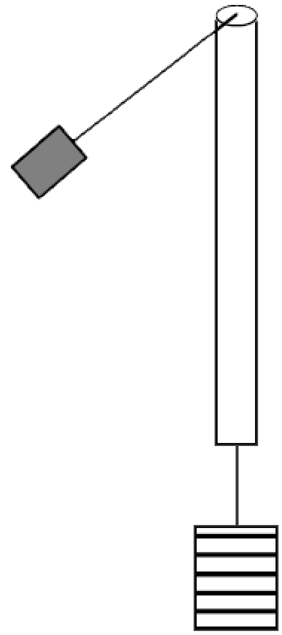
Name:___________________________ Date:____________________________

Centripetal Motion

What force holds the moon in motion around the Earth? What force holds the Earth in motion around the sun? What force keeps a car on the road while going around a turn? What force causes a ball tied to a string to move in a circular path when swung around your head? In all cases of circular motion, the object is undergoing a "center seeking" force that keeps it moving in a circle. This force is a 'real' force and it is called a **centripetal force**.



The objective of this laboratory experiment is to make observations of an object in circular motion, collect data, graph the data, and from the relationships depicted on your graphs to derive a formula for centripetal force, Fc.

<u>Procedure</u>

- Obtain the circular motion apparatus pictured at right:
- Tie a stopper on the end of a 1.5 meter piece of string. Feed the string through the tube. Attach 100g to the string and practice using the apparatus until you can spin the stopper at a constant speed (at a radius of about one meter while keeping the metal indicator (paper clip) at a distance of about 1 cm below the tube.

A. Speed vs. Force

- Determine a radius you would like to rotate your rubber stopper in. Record the radius value above table 1.
- Place a weigh on the mass hanger and complete 20 revolutions (be sure to maintain a constant radius while spinning). Record the time in data table 1.
- <u>Keep the radius constant</u> and adjust the weight by at least 0.49N. Repeat two more times. Record your results.

DATA TABLE 1 Object Mass (kg):____________________ Radius: ____________

Trial	Hanging Weight (N)	Time (20 Rev) (s)	Period (s)	Circumference (m)	Tangential Velocity (m/s)	Tangential Velocity Squared

B. Speed vs. Radius

- Attach around 1.96N to the string as the hanging mass and spin the rubber stoppers at an approx. radius of 1.0 m. Record the time for 20 revolutions.
- Repeat the above step two more times <u>keeping the hanging weight constant</u> but varying the radius from 0.25 m to 1.0 m. Record results.

DATA TABLE 2 Object Mass (kg):____________________ Hanging Weight: ____________

Trial	Radius (m)	Time (20 Rev) (s)	Period (s)	Circumference (m)	Tangential Velocity (m/s)	Tangential Velocity Squared

C. Speed vs. Mass

- Attach around 4.9N to the string as the hanging mass and spin the rubber stoppers at an approx. radius of 1.0 m. Record the time for 20 revolutions.
- Repeat the above step two more times keeping hanging mass and the radius constant and varying the mass at the end of the string by using different objects on the end of the string.

DATA TABLE 3 Hanging Weight (kg):_____________________ radius: _____________

Trial	Object Mass (kg)	Time (20 Rev) (s)	Period (s)	Circumference (m)	Tangential Velocity (m/s)	Tangential Velocity Squared

Analysis:

- Calculate the hanging weight using the equation Fw = m * g.
- Calculate the period of rotation (time for one revolution), the circumference of the circle (C = πr), and the speed of the object (v = 2πr/T), and the speed squared.
- Make three graphs showing how v^2 depends on the centripetal force (hanging weight), the radius, and the mass of the revolving object.
- Using the coefficient of determination discuss the error each of the data sets.

Questions:

1. What is the source of the centripetal force in this activity? What is its direction?
2. What is the relationship between the velocity of a spinning object squared and the centripetal force applied to it?
3. What is the relationship between the velocity of a spinning object squared and the radius of revolution?
4. On the basis of the 3rd graph, what is the relationship between the velocity squared and the mass of the spinning object?
5. Write an equation showing the relationship between v^2 and m, Fc, r. Solve that equation for Fc.
6. Find the maximum speed at which a 2.0 ton truck could maneuver a turn of radius 50.0 m when the coefficient of friction is μs = 0.875. How would the maximum speed change if the road were snow covered and μs was halved?