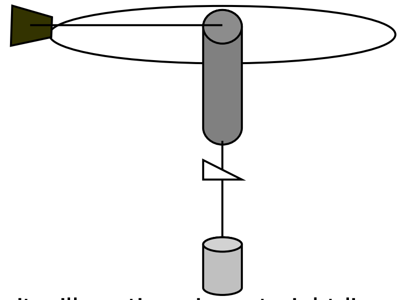
CIRCULAR MOTION

*NAME*_________________
*PARTNERS*___________________________



If no net force acts on a moving object, it will continue in a straight line. To cause an object to travel in a circular path, a force must constantly act perpendicular to the direction of motion forcing it inward. This force, called the ***centripetal force***, will therefore always be directed toward the center of the circle.

Objectives:

During this investigation you will study circular motion experimentally. You will use graphical analysis of circular motion to study the relationship between the centripetal force and the speed of an object in a circular path.

Materials:

Metal tube, string (about 1.5 m long), 2-hole rubber stopper, 5 large washers, washer holder, alligator clip, stopwatch, safety goggles.

Procedures:

CAUTION: SAFETY GOGGLES <u>MUST</u> BE WORN BY ALL.

1. Hold the string in your hand and practice whirling the rubber stopper in a **horizontal** circle at a constant speed above your head. You will find that the faster you whirl, the larger the force required to hold the string.
2. Let the string hang through the tube and hold the tube only. Adjust the string length so that the radius of the circular path will be 80 cm (0.8 m). Place the alligator clip on the string 1 inch from the bottom of the tube. [This will remind you of the required 80 cm radius throughout.]
3. With 5 large (or 10 small) washers on the holder, whirl the stopper in a circle moving the tube as little as possible. The clip should stay at the same spot! If it rises, slow down. If it falls, speed up slightly. When the clip remains at the desired location for a moment have your lab partner use the stopwatch to time 10 complete revolutions. Record this value in the table.
4. REPEAT 5 more times, removing one large or two small washers each time.

Data & Results:

Radius = _____ m
Circumference = 2 π r = _____ m
Mass of rubber stopper = _____grams = _____ kg
Hanger mass = _____grams = _____kg

5. Calculate the period (time for 1 revolution) of the stopper.
6. Determine the speed of the stopper (as circumference /period).
7. Calculate the speed squared for each trial to be used in a later graph.

Trial 1 = hanger only = ___grams = ____Newtons. Record in row 2, column 2 below.
Trial 2 = hanger + 1 washer = ____grams = ____Newtons, etc...

Trial #	**Force (mass of hangers in kg * 9.8)**	**Time for 10 Revolutions (s)**	**Time for 1 Revolution (s)**	**Speed (m/s)**	**Speed^2 (m/s)^2**
0	0	-	-	0	0
1					
2					
3					
4					
5					
6					

Interpretation:

1. In this investigation, you varied the force (# of washers) in each trial. Plot a graph of speed on the horizontal axis vs Force (mass of hangers) on the y-axis. Draw the best-fit line (it may not be linear). Be sure to include the 0,0 point.

2. What does the shape of your graph reveal about the relationship between **F** and **v**? Is it a direct-linear (straight line) relationship or is it a direct-square (parabola) relationship?

3. Plot a second graph of force vs speed^2 . What does the shape of your graph reveal about the relationship between **F** and **v^2**? Is it a direct-linear (straight line) relationship or is it a direct-square (parabola) relationship?

4. The equation for centripetal force is $F_c = mv^2/r$. How do the results of your graph support this equation? How so?

Enrichment: Mandatory for AP physics students, +2 Bonus for Regents physics students.

5. Calculate the slope of the F vs v^2 graph (be sure to show both points on the graph used).

6. Since the general equation of a straight line is $y = mx + b$ with $b = 0$ here, $F = kv^2$ where k = the slope of the line. Set k = mass of stopper / radius and solve for mass of stopper.

7. Mass the stopper and determine the % error between the two values.

8. Explain why the masses differ at all citing at least two legitimate sources of error.