PHSX 101L **Experiment 6** **Name:**______________________

Title: Centripetal force

Object: To measure the centripetal force which acts on a body when it is undergoing circular motion, and to compare with theory.

Theory: An object traveling at constant speed in a circular path experiences an acceleration which is directed toward the center of the circle and has a magnitude given by the formula

$$a_c = \frac{v^2}{r} \tag{1}$$

where v is the speed and r is the radius.

The speed v can be computed from $v = 2\pi r/T$ where T is the time for one revolution (known as the period). This acceleration, since it is directed toward the center of the circular path, is called centripetal (or center-seeking) acceleration.

By Newton's 2nd Law it is known that a force accompanies any acceleration. Thus, a centripetal force must be applied to the rotating body in order for it to experience a centripetal acceleration. This force is calculated from Newton's 2nd Law as:

$$\boldsymbol{F}_c = m\boldsymbol{a}_c \tag{2}$$

where m is the mass of the rotating body and $\boldsymbol{a}_c$ is the centripetal acceleration as computed from the above formula.

Procedure: The experimental apparatus consists of a variable speed rotator which rotates a known mass attached to the end of a spring. As the mass rotates the spring stretches and exerts the required centripetal force on the mass.

1. Measure the tension in the spring by removing the spring and mass assembly from the rotator and hanging it from a support. With the spring tension adjusted to the desired value, weights are hung on the spring until it stretches out to the point where it activates the trigger/pointer. The spring tension force (which is the centripetal force when rotating) is then equal to the combined weights of all the masses hanging on it.

2. The spring and mass assembly is then replaced in the rotator and set into rotational motion. The rotational speed is adjusted until the spring stretches out and activates the trigger/pointer.

3. Measure the number of revolutions in a given time. Also measure the radius of the path, the mass of the rotating body and elapsed time.

4. The centripetal force is then calculated using the above theoretical formula, and the result is compared with the spring tension force found in step 1.

5. Now adjust the spring tension to a different value and repeat the above procedure. This will be trial 2.

Apparatus: Make a drawing of the rotator and the spring-mass assembly.

Results:	Trial 1	Trial 2
Total mass of hanging objects:	__________	__________
Tension force in spring (weight of hanging objects):	__________	__________
Number of revolutions:	__________	__________
Elapsed time (total):	__________	__________
Radius of path (to center of mass):	__________	__________
Circumference of path ($2\pi r$):	__________	__________
Speed of rotating body:	__________	__________
Acceleration of rotating body (use equation 1):	__________	__________
Mass of rotating body:	__________	__________
Centripetal force calculated from $\boldsymbol{F}_c = m\boldsymbol{a}_c$:	__________	__________
Percent difference between theoretical centripetal force and measured spring tension:	__________	__________

Questions: Suppose you tied a 1.5 kg rock to the end of a cord 2 m long and swung it around you in a horizontal circle so that it made one revolution every 2 seconds.

1. Compute the speed of the rotating rock.

2. Compute the tension force in the cord.

Conclusions: