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Rattlebacks (Celt Stones)

SS-310/323/335

Introduction

These half-ellipsoid plastic objects are modeled after stone pieces made millennia ago. Archaeologists discovered them along with stone axes and adzes and dubbed them "celt stones." Soon it was discovered that the stones would spin freely in one direction, but if forced in the opposite direction, they began to oscillate, slow, and then reverse direction.

Try it for yourself: simply place your Rattleback on a firm surface (like a tabletop) with its curved side down, and spin it counterclockwise. It should spin freely.

Now try to spin it clockwise. Initially it will start to turn in a clockwise direction, but very soon it will begin to wobble and slow down, until finally it reverses direction.

What's Going On?

The Rattleback is shaped much like a canoe, but if you look closely, you will notice that its keel is not parallel with the rest of the boat. This causes the center of gravity to shift right or left depending on which end of the 'keel' is in contact with the surface it sits on.

The physics governing the movement of the Rattleback have intrigued scientists for over a century until 1986, when The Royal Society of London published Sir Hermann Bondi's careful examination of the phenomenon in "The Rigid Body Dynamics of Unidirectional Spin."

If your students are curious to look at Bondi's work, you may want to direct them to this website: **www.jstor.org/stable/2397977.**

> "**Many people, even trained scientists, find it hard to understand that the behavior of the toy does not violate the principle of conservation of angular momentum.**"
>
> —Sir Hermann Bondi, F.R.S. Proceedings of the Royal Society of London, Series A, Volume 405, 265-274 (1986).

For another excellent explanation of the forces behind the Rattleback, see this analysis from the Physics department of Oklahoma State University: **www://physics.okstate.edu/ackerson/Museum/Rattleback.html**

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NGSS Correlations

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

Elementary

3-PS2-2
Students can make observation and/or measurements of the Rattleback's motion to provide evidence that a pattern can be used to predict future motion.

Middle School

MS-PS2-2
Students can make observation and/or measurements of the Rattleback's motion in an investigation plan to provide evidence that the change in an object's motion depends on the sum of the forces on the object and mass of the object.

High School

HS-PS2-2
Students can make observation and/or measurements of the Rattleback's motion and then use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the systems.

Suggested Science Idea(s)

3-PS2-2 • MS-PS2-2 • HS-PS2-2

Place your Rattleback, curved side down, on a firm surface, like a tabletop, and spin it counterclockwise. It should spin freely. Now try to spin it clockwise. Notice that it begins to wobble and slow then reverses direction.

The Rattleback is shaped much like a canoe, but its keel is not parallel with the rest of the boat. This causes the center of gravity to shift right or left depending on which end of the 'keel' is in contact with the surface it sits on. Try simply setting your Rattleback on a table. Without trying to spin it, press down and release one end. As it rocks, it will begin to spin. Variations: Try your Rattleback on different surfaces. Try attaching small weights or coins to each end.

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Fun with Rattlebacks

Try this!

Set your Rattleback on a table. Without trying to spin it, press down and release one end. As it rocks, it will begin to spin!

Try your Rattleback on different surfaces. Note how each type of surface alters the Rattleback's spinning.

Try attaching small weights or coins to each end of the Rattleback—even layers of transparent tape can be used!

Challenge your students to make a Rattleback from clay or other some other material.

Watch a Rattleback in Action

https://youtu.be/_wrkDz6LlJ8

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:

www.TeacherSource.com

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

http://blog.TeacherSource.com

To extend your lesson, consider this Educational Innovations product:

PhiTOP (TOP-410)

We've fallen in love with the PhiTOP, and bet you will, too! This beautifully crafted top does for angular momentum what Newton's Cradle does for linear momentum. 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. Invented by astrophysicist Kenneth Brecher, the PhiTOP encourages exploration of force, mass, density, gravity, friction, and time. In short, the PhiTOP is an elegant scientific, mathematical, and aesthetically-pleasing object that makes a perfect gift, desktop display piece, or student stumper.

Mysterious Spinning Top (TOP-375)

Give this top a spin and watch it move for hours without stopping. What's the secret? The top contains a small magnet. When this magnet moves past the center of its base, the top's spinning magnetic field induces a current in a coil, which closes a switch, allowing a battery to momentarily energize a small electromagnet. The top increases its rate of spin and moves away from the center of the base.

Wacky Hall Walker (WHW-100)

Students investigate the amount of potential energy given the rubber band vs. the distance traveled by the Wacky Hall Walker. After collecting data and graphing the results, students are challenged to make their Wacky Hall Walker travel a certain given distance. Lesson plans included.