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Euler's Disk

TOP-400

Introduction

The Euler's Disk is named after Swiss physicist and mathematician, Leonard Euler (whose last name is pronounced "oiler").

The Euler's Disk is widely known for the uncanny way its spin rate speeds up as the disk loses energy. It takes a mind-boggling amount of time for the disk to stop spinning.

What's in the box?

The Euler's Disk set comes with a chrome plated steel disk that is ½" thick and 3" wide. You'll also receive a concave mirror base that provides a dramatic setting for the disk.

In addition to the Euler's Disk and the plate, you will also receive nine magnetized holographic foil pieces to further enhance this captivating visual presentation.

How Does It Work?

Many people call what they see the Euler Disk doing "spinning." But in actuality, that's not correct. It's actually spinning AND rolling. This term is called "spolling."

Hold the disk upright onto the concave mirror base and give it a twist. You don't have to twist it hard or fast—just enough to get it going. That's it. That's literally all you have to do, and let science do the rest! After that, sit back for the hypnotic display that will captivate both your eyes and ears.

For Higher Grade Levels:

This link contains helpful information about how the Euler's Disk works:
www.real-world-physics-problems.com/eulers-disk.html

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NGSS Correlations

Our Euler's Disk and these lesson ideas will support your students' understanding of these Next Generation Science Standards (NGSS):

Elementary

K-PS2-1
Students can use Euler's Disk in an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.

2-PS3-1
Students can use Euler's Disk in an investigation to describe and classify different kinds of materials by their observable properties.

3-PS3-1
Students can use Euler's Disk to plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on an object's motion.

4-PS3-1
Students can use Euler's Disk in an investigation to gather evidence to construct an explanation relating the speed of an object to the energy of the object.

Middle School

MS-PS2-2
Students can use Euler's Disk in an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS3-1
Students can use Euler's Disk as a concrete introduction and demonstration on mass and motion. Students can construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

High School

HS-PS2-2
Students can use Euler's Disk to demonstrate how mass and momentum affect motion. This can be transferred into a mathematical representation to support the claim that the total momentum of a system of an object is conserved when there is no net force on the system.

HS-PS3-1
Students can use Euler's Disk as a physical model in conjunction with a computational model to calculate the change in the energy of one component in a system when there is a change in energy of the other components.

Suggested Science Idea(s)

Euler's Disk encourages exploration of force, mass, density, gravity, friction, and time.

2-PS3-1 • 1-PS4-1 • 2-PS1-1 • 4-PS3-2 • 4-LS1-2 • MS-PS3-5 • HS-PS3-3 • HS-PS4-1
Younger students can use Euler's Disk for a compare-and-contrast investigation using a variety of textured materials to spin the disk on.

Students can use the Euler's Disk to run a variety of investigations to study potential and kinetic energy. The spinning and rolling - referred to as spolling - is a captivating visual presentation. The Euler's Disk's unique sounds create opportunities for understanding energy transfer in the form of sound energy and ultimately Conservation of Energy principles. With observations and collection of data during trials, physical factors such as friction and gravity can be discussed and examined.

Euler's Disk

What scientific concepts does the Euler's Disk cover?

Potential Energy	**Conservation of Energy**
Kinetic Energy	**Angular Momentum**
Convex	**Concave**
Friction	**Neutron Stars**
Gravity	**Ring Puckering**
Finite-Time Singularities	**Non-Linear Oscillations**

Watch a video of the Euler's Disk in action:

Our full video runs a bit over 90 seconds… but it's well worth the time to see (and hear) this amazing demonstration.

https://youtu.be/ug2bKCG4gZY

If you're short on time, the abbreviated version is just 26 seconds:

https://youtu.be/rXY6eC1Sqrg

Classroom Ideas:

1. Athletes in Motion

Ask your students if they have ever noticed acrobats, gymnasts, ice-skaters or skateboarders tuck their arms and tightly curl their bodies while they fly and spin around.

Your students will probably recognize these motions. But **why** do athletes use them? Because they understand the science behind their moves—in other words, angular momentum and its conservation. By tucking in their extremities, the athletes are concentrating their centers of mass to a single location. Because their energy is conserved, they will rotate faster.

Angular momentum depends on two key factors:

The SPEED of the rotation and the distribution of the CENTER OF MASS.

The faster the speed, the longer the rotation. The more centralized center of mass an object has, the longer the rotation.

2. Give It a Spin

Divide the students into small groups of two to three students. Give each student a copy of the worksheet on page 4, a **MyChron Student Timer** or stopwatch, a penny, a nickel, a dime, and a quarter. Make at least one Euler's Disk available, or more if possible.

Before the students proceed, have them consider which coin they believe will spin the longest. Give students a few minutes to discuss their thoughts as a group and to write their collective hypothesis on the worksheet.

After they have prepared their hypotheses, students can start spinning the coins on top of their desks. Encourage them to try to spin each coin with about the same amount of force. They should do the same with the Euler's Disk. Using the stopwatch, spin each coin three times. Students should write those times down and calculate to find the average. (NOTE: If you only have one Euler's Disk available, you might have to rotate groups to that station.)

3. Spinning Students

For this activity, you will need to find several swiveling office chairs. Instruct a student to sit in a chair while holding objects—such as textbooks, weights, or boxes—in each outstretched arm. Ask another student to spin the first student around and then let go. Once spinning freely, ask the seated student to pull in their arms to their chest, centralizing the center of mass. If done correctly, you should see a change in the rate of spinning chair. BE CAREFUL!

4. Let Fate Decide!

Take one or more of the magnetic holograph wedges that came with your Euler's Disk and place them on the disk surface. Make sure that they are arranged so that there is a specific corner pointing out from the disk—this will be your "pointer." Now give the Euler's Disk a spin and let it help you make decisions. For instance, in your group, who will act as the spokesperson? Supply collector? Data recording secretary?

Name: _____

Give it a Spin

Materials:

- 1 Penny
- 1 Nickel
- 1 Dime
- 1 Quarter
- 1 Euler's Disk with base

Hypothesis:

Time:

OBJECT	1st spin	2nd spin	3rd spin	Average Time
Penny				
Nickel				
Dime				
Quarter				
Euler's Disk				

Interpret the Data:

Draw a conclusion:

Ask a new question:

Take Your Lesson Further

As science teachers ourselves, we know how much effort goes into preparing lessons. For us, "*Teachers Serving Teachers*" isn't just a slogan—it's our promise to you!

Please visit our website for more lesson ideas:

TeacherSource.com/lessons

Check our blog for classroom-tested teaching plans on dozens of topics:

http://blog.TeacherSource.com

To extend your lesson, consider these Educational Innovations products:

The PhiTOP (TOP-410)
When spun, it starts out horizontal and then, surprisingly, stands upright. Wow! In the process, it illustrates the difference between equilibrium and stability. The rise of the "center of mass" is a fascinating physics problem. It will spin for minutes on end, producing a marvelous optical illusion as it slows down.

Wind Gyro (TOP-380)
This elegant top can be spun by hand, but why use your fingers when you can rely on science? Simply blow a steady stream of air downward onto the top, and it will start to spin! Use a straw for more concentrated airflow, and it will keep going for as long as you continue to blow upon it. Similar to a wind or water turbine, this top is a fascinating way to teach about aerodynamic design, energy, friction, rotational inertia, and gyroscopic stability. Use it "freestyle" on your desk or set it upon its magnetic storage case and watch it go. You can even suspend the top upside down and power it using your breath! Whichever way you try, this top is an amazing demo. Approx 4 cm (1.5") tall. Colors may vary.

The PhoTOP (TOP-415)

The PhoTOP consists of a flat disk 12 cm in diameter and a two-part aluminum spindle. The resulting spinning top has phosphorescent paint on one surface and instructions for its use on the opposite surface. It is intended to be combined with a near UV/deep purple 405nm laser pointer (included) - though part of the fun is experimenting with other light sources, even a smartphone light.
When the top is spun, the UV or other light source is pointed at the spinning top's phosphorescent surface, resulting in green luminescent spiral patterns, as well as Lissajous and other figures. It is a mesmerizing piece of kinetic art, a toy or plaything for the amusement of children and the young at heart, and an educational apparatus to illustrate principles of quantum mechanics and phosphorescence, as well as principles of pattern formation. Requires 2 AAA batteries (not included).