**Centripetal Force (Acceleration)**

**Equipment:**

constant velocity car, string,

stopwatch, ruler, calculator, scale

table or chair leg or ring stand or pencil

**Group roles**: (record names)

Reader/recorder (reads instructions and records data, operates stopwatch in group of 3):

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Driver (operates car and manages string; holds scale ): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Measurer (measures radius and counts laps; reads scale):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Timer (operates stopwatch in a group of 4): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remember that Newton’s 2nd law says that every unbalanced force acting on an object produces an acceleration. The force that keeps an object moving in a circle is called a *centripetal* force and the acceleration it produces is called centripetal acceleration, sometimes also called radial acceleration. This acceleration is always provided by some force already acting in a situation, not by a new, separate force. For example, a car going around the curve in a road keeps going in a circle because of the friction between the tires and the road surface. In this experiment we will use the *constant velocity car* and some string to do an experiment with this type of acceleration.

**Measurements:**

See the illustration on the next page. Tie a string that is about 30 cm long around a ring stand or the leg of a table or chair. Tie the other end of the string to the steering wheel of your “constant velocity” car. The car will move in circle around the post or leg (why?). The car now has constant speed and a constantly changing direction so its velocity is constantly changing (acceleration).

car

string

r

 Sketch of set-up

Measure the distance, to the nearest tenth of a centimeter, between the center of the ring stand, chair, or table leg and the inside edge of your car and record this distance as **r**. Express your measurement in meters.

 **Radius of circle r =**\_\_\_\_\_\_\_ m

The period, **T**, is the time it takes for one trip around the circle. Measure the total amount of time, in seconds, it takes for the car to make 10 full circles and then divide by 10.

Hold the car upside down (wheels up) in your hand with your fingers away from the wheels. Turn the car on using the switch. Place the car near the ground and stretch the string to the distance you measured for r. Let your lab partner know you are ready to turn the car over. Turn the car over. Let the car make one or two ‘practice’ circles before you start counting for your official measurement. This will help make sure the string does not stretch out too much during your data collection. After the first one or two circles, start counting circles (laps) and measure the total time it takes the car to make 10 full circles.

  **Time for car to make 10 full circles** \_\_\_\_\_\_\_\_s

 **Period** **T =** \_\_\_\_\_\_\_\_s

**Finding the centripetal acceleration:**

We can find the centripetal acceleration, ac, of the car using the data we have collected so far, R, and T.

We will use the formula $a\_{c}=\frac{4π^{2}r}{T^{2}}$

Show your calculation of the centripetal acceleration, ac, here:

**Finding the centripetal force:**

Newton’s 2nd law says that every unbalanced force **F** acting on an object of mass **m** produces an acceleration, **a**, $F=ma$

Measure the mass, **m**, of your car using the spring scale. Hold one end of the spring scale in your hand and hang the car by the hook on the spring scale by attaching it to the windshield. Hold your hand, the scale and the car still. The spring scale will give the mass in grams but we need it in kilograms (kg).

 **m =** \_\_\_\_\_\_\_\_\_kg

Now we know the mass of our car so that we can also find the *centripetal* force acting to keep it moving in a circle from $F\_{c}=ma\_{c}$

Show your calculation of the centripetal force, Fc, here:

**Further questions:**

Think about the experiment you just did and the formula for the centripetal acceleration that you used above. Describe how you would design an experiment to measure how the acceleration changes with changing radius. Predict how the magnitude of the acceleration changes with a longer radius.

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