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CARTHAGE COLLEGE

Falling for Teaching

Embedding Middle and High School Teachers in Parabolic Research Flight Teams

National Space Grant Directors Meeting
Spring, 2019

Kevin Crosby, Wisconsin SG
Michelle Peters, ZERO-G
Timothy Overocker,
Lakeview Technology Academy

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Project Overview

- Four Teachers in four years
- Student-driven experiments in mechanics, fluids, and physiology (tied to curriculum)
- Students propose, design, and build experiments in research teams
- Students/Teachers down-select to 4-5 experiments
- Each Teacher paired with a videographer

Middle School Physical Sciences Teacher Kristine Heuser, Lance Middle School, Kenosha, WI

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Example Experiments

Ferrofluids, angular momentum conservation, surface waves in liquids, density, liquid surface shapes, 3-axis flywheel control, artificial gravity, liquid mixing, heat transport, diffusion, “swimming,” sound speed, settling of Skittles, catenary shapes, yo-yo physics, walking on the moon, inertia and mass, the wrench turns you, shaken beads, the Brazil Nut in Space, Two-phase flow...

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Precedent and Sustainability

- 2008 - 2009 Space Florida/FSGC
- 2009 Cleveland Science Center
- 2006 - 2012 Northrop Grumman Foundation WFOD
- Other Programs: 2003 - present NASA HUNCH

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Research with ZERO-G

1. Opening dialogue
2. TDS Form
3. Confirm Reservation
4. RPP/Hazard Forms
5. ZERO-G Weightless Lab Campaign

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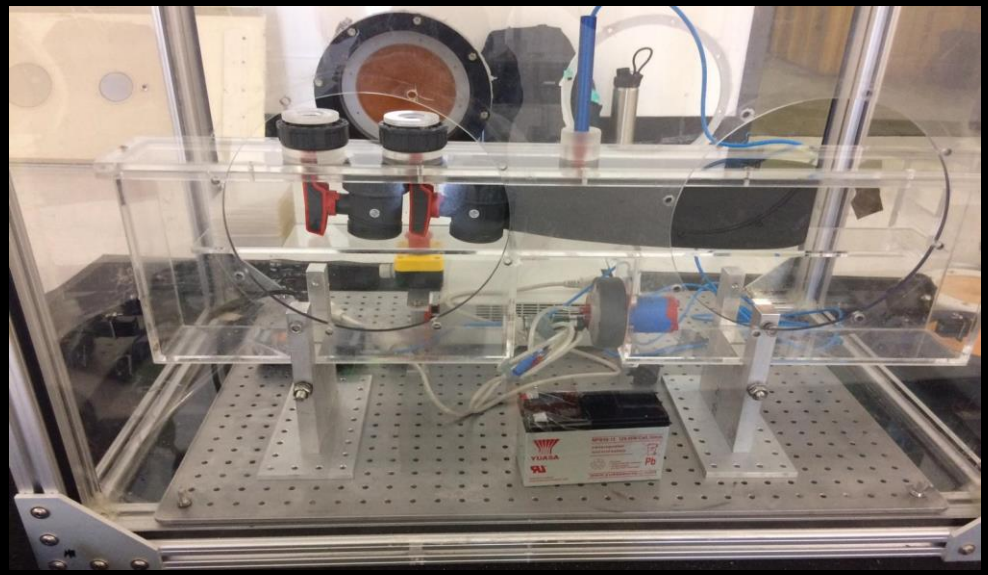

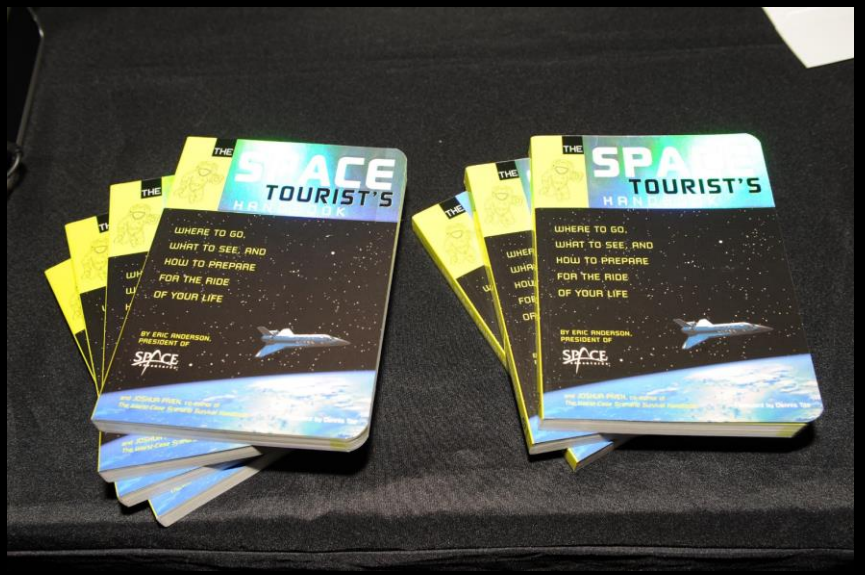

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Zero Gravity Corporation

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Research & Education

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Timothy L. Overocker

Physics & Computer Science Teacher

LakeView Technology Academy

Pleasant Prairie, WI

Can one Yo-Yo in space?

Yo-Yo's in Space

Introduction:

Yo-yos work by mixing potential energy, which is the distance the string it will let the yo-yo travel, with two different kinds of kinetic energy, the rotations and the and the vertical or horizontal movement based on how you throw it. It also uses a function of Rotational Kinematics, known as Conservation of Angular momentum. Conservation of angular momentum in terms of units and how those units are used, is similar to many other forms of physics where there is torque, which is the amount of rotation to an object, the area where that torque is exerted, and what forces are resisting it, such as friction and gravity. When in reference to a spinning ice skater that has their arms out, the area that has the torque applied is large, so they will spin slowly. However when they pull their arms in, the rotational inertia decreases and the rotation rate increases in order to keep the angular momentur the same. When using this in reference to a Yo-yo, it will act differently than the ice skater since the area of the yo-yo is not changing. The yo-yo is released with a given amount of momentum, which causes th string to unwind, turning that momentum into rotational, or angular, momentum. Once the yo-yo reaches the bottom, then the yo-yo will start to 'sleep' where it stays in position continuing to rotate. The reason a yo-yo returns is due to the friction of the string eventually catching and winding back up, reducing the rotational pivot point which, in turn, increases the angular momentum since it is being conserved. When used in zero gravity, the direction it is thrown will not matter once it reaches the end even if it's thrown straight up. Without the resistance of gravity, then the yo-yo would continue spinning, or 'sleep', and begin to spin like a tire on ice, very slowly moving, but picking up speed, since the air molecules will interfere due to it not being in a vacuum, because of the conservation of angular momentum, and would continue accelerating until it hit the rpm's of the yo-yo if there was no change in momentum on the yo-yo and no friction between the string and yo-yo once it starts to sleep.

Materials Used:

A standard sized yo-yo.

Hypothesis:

If a yo-yo is spun in zero gravity, then it would rotate until the end of the string and then will start sleeping. It will then begin to act similar to that of a tire on ice, very slowly but surely accelerating, due to conservation of angular momentum and the resistances of the air molecules, will start rotating like an orbit around the user and will sleep for a heavily increased amount of time. The representative from Lakeview Technology Academy will be sent up with the materials listed below, to conduct an experiment on the yo-yo hypothesis.

Procedure:

Release the yo-yo as you would normally; but, do not pull it back up. Observe yo-yo's movement to see if it will roll back up on its own, potentially spin around, or if any other outcomes occur.

References:

How do yo-yos work? | Who invented yo-yos? (2018, July 21). Retrieved from https://www.explainthatstuff.com/yoyos.html

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maximizing the brilliance of children

Discussion and Conclusion coming soon!

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WSGC

Can you simulate gravity?

Artificial Gravity Simulator

How it works

Artificial gravity, or pseudogravity, is the creation of an inertial force usually caused by rotation. Rotational gravity, has the appearance of an internal force directed away from the axis of rotation that seems to act on all objects present in the rotating frame of reference. For example, if we have a disc, and if it is spun at just the right speed, objects inside the frame of reference would experience an outwardly directed centrifugal effect, simulating gravity. Our project, the gravity simulator, mimics this phenomenon. Using two spring scales mounted on an enclosed disc, we are capable of measuring this simulated gravity within our frame of reference despite the absence of actual gravity.

Introduction

The experiment that we are designing for the zero gravity flight is an artificial gravity simulator. A gravity simulator has the ability to create artificial gravity through the inertial effects of rotation. Artificial gravity is used in space to allow astronauts to stay familiar with Earth's gravity so their body is not overwhelmed with the symptoms of Space Adaptation Syndrome (SAS). Artificial gravity can be simulated by centripetal force pulling in with the centrifugal effect pushing out, allowing the system to move in a circle. An example of this effect can be felt when a car corners too quickly and the passenger is pushed against the door. Our experiment will be simulating this phenomena on a much smaller scale with our own apparatus.

According to our calculations we only need to rotate our simulator at 1.3 revolutions per second to achieve 1 g of simulated gravity.

Procedure

The disc will be hand spun, by a bearing on the backside of the container. Attached to the bearing is a handle that will be used to assist the rotation

$$F_c = \frac{mV_t^2}{r} \qquad V_t = 2\pi rf \qquad F_c = \frac{m(2\pi rf)^2}{r} \qquad F_c = 4mr\pi^2 f^2$$

$$F_c = \text{mg} \qquad 4mr\pi^2 f^2 = \text{mg} \qquad f = \frac{1}{2\pi}\sqrt{\frac{g}{r}}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{9.807\ {}^{m}/_{s^2}}{0.15\ m}} = 1.287\ rotations/s$$

Materials

For our project, we used a 30cm diameter cake container to use as our apparatus. The two spring scales that we have placed in the apparatus are used to measure the artificial gravitational pull. Two 50 gram weights are attached to the spring scale to assist the pull. They are attached by line. Hot glue was then used to seal the apparatus and ensure that the experiment and its components remain encased. The entire encased experiment is then attached with a bearing to a 3d handle that was printed out to fit into the bearing, which allows Mr. Overocker to spin it as a whole.

Original idea with the frisbee

3D Printed part for the weights

Fast Fact

- The Space Adaptation Syndrome comes into effect in the absence of gravity that causes the body to weaken

Citations

NASA Archives. "Space History Photo: Artificial Gravity Space Station." *Space.com*, Space.com, 21 Nov. 2012,

Dunbar, Brian. "What Was the Gemini Program?" *NASA*, NASA, 23 Feb. 2015,

Hewitt, Paul G., et al. *Conceptual Physics: the High School Physics Program*. Pearson Education Inc., 2009.

Can you swim in zero gravity?

Swimming in Zero-G

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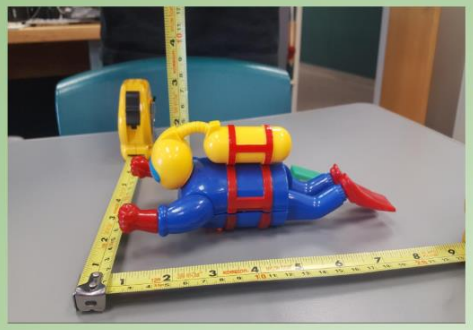
NASA
zero G



Question: Can one swim in the air in zero gravity?

Background:

Swimming is an action that can be performed in most fluids via movement of one's body and limbs. As air falls under the category of fluids, swimming should be possible to do. However, there is one obstacle preventing this from happening: gravity. Humans, being far denser than air, are dragged down to Earth by gravity. However, if you were to remove gravity from the equation, swimming through the air becomes a possibility.

Materials:

Wind up diver and battery operated swimming frog, using commercial AA batteries.

Hypothesis:

Due to air being a fluid, thus having the same dynamics as liquids, a toy designed to swim through water will also be able to 'swim' through the air when zero gravity is simulated.

Procedures:

In order to undergo an experiment testing this without causing damage to equipment or other people, a small toy should be used in place of an actual human. The motions of swimming will still be performed by the toy, but at a smaller scale than if it were to be done by a human being.You start by winding up the diver, after which you release it. In regards to the frog, you must turn it on.

2018, Mr. Overocker
Nino B.
Delia G.
Reed M.

What effect does angular momentum have in zero gravity?

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LAKE VIEW TECHNOLOGY ACADEMY

WSGC

Human Gyroscope

Hannah, Josh, Adam and Toby Supported by: Mr. Overocker

Introduction:

The Conservation of Angular momentum is momentum that is distributed on a rotating object. Angular momentum and velocity is present in many aspects of physics, and even various athletics. An ice skater is a perfect model for the principals present in an experiment such as this. As the skater moves their mass close to their body enables them to travel at a faster speed than before. This same property applies to what we are trying to prove in zero-gravity.

Hypothesis:

After considering the properties of zero gravity, we believe that the human gyroscope will maintain a slower angular momentum, but will continue to spin for a longer period of time compared to functioning in regular gravity.

Question:

Does a human gyroscope work in zero gravity? If so, will it stop?

Josh and Adam going through the gyroscopic motion in full gravity.

Materials:

1 kg weights (x2)

Procedure:

The researcher will spin in a circular motion with their arms stretched out, holding weights with a mass of 1 kg. Pushing themselves off the ground, they will begin to spin, and then they will move their arms inward. In doing so, the mass of the weights will be moving closer to their center of mass, therefore increasing the participant's angular velocity.

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Does varying acceleration of gravity change the shape of a catenary arch?

Catenary Arches in Multiple Gravitational States

Question

Do different arches form from catenary arches when placed in zero gravity?

Hypothesis

There will be a different arch formed when gravity is removed from the environment.

Materials

- Camera
- Metal chain - hangs from mount to form arch (no more than 600 grams)
- Acrylic mount with etched in graph
- Velcro
- Level

Procedure

1. Take arch mount out of transport container.
2. Take special velcro out of transport container.
3. Use space velcro to stick it to the wall of the airplane before takeoff, making sure it is level with the floor.
4. Take a picture of the arch formed before takeoff (at standard Earth gravity), making sure the camera is level with the mount.
5. During the incline to zero gravity (stronger gravity), take a picture of the arch, making sure camera is level with the mount.
6. At peak of flight (zero gravity), take a picture of the arch, making sure camera is level with the mount.
7. During the decline of the flight (stronger gravity), take a picture of the arch, making sure camera is level with the mount.
8. Repeat as many times as allowed, until the plane lands.
9. Take a final picture of the arch formed at standard gravity once the plane has landed.
10. Remove mount from the wall of the plane.

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NASA

WSGC

zero G

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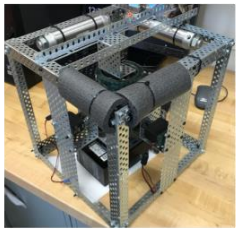
Can we build a remote controlled satellite?

Pseudo-Satellite Movement Through Angular Momentum in Zero Gravity

The pseudo-satellite is a device to test the efficiency of angular momentum in navigating satellites. This technology could be used to return satellites to earth, so long as one of the motors is placed near the edge.

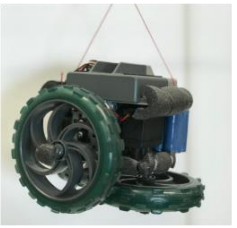
The satellite create it's angular momentum by spinning large diameter tires by a fast motor, creating a rotational kinetic energy that will spin the satellite and position it during the experiment.

When developing the pseudo-satellite, originally, it consisted of a giant cube structure that would contain the motors and a pneumatic system. Upon further reviewing the guidelines for the project, the prototype was quickly abandoned. The pneumatic system was also discarded. Redesigning the project, we quickly came up with a system to eliminate most of the weight by mounting the motors to the vex controller. In order to produce a greater kinetic energy, the gears inside the motors were replaced with a turbo upgrade to make them more than two times as fast.



Originally, we intended to use a cubic frame.

Due to weight constraints, the pseudo-satellite had to be renovated.



Following safety regulations, all the metal edges are covered by foam.

Acknowledgments

LakeView Technology Academy - Semester 1 Physics Honors - Mr. Timothy Overocker
Hunter R., Nathan R., & Ian M.

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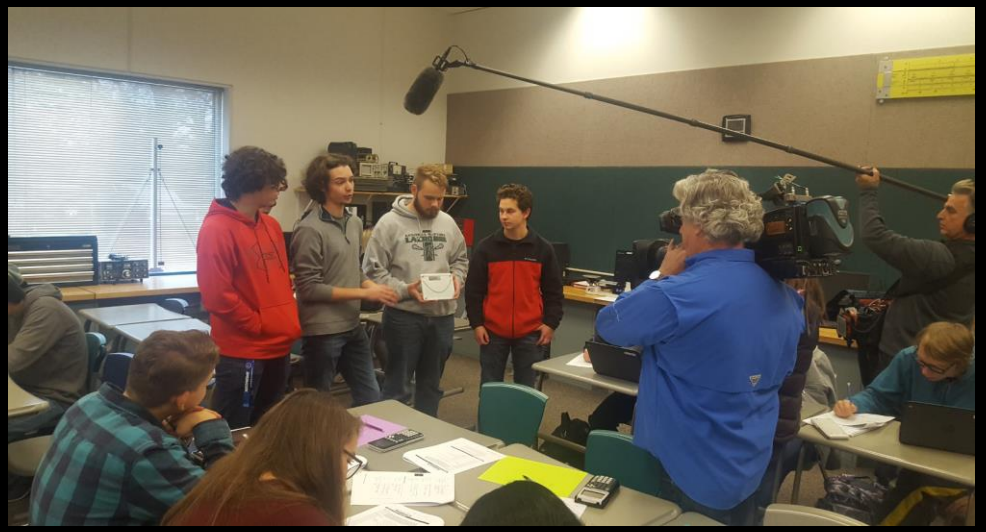

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Thank you
For investing in my future!

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Falling for Teaching

The Ask

If you know of a researcher in your state who regularly flies RG flights (CO, FL, IL, IN, KY, MA, MD, MI, MO, NC, TX) consider asking them to invite a teacher to embed with them on their next flight.