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PH114-08

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Centripetal Force

Statement of Purpose:

Our group will observe the centripetal force applied to a mass when spun in a circle by placing the mass on a track and utilizing a pulley system to bind it to a force sensor.

Introduction:

Our group used a contraption consisting of a horizontal track symmetrically fastened to a motor. The motor was controlled by a DC variable power supply. The track had two carts on it, one fastened down and the other able to slide along the track. Several scale weights were used to adjust the weight of the mobile cart on the horizontal track. We then spun the track and collected data from a force sensor coupled to the cart. The data we collected shows a relationship between the amount of mass, it's position on the track, and the centripetal force generated.

Equipment:

Power supply, motor, track, carts, string, force sensor, masses, datastudio, photogate.

Procedure:

1. Turn on the computer and open Datastudio
2. Check that the apparatus is correctly set up
3. Add 20 grams to the carts
4. Make sure one cart is free to move and the other is secured
5. Both carts should be at .08m from the center of the track
6. Record the mass of the cart plus scale mass
7. Set up datastudio to record the force and revolutions
8. Start recording
9. Increase motor voltage to 8V
10. Stop recording
11. Turn off motor voltage
12. graph force vs velocity and select quadratic fit
13. Use the smart tool and pull three coordinates, record them
14. Calculate the centripetal force
15. Reset Datastudio
16. Keep the radius and voltage constant
17. Record data with four different masses on the track, 20g, 25g, 30g, 35g
18. Collect data on force vs mass
19. use linear fit to describe relationship on the graph

Data:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 1 | V (m/s) | Fr (N) | Fc (m\*v2/r) | % difference |
| Run 1 | 1.523 | 0.55 | 0.69 | 25.5 |
| Run 2 | 2.037 | 1.06 | 1.25 | 17.9 |
| Run 3 | 3.053 | 2.51 | 2.80 | 11.6 |

Mass = 0.024kg Radius = 0.08m

Velocity vs Force, Graph 1:

Radius = 0.08m Voltage = 7.0V

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 2 | Run 1 | Run 2 | Run 3 | Run 4 |
| Mass (kg) | 0.024kg | 0.029kg | 0.034kg | 0.039kg |
| Mean Force (N) | 3.47N | 4.03N | 4.59N | 5.14N |

Mass vs Force, Graph 2:

Analysis:

The data we collected during the experiment shows the relationship between the amount of mass, its velocity applied in circular motion, and the centripetal force inacted on it. Possible sources of error in this experiment include calibration of the force sensor, motor, and power supply, as well as interference in the force sensor's apparatus attaching it to the free mass and the ability of the mass to move freely. We saw that as the velocity of the mass increased, so did the force acting on it. We then used F=(mv2)/r to calculate a the centripetal force, and found it to be fairly close to the recorded values, within reason assuming the error losses. In the second part of the experiment, we kept the voltage and radius constant, while the mass was adjusted. A small change in the mass had a fairly large impact on the force, increasing it by a large factor (0.005kg to an effect of ~0.5N). Both the relation between speed and force and mass and force appear to be positive, and act much like linear motion. The relation between radius and force was inconclusive save for its cameo bolster as a variable in the aforementioned equation.

Conclusion:

In our experiment we discovered the relation between centripetal force and the kinematic properties of a mass it is acting on. By increasing either the mass or the speed of the mass we can similarly increase the amount of centripetal force acting on it.