Phy 105/02 Fall 2003
Lab Group 77 (Group Members: Lennon/DiDio/McCartney)
Lab Date: September 2, 2003
Lab Report Submittal Date: September 9, 2003

Lab 1: The Pendulum

Abstract
The goal of this experiment was to determine the effect of mass and length on the period of oscillation of a simple pendulum. The results of this experiment are in close agreement with theory: mass had no measurable effect on the period of our pendulum, while the data for period vs. length is well-described by a power-law relationship very-close to the theoretical square-root dependence.

Introduction
Theoretically, the period of a pendulum is independent of its mass, and depends on length according to the power-law relationship

$$T \propto \sqrt{L}$$

where T is the period of oscillation and L is the length. This result can be determined using a dimensional-analysis approach. The independence of mass is a result of the fact that all objects are accelerated towards the center of the earth with the same acceleration of gravity.

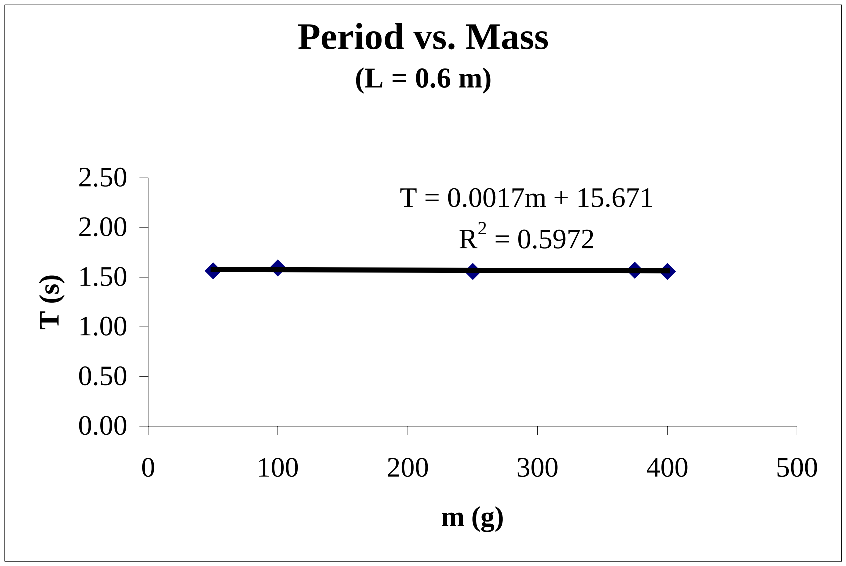
Procedure/Data Analysis
A mass was attached to a string and suspended from a ring stand. A piece of paper with an angle drawn on it was used to start the pendulum from the same initial angle for each measurement. The pendulum swung through a photogate timer connected to a PASCO interface box, and data was collected using Science Workshop

All data collection started a few seconds after the pendulum's release, allowing the pendulum to settle down into a regular motion. The pendulum was allowed to swing through 4-6 oscillations. Scientific Workshop was used to calculate the average period of oscillation. These periods were then recorded for a set of different masses for the same length of string, and then for a set of different string lengths for the same mass.

Mass variations
For this part of the experiment the length was fixed at 0.6 m.

mass (g)	**T (s)**
50	1.56
100	1.59
250	1.56
375	1.57
400	1.56

The data was copied into Excel and graphed. A straight line was fit through the data.

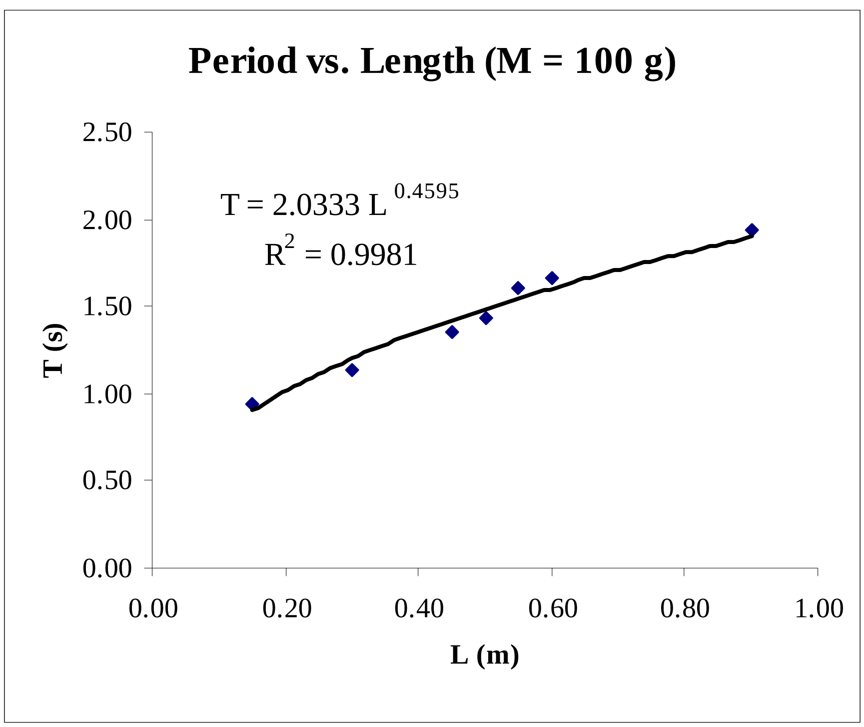


Length Variation

For this part of the experiment the mass was fixed at 100 g.

L (m)	T(s)
0.15	8.31
0.30	11.54
0.45	13.63
0.50	14.77
0.55	15.06
0.60	15.70
0.90	19.25

The data was copied into Excel and graphed. A power law was then fit through the graph:



Conclusions

Our period vs. mass measurements showed almost no noticeable variation with mass. Theory predicts no variation at all. Our variations may have been due to the fact that, as the masses were varied, the length of the pendulum may have changed as the string was unattached and attached. Another possibility for the variation was that the photocell might have reacted differently with the different shapes and materials.

The period vs. length measurements were well described by a power law. Using Excel to fit the data, the best power-law fit is:

$$T = 2.033\ L^{0.4595}$$

Theoretically, the result should be $T = 2.01 L^{0.5}$

Our exponent was close enough to the theoretical value of 0.5 that we are able to say that the length variation of a pendulum's period is a square-root dependence. Discrepancies in the power and in the leading term are most likely due to errors in measurement of length. These errors occur as we try to measure the length of the pendulum from where the string connects to the ringstand to the *middle* of the mass. Determining the middle is not very exact, and hence the L measurements suffer some random error.

Note also that the angle, though controlled, was also not precise. This experiment was not designed to look for starting angle effects on a pendulum's period. Therefore we cannot rule out starting angle effects leading to discrepancies between our results and the theoretical prediction.