Arms of a Spinning Figure Skater

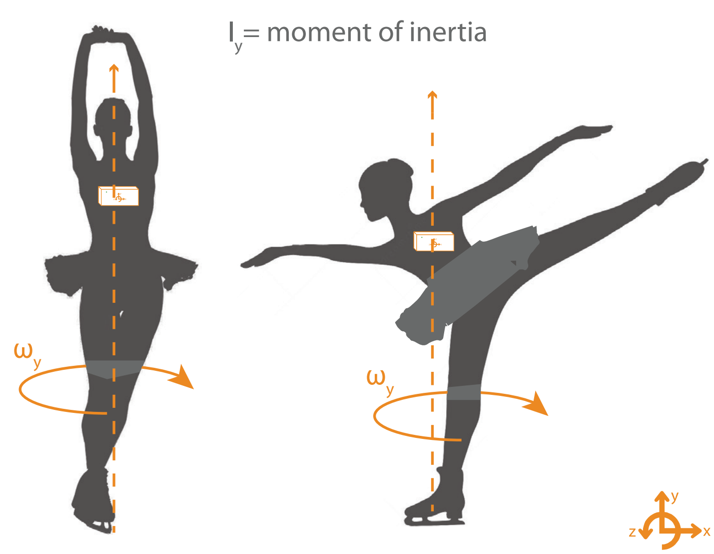
Exploration

When a figure skater spins he/she uses the positioning of his/her arms to control the speed of the spin/ angular velocity. The angular momentum of the skater is always conserved, no matter the positioning of the arms, and can be represented by the equation $L = Iw$, where L is angular momentum, I is moment of inertia and w is angular velocity. The moment of inertia is an object's resistance to change in angular velocity and is related to the distribution of the object's mass.

Materials

- Office Chair
- PocketLab

Optional: small heavy objects that students can hold out from their body such as 5 lb dumbbells, jugs of water, or textbooks.



Objective

In this experiment, students will:

1. Use an office chair that can spin 360 degrees to represent a spinning figure skater
2. Determine how the positioning of the spinner's arms affects the moment of inertia and therefore the angular velocity of his/her spin.

Method

1. Sit in an office chair and measure the distance between the center of your body and your arm completely extended. Record the measurement.
2. Tape PocketLab either to your center of gravity or the backrest of the chair. Orient the PocketLab so the rotation of the chair will be about the y-axis.
3. Have your partner spin you while collecting angular velocity data.
4. After a few seconds, bring your arms to your chest.
5. If you were the person spinning, write down whether you felt your angular velocity before you look at the graph changing.
6. Perform three trials with each group member.
7. Optional extension: Repeat the trials while holding small heavy objects that you can still safely control and hold extended from your body. Compare the change in angular velocity just using your arms to the trials with the weights.

Predictions

- How do you think the positioning of your arms will affect the angular velocity of your spin? How will it affect your moment of inertia during your spin?
- Will the length of the spinner's arms relate to the change in angular velocity as their arms are brought inward?
- Will the mass of the objects held out from the spinner's body relate to the change in angular velocity as the arms are brought inward?

Data Analysis and Observations

- When it is your turn to spin, write down how you felt your angular velocity change when you moved your arms inward. Do this before looking at the data collected from the graph.
- Look at the data collected from the graph. Do you notice a difference in the angular velocity between when the spinner's arms were extended and when they were brought inward? What is the difference?
Use data to support your answer.
- Look at the change in angular velocity for each person in the experiment and compare it to the arm lengths of each person. Is there a relationship between the arm length and the change in angular velocity? What is the relationship? Use data to support your answer.

Conclusions

- Explain how the positioning of the spinner's arms affects the moment of inertia. Explain using your knowledge of angular momentum, the equation for angular momentum, and the data collected to support your answer.
- Using the previous answer as a guide, explain why there is a change in angular velocity as the arms of the spinner move inward.
- Explain why you think there is or is not a relationship between the length of the spinner's arm and the change in angular velocity when the arms are moved inward. Use the data and your own reasoning to explain.

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