LAB REPORT: Centripetal Acceleration (CFA)
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OBJECTIVES

In this experiment, you will

• Collect force, velocity, and radius data for a mass undergoing uniform circular motion.

• Analyze the force vs. velocity graphs.

• Determine the relationship between force, mass, velocity, and radius for an object undergoing uniform circular motion.

• Use this relationship and Newton’s second law to determine an expression for centripetal acceleration.

MATERIALS

LabQuest Vernier Centripetal Force Apparatus

Vernier Photogate masses

Vernier Dual-Range Force Sensor

PROCEDURE

1. Attach a Dual-Range Force Sensor and a Vernier Photogate to the Vernier Centripetal Force Apparatus (CFA), as shown in Figure 1.

2. Connect the force sensor and the photogate to LabQuest.

3. Set up data collection.
   a. Tap Mode. The default Photogate Mode►Motion works for this experiment. Select
   b. To control when data collection stops, tap the option labeled “with the Stop button” in
   c. From the Graph menu select Graph 1. Change the axes of the graph so that it shows
   d. Tap the Meter tab.
4. Determine the mass of the sliding mass carriage. Add mass to both the sliding and fixed mass carriages as directed by your instructor. The mass of the sliding and fixed carriages should be the same so that the beam is balanced. Record the total mass of the sliding carriage and extra mass.

5. Position the fixed carriage so that its center is 10 cm from the axis of rotation. Adjust the position of the force sensor on the rail so that, when the line is tensed, the center of the sliding mass carriage is also at 10 cm.

6. Zero the force sensor.

7. Spin the beam by twisting the knurled spindle of the CFA with your fingers. When the force reaches 3–4 N, begin collecting data. Let data collection continue for 20-40 s. When you stop data collection, use the friction between your hand and the knurled spindle to stop the beam.

8. If your graph of force vs. velocity is not linear, create a “calculated column” that will enable you to obtain a linear graph (linearized graph F vs. v2 the User defined button. The distance to be entered is 1/10 of the circumference of the mass path. Because the radius in part 1 is 10 cm, this value should be 0.0628 m. the field labeled “End data collection.” Tap OK. force vs. velocity.). Your instructor will explain step by step how to do this if you cannot do it by yourself.

PART 2 – INVESTIGATING THE EFFECT OF MASS AND RADIUS

When a quantity (in this case, force) is a function of more than one variable, it is usually the case that the slope of the graph is related to the parameters held constant during the experiment.

Examine the units of the slope of your graph of F vs. v and radius that has the same units as that of your slope. Substitute the known values of these parameters; how closely does the value of this expression agree with that of your slope? Predict the effect of doubling the mass on the value of the slope. What effect would doubling the radius have on the slope? You can test your conclusions by varying first the mass and then the radius as follows.
PROCEDURE

1. Change the mass on both the fixed and sliding carriages and record the value of the total mass of the sliding carriage and any extra masses.

2. Re-zero the force sensor, then spin the beam as you did before. Once the force reaches 5–8 N, begin collecting data. When you stop data collection, stop the beam as you did in Part 1.

3. Change the system mass again and record the value of the total mass of the sliding carriage and any extra masses, then repeat Step 2.

4. Return the mass on both the fixed and sliding carriages to the original value used in Part 1. Decrease the radius of both the sliding and fixed mass carriage by 2-3 cm. Record the value of the radius. Adjust the value of the User defined distance in the Mode window so that it is 1/10 of the circular path of the mass carriage. A warning will appear. Choose to discard the data.

5. Re-zero the force sensor, then spin the beam as you did before. Once the force reaches 5–8 N, begin collecting data. When you stop data collection, stop the beam.

6. Now, change the radius so that it is 2–3 cm greater than your initial value. Be sure to adjust the User defined distance as you did in Step 5. Record the value of the radius, then repeat Step 6 and 7.

7. Repeat step 8 of last section to linearize your last plots. Again, create a calculated column for v2. Use this calculated column to plot F vs. v2.
Result

The Graph are show the circularmotion experiment

- First Graph at the bottom use 100 gram on both side at the radius 10 cm.

- Second Graph at the middle use 200 gram on both side at the radius 10 cm.

- Third Graph at the top use 300 gram on both side at the radius 10 cm.

Analysis:

As the result from the experiment, graph 1 had the most acceleration however, it had the least mass among the 3 runs. The 2nd graph show the decreasing of acceleration, the reason is because we add more mass to both side of the spinner into 200g. The result was, the spinner contains more force than the first one. We can concluded that the more mass the spinner contain, the less acceleration are provided.

According to the formula of centripetal force $F = \frac{mv^2}{r}$, if we introduced more mass and velocity into the equation, the force is therefore getting bigger. On the opposite side, if we
increase the radius: the force however get smaller due to the formular. According to the Second Law's of Newton, the more mass object have, the accerelation had to be small to balance each other. The 3rd graph had the least acelleration. On the otherside it provided the most force(n) on the y-axis but contain least velocity x-axis.

**Conclusion:**

In conclusion, to investigate the centripical acceleration by using the formula of centripetal force $F=mv^2/r$ for supporting our evidence. At first, while the experiment take place we can recognize that we had to spend more force on spining the 200 and 300g runs. Therefore, the LabQuest Vernier Centripetal Force Apparatus quickly reach the 3N. However, we didn’t had to spend much force for spining compare to the 100g run.

For the result of all experiment, if we compare both result graphs and the formula of centripetal force together. The outcomes is, the more mass the spinner contain, the more force are increased. On the other hand, the bigger mass the spinner is, the lower acelleration and velocity are resulted.

From over all, there are some errors that effect my result. For instance, we had recorded the graph before spining the Vernier Centripetal Force Apparatus so we have to retry and record again. The way to improved this experiment to be better is to study the steps of the experiment before doing real experiment. Moreover, during the experiment the student need to give more attention in order to improve their lab ability and know the clear information for doing lab report.

**Evaluation of Data**

4. Examine the value of the slope of the first three runs (linearized plots). What relationship appears to exist between the value of the slope and the total mass of the sliding carriage?

- According to the graph above as you see that y axies is “Force” and on x axies is velocity, From Newton Second Law “$F=MA$” from run 1 mass was rest than other it make more acelleration that mean if the mass increase acelleration will be decrease.

7. Write an equation relating the net force, mass, radius and velocity of system undergoing circular motion?

1. $F=ma$ (From Newton Second Law)

2. $W=\text{Turns} / \text{Sec} (W = \text{Angular Speed})$

3. $F= \frac{MV^2}{R}$
8. Use what you have learned and Newton’s second law to write an equation for the acceleration of the object undergoing circular motion. Use your text or web resource to determine the meaning of term “Centripetal”?

The equation for acceleration are $A = \frac{V_f - V_i}{T_f - T_i}$

Centripetal force (from Latin centrum "center" and petere "to seek") is a force that makes a body follow a curved path: its direction is always orthogonal to the velocity of the body, toward the fixed point of the instantaneous center of curvature of the path. Centripetal force is generally the cause of circular motion.

Information from (http://en.wikipedia.org/wiki/Centripetal_force)

Extra point:
Wikipedia warns that the centripetal force is not to be confused with centrifugal force. It describes the latter as a fictitious or inertial force. Describe an example of such a force that you have experienced and how this interaction might better be explained in terms of centripetal force (do not use the example given in class).

- From my experienced carousel horse at the amusement park was one of the machine that make centripetal force, When the machine run make horse that stick with people go together in circle direction the force from the horse act toward to the center of the circle like picture below. When the machine run faster (if it could) it will make centrifugal force to make you fly away from machine. The path of inertia in this case of carousel horse can be wind that run against you when you playing it.