Determination of the acceleration of gravity using the simple pendulum

Introduction

The simple pendulum shown in Figure 1 is a mass, *m*, suspended from a point (*O*, assumed to be frictionless), using a rod of neglected mass and length *L*. When the pendulum is displaced from its equilibrium position and then released, it oscillates about that equilibrium position, swinging back and forth along a semi-circular trajectory. During its oscillation, the pendulum is subject to restoring force due to gravity *g*.

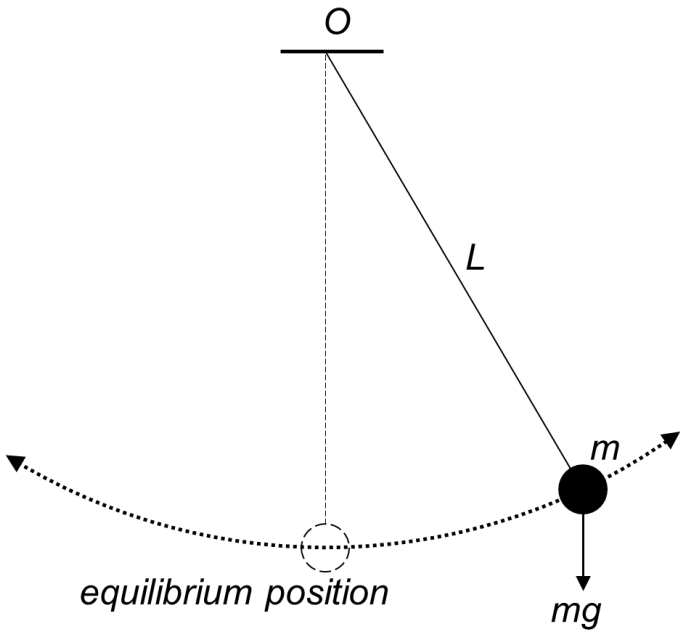

Figure 1: Simple gravity pendulum

Purpose

To determine the acceleration of gravity.

Apparatus

1. A metal sphere with a hook attached,
2. Stopwatch,
3. Meter scale, and

4. Stand and clamp.

Theory

The period *T* of a simple pendulum depends only on the length *L* and the gravitational acceleration *g* (i.e. it does not depend on the mass or the initial angular displacement), and it is given as:

$$T = 2\pi\sqrt{\frac{L}{g}} \qquad \textit{Equation 1}$$

By squaring both sides of Equation 1, a relationship can be established between the period *t* and the length *L*, that is given as:

$$T^2 = 4\pi^2\frac{L}{g} \qquad \textit{Equation 2}$$

It can be noted from Equation 2 that there is a linear relationship between the square of the period T^2 and the length *L*, i.e. it can be graphically represented as a straight line and it is illustrated in Figure 2.

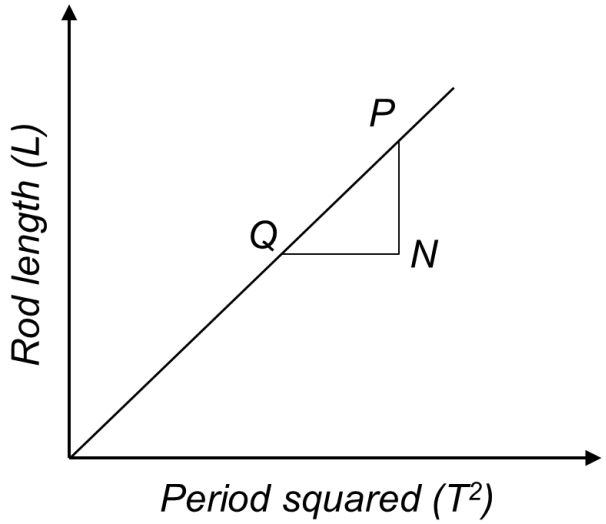

Figure 2: plot of pendulum rod length L and the pendulum period squared T^2

The slope of the straight line shown in Figure 2 can simply be calculated from the vertices of two convenient and well separated points on the line (say *P* and *Q*) as:

$$slope = \frac{\overline{PN}}{\overline{QN}} \qquad \textit{Equation 3}$$

The slope can also be numerically derived from Equation 2 as:

$$slope = \frac{g}{4\pi^2} \qquad \textit{Equation 4}$$

Using Equation 3 and Equation 4, the acceleration of gravity can be calculated as:

$$g = 4\pi^2 \frac{\overline{PN}}{\overline{QN}} \qquad \textit{Equation 5}$$

Procedure

1. Measure the length of the simple pendulum,
2. Displace the pendulum and record the time required to complete 10 oscillations, repeat this step two times,
3. Reduce the length of the pendulum,
4. Repeat 1-3 above until at least 7 different pendulum lengths are tested.

Questions to guide discussions

1. Why is it important to measure the gravitational acceleration?
2. What do we mean by oscillation?