Name **Section #**

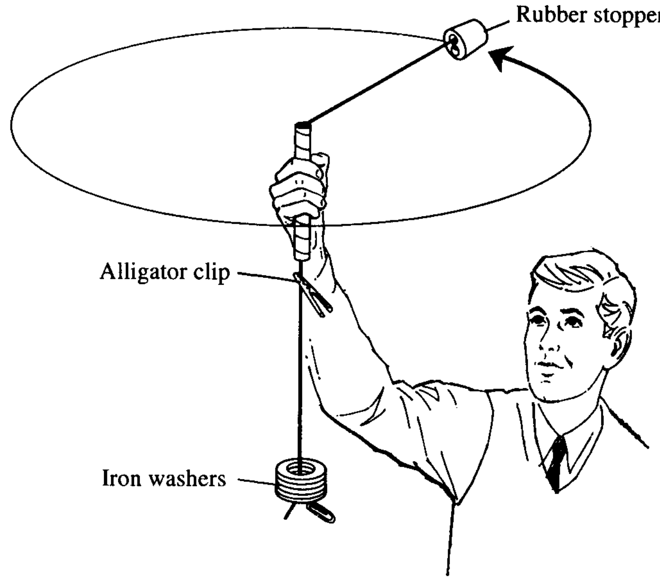
Uniform Circular Motion

Introduction

A body moving in a circular path such as a car rounding a curve requires a centripetal force. Should this force be lacking, as in the case of a car with bald tires, it would not be able to maintain its circular path, but rather go off in a tangent. The relationship between the centripetal force F the body's mass m, its speed v, and the radius of the circle R is given by the equation $F = \frac{mv^2}{R}$.

If the mass and radius are kept constant, the centripetal force varies directly with the square of the body's speed. (This is one reason neophyte drivers lose traction when rounding a curve at too high a speed; they don't expect the required centripetal force to become so large.) The purpose of this experiment will be to show that F varies directly with v^2.

Unfortunately, the design for this experiment has a serious flaw and one of your objectives will be to expose the design flaw. You will not be able to do so by simply reading the procedure section. The problem only becomes apparent when you actually perform the experiment.



Procedure

The equipment consists of a glass tube through which a cord is passed. A rubber stopper is attached to one end of the cord and a large paper clip which can hold iron washers is attached to the other end. The rubber stopper, representing the system's mass m, should be pulled out from the top of the tube so that its radius of revolution R, is approximately 0.7 meters. Connect an alligator clip to the cord at the other end of the tube in order to keep the radius constant during the experiment. The iron washers at the end of the cord will provide a centripetal force F to the rubber stopper.

To calculate the speed v at which the rubber stopper rotates, you have to obtain its period T, the time it takes to complete one revolution. The speed is then given by the relationship: $v = \frac{2\pi R}{T}$. Since the period is less than one second, measure the time to complete 30 revolutions, and then divide by 30 to improve upon the precision.

The amount of centripetal force is varied by changing the number of iron washers hanging from the cord's end. Start by attaching 12 washers, whirl the rubber stopper around for 30 revolutions, determine the elapsed time, and then compute the period T for one revolution. The purpose of the alligator clip is to keep the radius of revolution, R constant. While you whirl the rubber stopper in a level, horizontal circle, see to it that the alligator clip is always close to, but never quite touches, the glass tube. (Should the alligator clip press against the tube, it will be the clip, rather than the washers, that provides the centripetal force.) The stopper's speed can be found from the above equation. After all the data has been entered in the first row of the data table, remove one iron washer and repeat the experiment. Continue by decreasing the number of washers until you only have one left.

Plot the centripetal force, F (# of iron washers) as the ordinate versus the square of the speed, v^2 as the abscissa.

Number of Washers	t, Time for 30 Revolutions (s)	Period, $T = \frac{t}{30}$ (s)	Speed, v (m/s)	Speed squared, v^2 (m^2/s^2)
12				
11				
10				
9				
8				
7				
6				
5				
4				
3				
2				
1				

Graph of F versus v^2

Questions

What does the graph show you about the relationship between the centripetal force and the speed of the rubber stopper?

How would you change the experiment to investigate the relationship between the mass of the stopper and the centripetal force?

How would you change the experiment to investigate the relationship between the radius of the circle and the centripetal force?

What was the flaw in the experiment's design? Discuss how this problem affects the relationship between the speed and the required centripetal force.