slightly larger than given by Eqn (1), so we will keep the amplitude to less than 5 degrees.

PROCEDURE: Measuring g with a pendulum.

The length **L** of a pendulum is the distance from the top to the CENTRE of the mass at the bottom. Adjust the length **L** of your pendulum to be close to 1.00 m and measure it as precisely as you can with a meter stick.

Set the pendulum swinging with a small amplitude, less than 5^{o} . Measure the period **T** by using the stopwatch to measure the time for 10 complete swings and then divide by 10. Be sure to start counting from zero, not one! The ***SuperMouse*** software can time the swings for you.

If **L** = 1.000 m, you should get a value very close to 2.00 seconds for the period. A deviation of more than 0.2 seconds means that you have done something wrong. Measure **T** at least 4 times in order to get a good average value.

If we measure **T** as a function of **L** we can check that $T \propto \sqrt{L}$, as predicted by Eqn (1). To get rid of the square root sign we square both sides of Eqn (1):

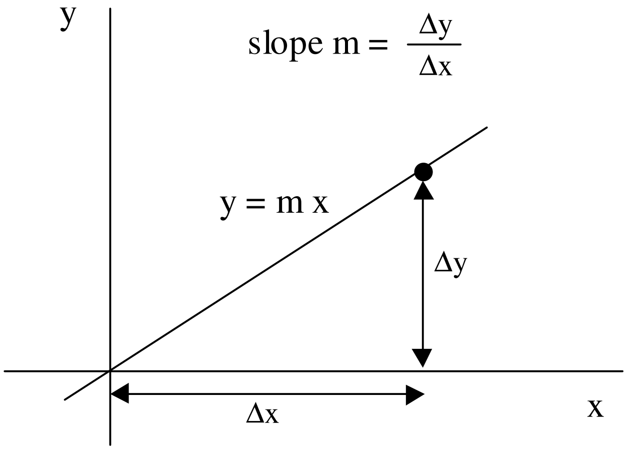
$$T^2 = \frac{4\pi^2}{g} L \qquad (2).$$

This equation has the form y = m x, where y = $\mathbf{T}^2$, m = $4\pi^{2}/\mathbf{g}$, and x = **L**. But y = mx is the equation of a straight line with slope m that passes through the origin. So, if equation (2) is true, then a graph of T^2 vs. L should be a straight line, passing through the origin, with slope = $4\pi^2/\mathbf{g}$.

Measure the period **T**, by timing 10 swings and dividing by 10, for at least 4 additional lengths **L** from roughly 0.2 m to 1.3 m.

Draw a graph of $\mathbf{T}^2$ vs. **L** ($\mathbf{T}^2$ vs. **L** means $\mathbf{T}^2$ on the y-axis, **L** on the x-axis.)

Measure the slope of the graph of $\mathbf{T}^2$ vs. **L** and compare with the predicted value of $4\pi^2/\mathbf{g}$.



Slope or gradient calculation: *If you are to find the gradient of the line show the triangle and the calculations you use. This triangle must be as large as possible and go from the line of best fit.*

Method 2: You will measure the time **t** for objects to fall a distance **d** and determine **g** from

$$d = \frac{1}{2} g t^2 \qquad (3)$$

PROCEDURE: Measuring g with a falling body.
When an object falls freely under the influence of gravity alone, it falls with a constant acceleration, **g**. You will measure **g** by measuring the time **t** it takes a ball to fall a measured distance **d**, starting from rest, and then compute **g** from Eqn (3):

The distance **d** that the ball falls is the distance from the bottom of the ball as it hangs to the floor. Work out a system to allow one person to release the ball while another times the fall. Otherwise the ***SuperMouse*** software will time the fall for you.

Record your procedure for determining **d** and its uncertainty. Record the times from several trails to get a good average value of **t** and an estimate its uncertainty. Use Eqn (3) to determine the value of **g**.

QUESTIONS:

1. Are the two values of g (from parts 1 and 2) consistent? What is their percent discrepancy?

2. In method 1 of the lab, you measure T by using a stopwatch to measure the time T for 10 complete swings, and then divide by 10. Why not measure the time for *one* complete swing?

3. For method 1, list two (or more) different reasons why the value of g you obtain might not exactly yield 9.8 m/s^2. **HINT:** Discuss sources of uncertainty.