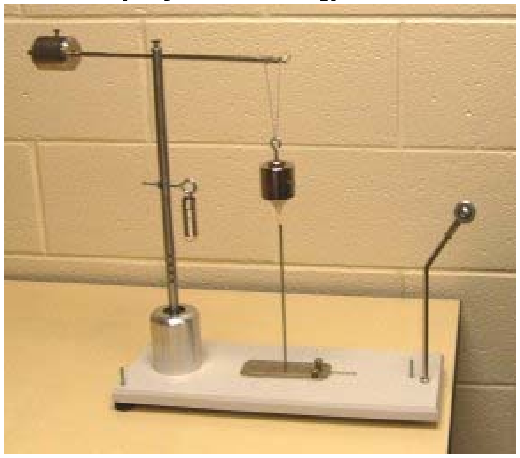
Name:	Teammates:

Introduction

One of the important aspects of velocity is the fact that it has a magnitude and a direction. As you have learned when you studied acceleration, you can change the velocity by changing its magnitude, its direction or both. In the first part of the lab, we will investigate the motion of an object moving at constant velocity in a circle. In this case, the acceleration of the object is due only to the change in direction of the velocity.

In the second part of the lab, we will deal with the concept of moment of inertia. If you have ever experienced a flat tire, you might have wondered why a tire is hollow and must be inflated with air. It cannot be just for the cushioning qualities that an inflated tire gives the wheel. Surely in this age of technological marvels we can develop a solid substance that will give a similar response. The reason that we do not have a solid tire has to do with the rotational properties of such a device. Besides the fact that a solid tire would result in a more massive wheel, and hence, a heavier vehicle, it would also require more mass to be further from the center of rotation for the wheel than an inflated tire. Even if you could somehow create a solid tire such that the entire mass of the wheel was still the same, the fact that more of the mass was near the outer rim would increase the amount of torque necessary to accelerate the tire. The reason is that the mass being further from the center increases the moment of inertia.

As wind resistance and friction sap energy from a moving car, the engine must continually replace this energy. Therefore, it is vitally important to make I as small as possible to limit the amount of energy that must be put into rotating the tire. This means limiting the amount of mass that is on the outer edge of the wheel.



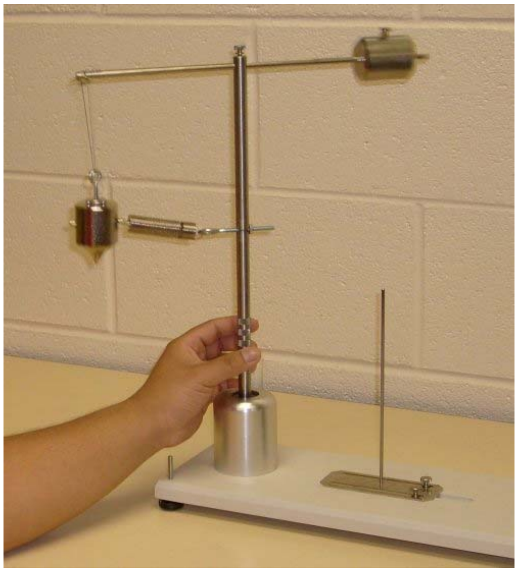
Activity- Part 1

The purpose of this part is to use the relationship between force and acceleration in uniform circular motion to determine the mass of rotating object.

1. Determine the mass of the rotating mass (the “bob”).
2. Start with the spring not connected to the bob and secure the cross-arm in the middle of its range. As shown in Figure 1, choose a radius point directly below the point on the bottom of the bob.
3. Measure the radius of rotation of the bob. This is the distance from the center of the radius point to the center of the vertical shaft.

Mass of bob = m_b = _____ kg

Radius of rotation of bob = R_p = _____ m



4. Attach the spring to the bob.
5. Use your fingers to rotate the center post by turning the vertical shaft. Adjust the rotation rate to keep the bob passing directly over the chosen radius point (over the cross-arm). As shown in Figure 2.
6. Measure and record the time required for the bob to complete 20 rotations. Repeat the measurement three times and provide the average.

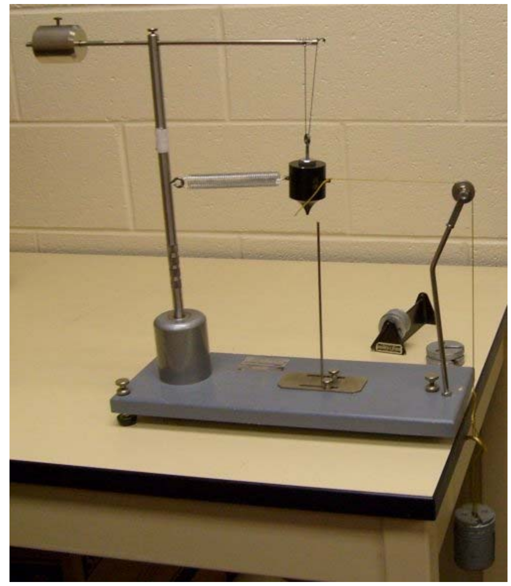
Time for 20 rotations = t = _____ s   Period = T = _____ s

Speed of the bob = v = _____ m/s $a_c = v^2/R$= _____ m/s^2

* Parts of this lab were adapted from labs developed by faculty from the department of physics of the University of South Carolina

7. Stop the rotation. Connect a string to the bob and extend it over the pulley. Measure and record the force necessary to position the point on the bottom of the bob directly over the cross-arm.

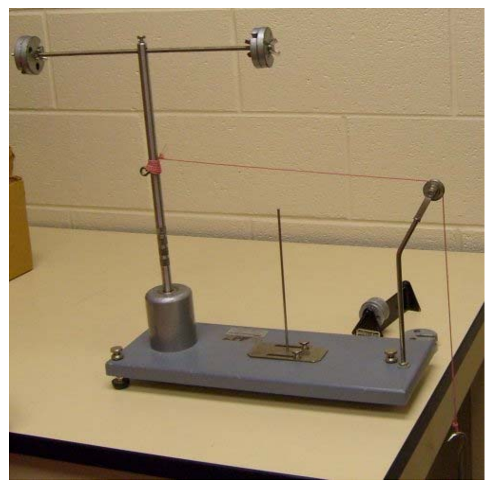
Force on the Spring = F = _____ N m = F/a_c = _____ kg



8. Compare m to the mass of the bob.

9. What are the sources of error in this experiment?

Activity- Part 2



The purpose of this part is to use the relationship between the mass position and the moment of inertia of a rotating object.

1. Record the masses of the wing nuts, the threaded rodand find the length of the threaded rod.

mass of 2 wing nuts = m_n = _____ kg mass of rod = m_R = _____ kg

Length of rod = L_R = _____ m

2. Adjust the 200 gram masses, M, so that they are at the end of the threaded rod. They should both be the same distance from the center. Measure the distance from the center of the shaft to the center of each of the 200 g mass.

Radius = _____ m

3. Tie one end of a string to the eyehook on the shaft and attach a mass of 100 g to the other end of the string.
4. Wind the string around the shaft neatly and hold the shaft so that it does not rotate. When you wrap the string it is imperative that it form a single layer around the shaft. That is, do not overlap the string when you wind it.
5. Simultaneously release the shaft and start the stopwatch. Measure and record the time required for the weight hanger to fall to the floor. Also, count the number of rotation the threaded rod completes to the nearest ½ rotation. Repeat the experiment 3 times and provide the average.

distance traveled by the hanging mass = _____ m N (number of rotations) = _______

Radius (m)						
Average Time (s)						

6. Move the 200 g masses 1.5 cm towards the center and repeat the experiment.
7. Using a spreadsheet, collect the same data as in step 5.
8. Repeat step 6 until you cannot move the 200 g masses any longer.
9. Using a spreadsheet, for each of the averaged data points, calculate the linear acceleration of the hanging mass.

10. What is the relationship between the distance traveled by the hanging mass and the number of rotations?

11. Plot the obtained acceleration versus the radius of rotation of the 200 g mass.

12. What is the relationship between the acceleration and the radius of rotation of the 200 g mass?

13. What do you conclude about the moment of inertia?