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Lab 4: Centripetal Motion

Introduction:

This lab explores the phenomena surrounding centripetal force as well as circular motion. The experiments test the theory that for an object to travel in a circular motion, there must be a force directed towards the center of that circle of motion. Students used previously existing formulas relating to angular velocity and the centripetal force of a system in order to verify the accuracy of the formula for the centripetal force of an object's circular motion. This was done by comparing the centripetal force to gravitational force.

Hypothesis:

It was hypothesized that the formula for centripetal force should be accurate. There may still be some percent error however, possibly due to machine or human error.

Methods & Materials:

The materials used during this lab all came together to form an apparatus that simulated circular motion. In it, the bob acted as the object as it was spun around the pole. It was connected to the pole by a spring, and the faster the bob was spun the greater the spring was stretched. Students first found the period of the motion of the bob when the spring was stretched to a specific point. This point was also used to find the radius by measuring the horizontal distance between the pole and the bob. The period was measured by counting 50 revolutions of the bob and also measuring the time needed for the bob to make these revolutions. Using this information, students found

Materials Needed:

- Masses
- Pan
- Bob
- Spring
- Counter-weight
- Cross arm
- Pole
- Weight scale

angular velocity through the formula $\omega = \frac{2\pi}{T}$. This formula works because velocity is a function of distance over time. Similarly, 2π represents the whole of a circle and T represents the period or the time needed for the bob to travel the whole circle. After finding angular velocity, students then described the centripetal acceleration using the formula $a_c = \frac{v^2}{r}$. From here, centripetal force can be calculated by multiplying the centripetal acceleration with the mass of the bob, which was weighed on a scale beforehand. This experiment was then repeated two other times, but in the second experiment the radius of the system was changed and in the third experiment the mass of the bob was changed.

Results:

We found T to be an average of 0.64 seconds in our first experiment. From there we found ω to equal 9.82 m. Multiplying this by the radius of 0.68, we found a velocity of 1.65 meters per second. Finally, using the formula for centripetal force we found an F_c of 7.29 N. Comparing this to the amount of gravitational force needed to move the bob, 610 grams were required to pull the bob to that specific radius. This is a gravitational force of 5.29 N. With the subsequent experiments, our percent error lowered possibly because we reduced human error through practice. Changing the radius to a larger value, we found T to be 0.5627, ω to be 11.08, and v to be 2.33. This gave us a centripetal force of 11.6 N. The gravitational force required in this situation was 11.858 N. With the larger radius, the bob most likely had to travel faster to stretch the spring with a larger force and thus creating a stronger centripetal force. Finally, after changing the mass of the bob by 100 grams we found the centripetal force of the system to be 13.66 N. This was compared to a gravitational force of 12 N

Conclusion:

Through the experiments in this lab, it can be said that the centripetal force is equal to the mass of the object multiplied by its centripetal acceleration. The error between the gravitational force and centripetal force required may have been caused due to either human error or machine error. When finding *T*, students had to count the number of revolutions while simultaneously keeping the bob at an exact radius. This has much potential for human error. What can also be found through these experiments is that centripetal force is directly proportional to the mass of the object. This can be seen by the fact that the centripetal force increased when added mass was placed on the bob.