# 10 Circular Motion

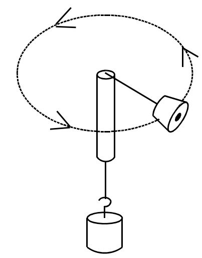
Name ____________________________________________

Lab: GOING IN CIRCLES

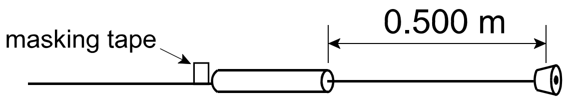
AP/Inquiry Physics

### Setting Up the Stopper, Tube, and Line

You will put a rubber stopper into circular motion, and discover the relationship between the force on the stopper and its speed. **Be sure to get the stopper that matches your group number.** The stopper will be tied onto some string or fishing line, with the line threaded through a short glass tube. Check that the tube is not cracked or broken, and be careful not to drop it.



You will maintain a constant radius of 0.500 m by checking that the distance from the middle of the stopper to near end of the glass tube is that length when the line is taut. Fasten a piece of masking tape to the line just beyond (but not touching) the opposite end of the tube. You will whirl the apparatus, keeping the tape close to the bottom of the tube without touching it. ***Be sure that the stopper is securely tied! All students are required to wear safety glasses during this lab.***




The free end of the line will be tied onto different weights. Each will provide a different force to draw the stopper into a circle, and this will affect the stopper's speed. Be sure the stopper's motion is perfectly horizontal (parallel to the ground), and that you keep the masking tape near (but not touching) the bottom of the tube. ***Be careful not to strike yourself or your partners!***

### Determining the Period

You need to find the time for one revolution of the stopper, which is called the *period*. You can do this either by timing the number of revolutions the stopper makes in a set amount of time, or by timing how long it takes to make a set number of revolutions. Use whichever method you prefer, then divide the total time by the number of revolutions to obtain the sec/rev, which is the *period* in seconds. Repeat the process for a given mass, and then change the mass as needed until you have filled out everything except speed in **Table I.**

**Table I**

| Added Mass | WEIGHT [F] of Hanging Mass (N) | Time [t] (s) | No. of Revolutions [cycles] | Period [T] (s) | Distance Moved per Cycle (m) (see below) | Speed [v] (m/s) (see below) |
|---|---|---|---|---|---|---|
| 50 g | | | | | | |
| | | | | | | |
| 100 g | | | | | | |
| | | | | | | |
| 200 g | | | | | | |
| | | | | | | |
| 300 g | | | | | | |
| | | | | | | |

### Calculating Speed

1. Now you can determine the speed of the stopper. You need the distance traveled divided by time. What is the complete **formula** for the distance around a circle, in terms of the circle's radius [r]?

   d = ______________________ Use that formula to calculate the distance for each cycle and record it in **Table I**.

2. What then is the **formula** for circular motion speed [v] in terms of the radius [r] and the period [T]?

   v = ______________________ Use that formula to calculate the stopper's speeds and enter them in **Table I**.

## Creating a Graph of Force vs. Speed

Once **Table I** is complete, use the computer's Graphical Analysis program to create a graph of Force vs. Speed. Plot force on the y-axis and speed on the x-axis. (For clarity we are going to violate the usual rule that one plots the independent variable on the x-axis. We won't worry about calculating averages, but just plot all of the data.) Create a best-fit line or curve to your data.

**Ask Mr. Meador to examine your graph before you print it.**

3. The graph has a best-fit curve. What type of fit did you instruct the computer to perform (linear, quadratic, inverse, etc.)?

___

4. Given that type of fit, what is the basic relationship between force and speed for circular motion? State your answer as a **proportion** in symbolic form:

___

5. Your best-fit curve allows you to now express the precise equation for your group's data. Write down the complete **equation**, rounding off the values to the appropriate number of significant figures while using F for force and v for speed:

___

## Finding A General Equation for the Force of Circular Motion

6. As we have seen before, the primary constant in your equation (in this case the coefficient of the highest-power term) is related to one or more things that were held constant in the experiment. What did you **NOT** change in the course of the experiment? USE COMPLETE SENTENCES

___

___

7. If you have not measured the values of any of the things you mentioned in answer 6, measure them now. Fill out the table with the names, symbols, and values for all quantities held constant.

8. Looking at the primary constant in your equation in answer 5, play around with the constants and see if your group can discover some ways to combine them mathematically to obtain a value similar to that primary constant. Use the space below for your attempts, and box any equations that seem to work. (Eventually the class will work together using class averages to look for an equation.)

**Constants in this Experiment**

| Name | Symbol (NOT the unit!) | Group Value (with units) | Class Avg. Value (with units) |
|---|---|---|---|
| Radius | r | 0.500 m | 0.500 m |
| | | | |
| | | | |
| | | | |

## Class Analysis: Finding an Equation

The class averages yield the following simplified equation between force and speed: ___

The proportionality constant in that equation should be related to one or more of the constants in the experiment.

Notice that if we calculate ______________ , the class averages yield a value of ________________ .

The **percentage <u>error</u>** between that value and the class average proportionality constant is calculated below:

Thus we can conclude that the following equation applies to circular motion: ___