**CFaA v2**

**FEEL THE FORCE**

**Centripetal Force and Acceleration**

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Hour\_\_\_\_\_\_\_\_\_Date\_\_\_\_\_\_\_\_\_\_\_\_\_

**PURPOSE**: What is the relationship between the centripetal force (the inward-pulling force) acting on an object moving in a circle of constant radius, the velocity of the object, and the time required for one revolution of the object?

**PROCEDURE:**

1. **WEAR SAFETY GLASSES WHEN DOING THIS PROCEDURE**.
2. Obtain the centripetal force apparatus. Make sure that the string and rubber stopper are securely fastened together. Set the top of the clamp that holds the spring scale at the topmost mark of the 10 marks that are etched onto the barrel of the apparatus.
3. Whirl the stopper over your head, holding onto the apparatus below the spring scale. Adjust the speed of the motion so that the scale reads 1.0 N of centripetal force. Whenever you are ready to increase the force by 0.5 N, move the clip downward one notch to help guarantee that the circle described by the stopper keeps a fairly constant radius.
4. Whirl the stopper over your head, adjusting the speed to show a force of 1.0 N. Hold the rate constant for 30 revolutions, counting out loud and having your partners measure the amount of time it takes to make the 30 revolutions. Record the time needed for 30 revolutions.
5. Lay the apparatus flat on the table or floor. Gently pull the string and stopper straight out until the force scale reads 1.0 N. Measure the length of string from center of stopper to tip top of apparatus. You are measuring the radius of the circle created by the moving stopper. When you repeat this step after other trials, always be sure to move the clamp down one notch and to pull the string and stopper out until the scale reads the same force as you used. DO NOT MEASURE THE RADIUS AGAIN--IT WILL REMAIN CONSTANT AT THIS VALUE IF YOU REMEMBER TO MOVE THE SPRING SCALE DOWN ONE NOTCH WITH EVERY NEW FORCE.
6. Repeat the procedure several times. Complete the tables.

|  |  |
| --- | --- |
| **USEFUL INFORMATION**:  circumference, **C**  radius of circle, **r**  time for one revolution, **t**  centripetal force or circular force, **Fc**  centripetal acceleration or circular acceleration, **ac**  **C= 2**π **r**  **v= d / t = C / t = (2** π **r) / t**  **ac= v2 / r** |  |

Newton's second law, as written for centripetal force: **Fc = m ac**

**Time Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Force (N)** | **Time for 30 revolutions (s)** | **Time for 1 revolution (s)** | **Radius of circle (m)** | **Circumference of circle (m)** |
| **0** |  |  | **\_\_\_\_\_\_\_\_\_\_**  **(Measured once; will be the same for all trials)** | **\_\_\_\_\_\_\_\_\_\_**  **(Measured once; will be the same for all trials)** |
| **1.0** |  |  |
| **1.5** |  |  |
| **2.0** |  |  |
| **2.5** |  |  |
| **3.0** |  |  |
| **3.5** |  |  |
| **4.0** |  |  |

**Results (Acceleration)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Force (N)** | **Velocity around the circle (m/s)** | **Acceleration around the circle (m/s2)** | **Mass of stopper (kg)** |
| **0** |  |  | **\_\_\_\_\_\_\_\_\_\_**  **(Measured once; will be the same for all trials)** |
| **1.0** |  |  |
| **1.5** |  |  |
| **2.0** |  |  |
| **2.5** |  |  |
| **3.0** |  |  |
| **3.5** |  |  |
| **4.0** |  |  |

**CONCLUSIONS**: Answer these questions on your own quadrille paper. Use complete sentences.

1. Since you kept the radius constant, the speed of the stopper moving in a circle of any radius is equal to **v = 2** π **r / t.**  If it takes more and more time to make one revolution of the stopper, what will happen to the velocity of the motion?
2. When the radius is kept constant, what kind of relationship is there between centripetal force and the velocity ?
3. What would you do to change the experiment to investigate how the radius and the time of revolution related to each other? What variable(s) would need to be kept constant?
4. Graph: Acceleration vs. Force. If the graph is a straight line, calculate slope and write the equation for the best fit line. What is the meaning of the graph? In what other experiment(s) or situations would you have see a graph like this?
5. Describe three examples of real-life objects in circular motion. Draw each situation and include an arrow to represent the centripetal force .
6. When an object that had been moving because of centripetal force suddenly loses its centripetal force, what happens? Why?
7. Write a paragraph (use at least five complete sentences)summarizing what you *did* and what you *learned* in this experiment.