CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)

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Project Number

J0231

Project Title

Faster Flips: Angular Momentum and Gymnastics

Abstract

Objectives/Goals

My goal in this project was to find out why it is easier for a gymnast to do a tuck positioned flip compared to a lay-out flip. My hypothesis was that when the mass in a rotating object is moved closer to its center of rotation, it will rotate faster than with its mass further away from the center of rotation.

Methods/Materials

An apparatus was built with a rotating arm with masses which could be moved closer or farther from the axis of rotation. A mass suspended over one end of the arm could be dropped to exert a force and get the arm to rotate. Experimental trials were conducted with the moveable masses positioned at different rotational radiuses. For each trial, the number of revolutions the object made in a fixed period of time was counted. Materials included wood; screws and bolts; a large mass to drop; string to suspend the mass; a ruler and a stopwatch.

Results

The experiment showed that with the same force applied, the object consistently rotated faster with its mass closer to its center of rotation. Trials were done with the masses at several different radiuses. On my first trials the rotation slowed down much faster when the rotating weight was closer to the center of rotation. I think this might have something to do with friction overpowering the lower inertia of the spinning mass. More initial force and a shorter timing period seemed to reduce the impact of friction or other forces on the results.

Conclusions/Discussion

The experimental results support my hypothesis. Newton's 1st law states that a mass at rest tends to stay at rest and a mass in motion tend to stay in motion unless acted upon by an external force. For a mass rotating around an axis, this is called rotational inertia, and this inertia increases as the distance of the mass from the center of rotation increases and vice versa. This means given the same force, the mass will be accelerated to a higher velocity as it is moved closer to the axis of rotation. When a mass is in motion it has something called momentum which is conserved. As a gymnast starts a somersault and pulls into a tuck position, the momentum from the takeoff is conserved but the radius of the rotating mass gets smaller, so the velocity of the spin increases. This makes it easier to do the somersault with less force than if the gymnast stayed in a layout position.

Summary Statement

My project explores the relationship between mass, acceleration, and momentum in circular motion.

Help Received

My dad helped me build the experimental apparatus, and he also asked me lots of questions.