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Writing Final: Measuring Inertia

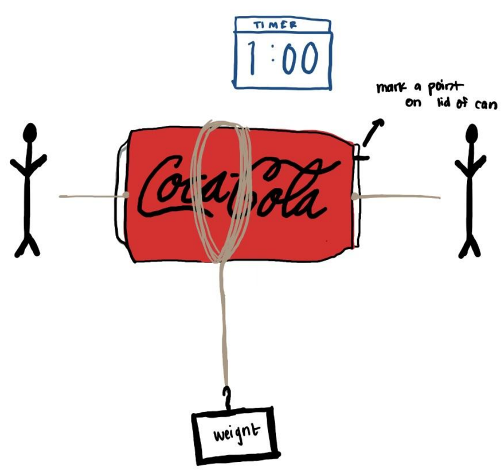
Writing Option B

Abstract

This paper will be discussing an experiment in which inertia of a US standard soda can was measured. Within the experiment the soda can's rotations were measured along with its torque in order to determine the object's inertia. The average inertia of the cans was compared to a cylinder's theoretical moment of inertia. Since a soda can has a very similar shape to a cylinder, the theoretical moment of inertia should better match the actual inertia of the can. The calculations done within this experiment in the end did not match the theoretical moment of inertia most likely due to different factors such as friction and a calculation error.

Introduction

In this experiment, a US standard soda can's inertia was calculated. In order to conduct the experiment first you need to take an empty US standard soda can and run a string through the middle of the circular top where you drink and the circular bottom of the can. Make sure you empty the can before you run the string through it. It is recommended that the ends of the string are tied to an object like a pencil so that the string doesn't accidentally run back into the can as stringing the can through the middle can be difficult. Then take 6 feet of string and attach 15 grams to the end of it. Then take the 6ft string and attach it to the can and wind it up. Take the device and hang it somewhere of equal height or higher then the 6ft string.



Place a marker on the can that will allow you to observe the number of times the can rotates. Use a camera that can record the cans rotations as the can will spin very quickly. You can optionally place a timer in the background to help you with calculations or use the timer on your camera. The hypothesis of the experiment is that the theoretical inertia will not be as great as the experimental inertia due to factors like friction lowering the angular acceleration which would mathematically lead to a higher inertia.

Procedures

Once your device is set up, prepare the camera to record the trials of the experiment. Take the device and have the 6ft string wound around the can and then release it. The soda can will spin like a wheel and you will . Repeat this process two more times for a total of three trials. Once you are done with the experiment you can begin calculations. In order to calculate the inertia of a rotating object the equation I=Tα was used such that I is inertia, T is torque, and α was the angular acceleration of the object. Determining angular acceleration the following equation was used below.

$$\alpha = \frac{W\,final - W\,initial}{t\,final - t\,initial}$$

W final and W initial is the angular velocity and t final and t initial is the time. Use the video of the experiment to determine the angular acceleration. It's important to remember that angular acceleration needs to be expressed in radians per second squared. The inertia equation is similar to the force equation in which F=ma in which F is force, m is mass, and a is acceleration. In order to calculate the torque of a rotating object, T=rF in which torque is equal to the object's radius times force which is mass times gravity of the weight rotating the can. Finally you need to determine the theoretical moment of inertia. In order to calculate the moment of inertia you need to use the equation ½ mr^2 where m is the mass of the can and r is the radius of the can. It is important that you convert your units to be in kgm^2.

Results

In the experiment it was found that the soda can was 14 grams and its radius was 3.5 centimeters. Using the theoretical moment of inertia equation, the can's theoretical inertia was found to be $8.75*10^{-6}$ kgm^2. Using the equation to find torque it was found that torque was equal to .005Nm. With the videos of the experiment the angular acceleration of each trial was found. After finding the angular acceleration, multiply it with torque in order to find the inertia. Using the calculated torque and the videos of the experiment, the following results were found.

	Angular Acceleration	**Inertia**
Trial 1	4 radians/s^2	.0013kgm^2
Trial 2	2 radians/s^2	.0025kgm^2
Trial 3	4 radians/s^2	.0013kgm^2

The average inertia from all three trials comes to be .0019gkm^2. Using the average inertia found from the three trials it was compared with the theoretical. The average inertia compared to the theoretical inertia was much higher. While this does satisfy the hypothesis, the experimental inertia is much higher than expected. This can be due to different sources of error.

Error

There are a couple of different sources of error present in this experiment. One of the errors has to do with the design of the experiment. A small issue present in the experiment is that stringing a line through the can lead to the string swinging around with the can despite how taut the string was. A way to fix this would be to use a rigid object that ran through the can to prevent the can from swinging. Another source of error for the inertia would be forces such as friction and air resistance. The friction that the can had on the string would lead to some loss in acceleration leading to a higher calculated inertial. Perhaps if the object the can spun on had less friction it would be a little closer to the theoretical inertia. The biggest source of error encountered in this experiment was the calculation used to find the angular acceleration. The angular acceleration found in the experiment might have been an underestimate based on the way it was calculated. Perhaps if the calculations were done differently then maybe it would be closer to the theoretical inertia. While the way inertia was calculated seems correct it is possible that the acceleration should have instead been calculated by counting the total rotations and dividing by time to get a higher angular acceleration and therefore a lower inertia.

Conclusion

While the hypothesis was correct, further investigation may need to be done. Our calculations seem to be the biggest possible source of error which could lead to our hypothesis being correct for the wrong reasons. In possible future experiments, different cylindrical items could be used with different materials. Another idea for future experiments would be to use items that are different shapes that aren't close to cylinders.