Lab 5: Centripetal Force

This week we will measure the value of g.

The way we will do this is that we will observe the circular motion of a mass on a string. The centripetal force will be provided by the tension in the string, and we can write

\[ \text{Tension \ Cos \ \theta = m \ \frac{v^2}{r}} \]

The other end of the string will be connected to a mass \( M \), and if the mass \( M \) is not accelerating, then \( \text{Tension} = Mg \).

The following diagram might make these relationships a little more clear:

![Diagram of centripetal force](image)

This gives us:

\[ M \ g \ \text{Cos} \ \theta = m \ \frac{v^2}{r} \]

If we note that the formula for the period is:

\[ T = 2 \pi \frac{r}{v} \]
We get that

\[ v = 2 \pi \frac{r}{T} \]

\( r \) can be given as a function of the length of the string and theta:

\[ r = L \cos \theta \]

A quick few lines of algebra give:

\[ T^2 = \frac{4 \pi^2 m L}{M g} \]

With that formula, here's what we will do. Pick a series of values for \( M \). Also pick a value of \( L \) and use the alligator clip to help establish this.

Rotate the stopper above your head without bonking anyone near you. While you are concentrating on keeping a constant speed, your lab partner should count 30 revolutions and use a stopwatch to time this measurement.

Graph \( T^2 \) as a function of \( L/M \). What should the slope be? Again, like last week use both this number, and the mean of the values you calculated at each trial. Re-read last week's lab if you don't remember why this is important. Compare your derived value of \( g \) to 9.81 \( \text{m/s}^2 \).