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Computer Science
Physics 101 - 8

Demonstration of Conservation of Angular Momentum by Using a Spinning Wheel

Summary of the Experiment

The main purpose of this experiment is to show that angular momentum is conserved in our physical universe. Angular momentum is a quantity that has a direction and a magnitude, and both its magnitude and direction are maintained throughout the whole system if there is no external force acting on the system which creates a torque on the system. To experiment, I need a freely rotating platform, a freely rotating bicycle wheel, a volunteer to hold the spinning wheel, and an assistant who can turn the wheel for me during the experiment. I will also need a scale and a stopwatch to be able to take the measurements. In the measurement phase, at first, I will calculate the angular momentum of the wheel that is rotated by making the necessary measurements, then after the changes, I have applied, I will measure the angular momentum of the system and make comparisons to reach the result.

Summary of the Research

In high school, teachers gave us the example of a ballerina while they were teaching us the conservation of angular momentum, and this example caught my attention because I did ballet when I was little, so since then angular momentum became my favorite concept in high school. Later, when I saw angular momentum among the topics to be covered in Physics 101, I decided I wanted to do this laboratory project. Then I decided to research this subject on the internet, and I saw that there are many kinds of experiments that I can do, but I chose this experiment because this version was a version that would allow me to approach the concept in a more detailed way, where I could reach multiple conclusions about the subject. Also, another reason why I chose this version was that it was an experiment where I could access all the equipment, there is equipment that I could not find in other experiments on the internet.

Detailed Description of the Experiment

Description of the Setup

We put the rotatable platform on a horizontal, plain plane and while the wheel is not spinning, we get on the platform with the wheel in our hands then the setup is ready.

Procedure to Conduct Experiment

1. First, we measure the radius of the wheel with the help of a meter, its mass with the help of a scale, and the mass of the volunteer person to use in the calculation of angular momentum.
2. The volunteer holds the wheel vertically and climbs onto the rotating platform, and at this moment, we know that the system's angular momentum equals zero.

3. The assistant person turns the wheel with his hand, giving the wheel an angular velocity, that is, angular momentum, and we measure this speed with the help of a stopwatch.
4. Therefore, we have enough data to calculate the initial angular momentum of the system and we perform this calculation and collect the data found in Table 1.
5. We turn the wheel, which is currently rotating in the vertical position, to the horizontal position by turning it to the right in a way that we do not interfere with its movement.
6. After bringing the wheel to the horizontal position, we first recalculate the angular momentum of the wheel only, then we calculate the angular momentum of the volunteer holding the wheel by using known angular momentum equations and data from Table 1 and record these calculations in Table 2.
7. We repeat all the steps we have applied above, this time by turning the wheel to the horizontal position by turning it to the left side and we note the data in the second data table. While writing the data into Table 3, we keep in mind that angular momentum is a directional quantity.
8. Finally, when the person holding the wheel is on the platform, this time the starting position of the wheel is horizontal, and the assistant gains an angular velocity with his hand while the wheel is in this position.
9. The volunteer then turns the wheel in the opposite direction without applying any external force to the wheel.
10. Again, we calculate the wheel's new angular momentum and then the volunteer's final angular momentum, one by one, and reach the angular momentum of the system and see if the angular momentum is preserved in the system. We then save this data in Table 3.

Structure of the Tables

4 data tables will be used in the experiment, but no graphics will be used. Table 1 will include the physical properties of the wheel, namely its weight, radius, and the magnitude and direction of the angular velocity imparted to the wheel by the assistant at 3 different times. This table will also keep the physical quantities of the volunteer. The data in this table will be used to calculate the angular momentum of the wheel, that is, the system's initial angular momentum and the volunteer's angular momentum. Tables 2 and 3 will be almost identical to each other, the only difference is that Table 2 includes the before and after data when the wheel rotated to the right from vertical to horizontal, while Table 3 includes the data obtained by calculating the momentum of the wheel and the system when the wheel rotated to the left from vertical to horizontal. In Table 4, there will be data on the angular momentum of the wheel and the system, in which angular velocity is given to the wheel while in the horizontal position and then inverted.

Procedure to Analyze Data

Using the data collected in Tables 2, 3, and 4 the first angular momentum of the system will be compared with the last angular momentum, and it will be concluded whether the angular momentum is conserved or not. While making all these calculations and collecting data, errors that may occur due to measurement errors and friction should be taken into account.

The Theory

The main theory that I'm going to use in this experiment on the conservation of angular momentum says if there is no net external torque operating on the system, its angular momentum is conserved. Any object's angular momentum can be calculated and defined in one of two ways: if it's a point object in rotation, the angular momentum is equal to the radius times the linear momentum of the object,

$$\vec{L} = \vec{r} \times \vec{p} = \vec{r} \times m\vec{v}$$

The angular momentum of an extended object, like the earth, is determined by the moment of inertia, or the mass of the object multiplied by the distance from the center times the angular velocity,

$$\vec{L} = \vec{I} \times \vec{\omega}$$

But in both cases, the angular momentum before is equal to the angular momentum after a certain amount of time if there is no net force acting on it.

References

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