**Purpose:** to determine the relationship between the period of an object in circular motion and the force creating the circular motion.

**Materials:**



|  |  |
| --- | --- |
| balance | rubber stopper |
| string | glass tube |
| meter stick | tape |
| timer | paper clips |
| washers |  |

**Method:**

1. Find mass of your rubber stopper using one of the balances. Find the average mass of one of the washers (be sure they are all about the same size) by placing 10 of them on the balance and massing them. Then divide by 10 to get the average mass of one washer. Record both of these values.

2. Thread about 1.5 meters of string through the tube and then through the rubber stopper. Tie the knot securely on rubber stopper to make sure that it doesn't come loose during the lab. Tie a paper clip to the other end of the string and unfold it so that it can support the washers.

3. Pull the string so that there is about 80 cm of string from the **top** of the tube to the rubber stopper. Place a piece of tape on the string just **below** the tube to mark the length of the string. Measure the distance from the top of the tube to the center of the rubber stopper and record it.

4. Hang 4 washers on the paper clip and hold the tube vertically. Swing the stopper in a horizontal circle above your head and adjust the speed until the washers hang in equilibrium. The tape on the string should be just below the tube but not touching it. When you are sure the washers are in equilibrium and can swing the stopper at a fairly constant speed, then you can take data.

5. Measure the time it takes for the stopper to make 10 revolutions and divide by 10 to get the time for one revolution. Record this in a data table in your lab book. Repeat this measurement 5 times and record the period (time for one revolution) and the total time for each measurement.

6. Repeat steps 4-5 with 8, 12, 16 and 20 washers hanging on the paper clip. Record your data in a table along with the total mass of the washers for each trial.

**Data:**

Average mass of one washer =\_\_\_\_\_\_\_\_\_\_\_\_\_\_Kg rubber stopper mass ms =\_\_\_\_\_\_\_\_\_\_\_Kg

*Record the mass of the hanging washers and the time for ONE revolution (period) in the table below.*

|  |  |
| --- | --- |
| Mw (Kg) | T=Period |
| Trial 1T (s) | Trial 2T (s) | Trial 3T (s) | AverageT (s) | Standard Deviation |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

**Calculations:**

1. Calculate the average period for each of your measurements and record them in the data table above.

1. Complete the table below. **Mw** stands for the mass of the hanging washers and **ms** stands for the mass of the flying rubber stopper. Show one calculation for each quantity.

|  |  |
| --- | --- |
| **V = 2R/T** | **Fc=msv2/R** |
|  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Mw** | **Mwg** | **Tav** | **V = 2R/T** | **Fc=msv2/R** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

**Analysis Questions:**

1. The tension in the string which holds the washers in equilibrium is providing the centripetal force for the rubber stopper to travel in a circle. Therefore, the weight of the washers should be equal to the centripetal force. These are listed in the gray columns above. How close are these values? Are any values closer than others? Explain.

1. Plot a graph of Mwg (on the y-axis) vs. v (x-axis).



1. Determine how to modify the data to get a straight line. Plot the line of best fit on the graph. Record the equation below.

Equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



1. Using the relationship Mw­\*g= msv2/R, solve algebraically for the slope of this line. Plug in values for R, ms and g into this expression and compare this theoretical value for the slope to the experimental value you got in question 2 above. How do they compare? What is the percent difference?

1. How do you think you could have improved your measurements in order to reduce this percent difference? [I am assuming you eliminated any measurement blunders and re-measured anything you made a mistake on: what I want to know is how you could improve your precision.]