Name **Section #**

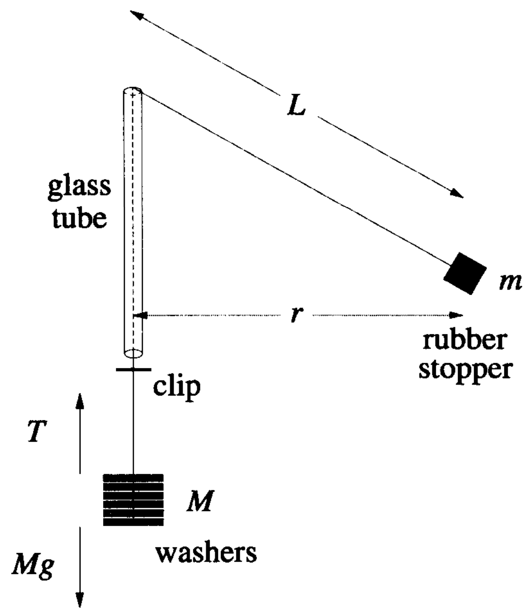
The Conical Pendulum

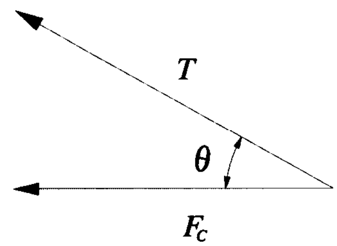
Introduction

The object of this experiment is to examine the conical pendulum as an example of circular motion, as well as to determine the acceleration due to gravity g.

Apparatus

String, paper clip, hollow tube, stop watch, meter stick, washers, standard weights.





Theory

Let T represent the string's tension caused by the hanging washers Mg. Then the centripetal force F_C on the rubber stopper m is given by the horizontal component of T, namely, $F_C \; (= T\cos\theta) = m\frac{v^2}{r}$.

But $v = \frac{2\pi r}{\tau}$ where $r = L\cos\theta$, L is the length of the string as measured from the top of the tube to the center of the whirling mass m, and τ, the period, is the time for m to complete one revolution.

Hence, $Mg\cos\theta = \frac{m\,4\pi^2\,(L\cos\theta)^2}{\tau^2\,(L\cos\theta)}$ from which, $\tau^2 = \left(\frac{4\pi^2 m}{Mg}\right)L.$

If τ^2 were plotted against the length L, the resulting curve should be a straight line with a *slope* of $\left(\frac{4\pi^2 m}{Mg}\right)$. The acceleration due to gravity, g could then be calculated from the relationship $g = \frac{4\pi^2\, m}{M\,(slope)}$.

Procedure

Arrange the apparatus as shown in the above diagram starting with a length, $L = 0.40$ m. Measure and record the masses m of the rubber stopper and M of the washers you will use to provide the tension in the string. Hold the hollow tube and move it in a small circular path to generate the circular motion of the mass m. Regulate the speed in such a way that the paper clip is always 1 cm below the tube. Measure the time for 20 revolutions with the stop watch, then divide by 20 to obtain the average period τ for one revolution. Record all your data under the appropriate columns in the table below. Repeat the above procedure six times, each time increasing the length of the conical pendulum L by 0.10 m. (Both m and M are kept constant in this experiment. L is the independent variable while τ is the dependent variable.)

m (kg) rubber stopper	M (kg) washers

L (m)	t (s) Time for 20 Revolutions	τ (s) Average Period	τ^2 (s^2) Period Squared
0.40			
0.50			
0.60			
0.70			
0.80			
0.90			
1.00			

Plot τ^2 as the ordinate versus L as the abscissa. Draw a line that best fits your data points and determine its slope. Calculate the value of g from the relationship given in the theory section. Show all work on the sheet containing your graph.

Analysis

Discuss any problems in the design or execution of this experiment that might have caused you to obtain an erroneous value for g.

Graph of τ^2 versus L

$slope =$

$$g\left(=\frac{4\pi^2 m}{M(slope)}\right)=$$