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Educational Innovations, Inc.®

Centripetal Spinner

PHY-250

Introduction

Our Centripetal Spinner is so alluring, you may forget to consider how many ways it can be applied to teaching science. There are connections to centripetal force, friction, gravity, inertia and light—to name only a few areas.

Let's start with the brilliant colors of the bands. Amazingly, all those brilliant colors originate from clear, colorless bands of polyester film (commonly thought of as Mylar®) which have been coated with an extremely thin film of aluminum.

This means the colors in the Centripetal Spinner are the result of structure, not pigment, just as are the colors of peacock feathers. Some bugs, fish, butterflies, birds, and even flowers use the same technique for their vibrant colors.

How Your Eyes "See" the Centripetal Spinner

Please refer to Fig.1 on the next page. Some white light (which is composed of all colors) reflects off the top surface of the aluminum film. Light that doesn't reflect there passes through the aluminum film where some light reflects off the bottom of the film. When the two reflected rays meet again on their way to your eye, their waves may be "out of step," because one ray has traveled farther (twice through the aluminum layer) than the other.

Think of two single file lines of marchers which are all in step as they walk side-by-side. But if one line walks further before turning around and the lines again walk side-by-side, they can be out of step. If the marchers are "out of step" by one or more full strides, they are back in step.

Just as with the marchers, if the waves are "out of step" by one or more full wavelengths, they are back in step and you will see that color. In the diagram on the next page, the two red rays

Try this!

Look at a piece of white paper through one of the polyester bands. You will see blue! Reddish colors have been reflected, leaving the blue waves to pass through.

5 Francis J. Clarke Circle, Bethel, CT 06801

Phone (203) 74-TEACH (83224)
www.TeacherSource.com

Fig. 1

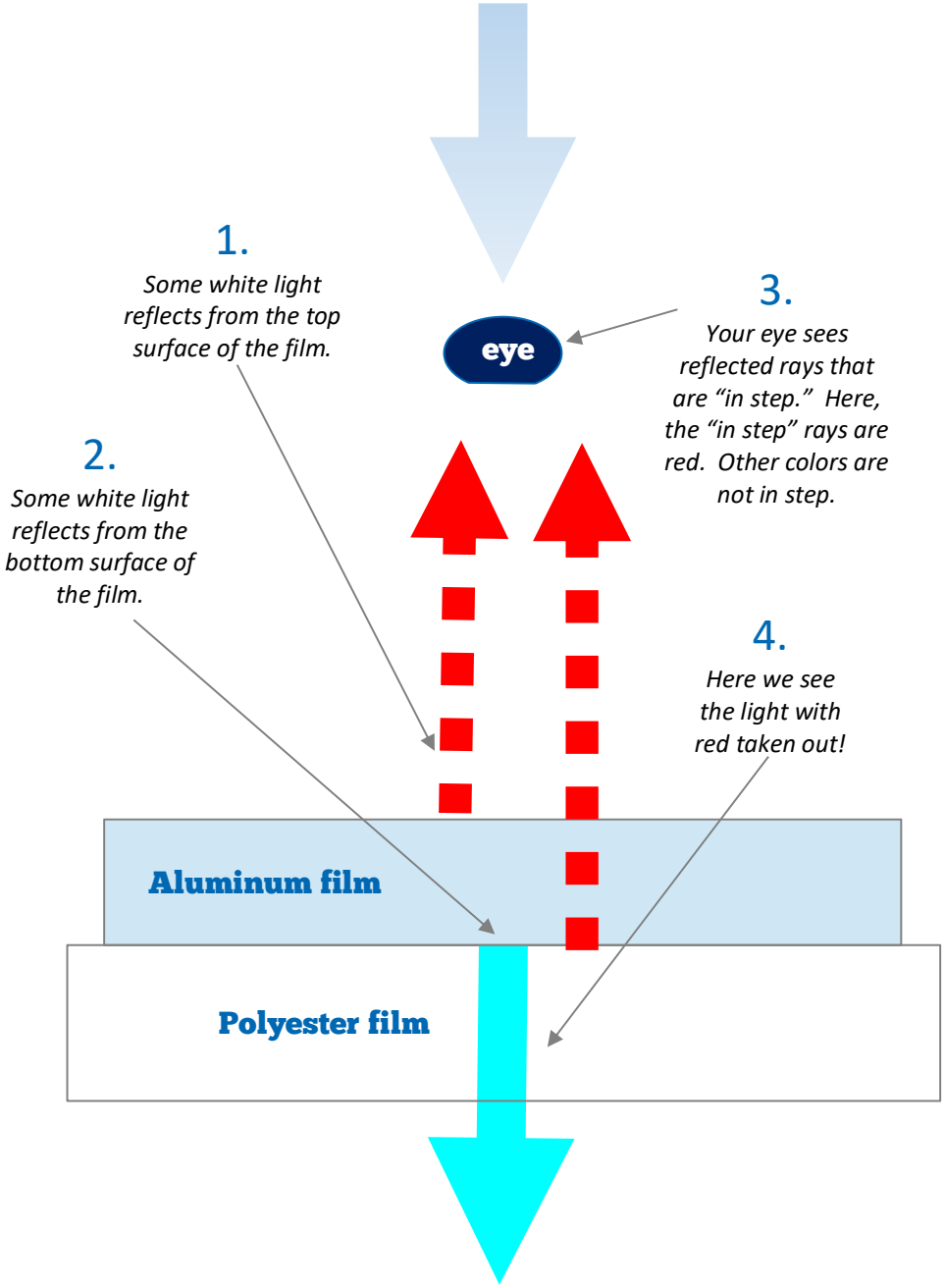
How Your Eyes "See" the Centripetal Spinner

are "back in step" as they arrive at your eye. At different angles of viewing, different reflected waves are seen since the extra path length changes so that different rays are in step.

The remaining unreflected light passes through both the top and bottom of the aluminum film, and consists of the colors not returned "in step" to your eye. For example, if reddish light is seen in the reflected light (as in the example of Fig. 1), then you will see bluish light that passes through.

Follow 1- 4 below to see how this **white light** can reflect as red light!

Fig. 1



NGSS Correlations

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

Elementary

1-PS4-2
Students can use the Spinner to make observations to construct an evidence-based account that objects can be seen only when illuminated.

2-PS1-1
Students can use the Spinner to plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

K-2-ETS1-2
Students can use the Spinner to develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

4-PS4-2
Students can use the Spinner to develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

4-LS1-2
Students can use the Spinner as a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.

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

K-PS2-2
Students can use the Spinner in an investigation to analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

1-PS4-3
Students can use the Spinner in an investigation to plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

2-PS1-1
Students can use the Spinner in an investigation to plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS3-1
Students can use the Spinner in an investigation to describe and classify different kinds of materials by their observable properties.

3-PS2-2
Students can use the Spinner in an investigation to make observations and / or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

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

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

4-PS4-1
Students can use the Spinner in an investigation to develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

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NGSS Correlations

continued

Middle School

MS-PS4-2
Students can use the Spinner to develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MS-LS1-8
Students can use the Spinner to gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate storage as memories.

MS-ETS1-4
Students can use the Spinner to develop a model to generate data for iterative testing.

MS-PS2-2
Students can use the Spinner 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 the Spinner as a concrete introduction and demonstration on mass and motion. Students can then 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.

MS-PS4-1
Students can use the Spinner as a concrete model for mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in the wave.

High School

HS-PS4-3
Students can use the Spinner to evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations, one model is more useful than the other.

HS-PS2-2
Students can use the Spinner to demonstrate how mass and momentum affect motion. This can be transferred into 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 the Spinner as a physical model in conjunction with a computational model to calculate the change in the energy of one component in a system when the change in energy of the other components.

Suggested Science Idea(s)

The Centripetal Spinner entices the student with its loopy and colorful patterns. The changes in speed and direction the user pushes and pulls on the stick, determine the shapes and the energy it produces.

Classroom demonstrations of: centripetal force, friction, gravity, inertia, and more are at your fingertips.

Persistence of Vision; when the eye and the brain work together to create an illusion of a whole image. This is demonstrated due to the spinning motion and the seemingly connection of the Mylar strips into a solid orbs or figure 8 images.

When the Centripetal Spinner is held in front of different colored backgrounds, an interesting investigation of light interference can be conducted.

It can be used at numerous grade levels as a concrete introduction into more abstract mathematical and physical science concepts.

An interesting element to introduce into the lessons and investigations is the use of the slow motion video option on many phones. The slow action will allow students to look more closely at the forces at work, shapes that are formed and changes that occur during an investigation. Students can utilize the stop action on the video to collect precise data/measurements or identify parts of a wave.

Using the Centripetal Spinner

What's Going On?

Using your thumb and forefinger, gently spin the wand of your Centripetal Spinner.

You will notice that the polyester bands bulge out as the spin speed increases. Just as when a fast car rounds a turn, the fast-moving bands need more inward force (called **centripetal force** or "center seeking" force) to keep them in a circle. This occurs as the bands bulge outward, providing a larger force pulling them in.

Ideas for Your Classroom

This simple "toy" has so many potential science applications, we don't know where to start! Below is list of just a few of the ways the Centripetal Spinner can be used in your classroom as part of a unit on topics such as:

- centripetal force (obviously!)
- friction
- gravity
- inertia
- light interference

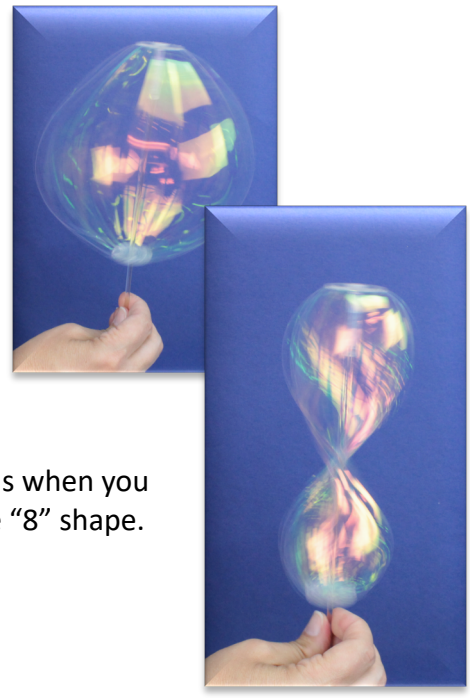
Are there other topics that can be introduced with the Centripetal Spinner? We're betting the answer is "yes." If you come up with an idea for a lesson using this wonderful gadget, please write to us at **lessons@TeacherSource.com**.

Using the Centripetal Spinner

continued

We've provided a few discussion starters and questions you may want to pursue with your class, depending upon the grade level and subject area you are teaching. Feel free to adapt these ideas to your own classroom needs and teaching style.

Inertia



Hold the spinner between thumb and forefinger and gently spin. You will observe the middle of the spinner bulge slightly.

This is due to **centripetal force**.

Now spin it very quickly in one direction only and then stop it suddenly.

What do you observe?

Though it may be hard to see at the beginning, it is quite obvious when you quickly stop the spinner that the polyester bands create a figure "8" shape.

What causes this?

Inertia!

How does inertia lead to the figure 8 shape?

Look carefully at the spinner. Notice the top hub is fastened to the stick but the bottom hub is not—it spins freely. As you begin to spin the stick, the stationary polyester bands remains at rest but since the top hub is connected to the stick, the top of the strands move more quickly than the bottom. Because the bottom hub is not connected, however, the bottom strands lag behind. This is what causes the figure 8. This will become even more noticeable when you quickly reverse directions.

Using the Centripetal Spinner

continued

Friction and Gravity

Demonstrate each type of energy using the spinner. Ask students:

- In what two ways does friction affect the inertia of the Centripetal Spinner?
- If the Centripetal Spinner were left in space to spin freely without friction, what shape do you hypothesize would be taken and why? Can your hypothesis be tested or demonstrated using the spinner?
- How does gravity affect the spinner as it is tilted from 0° to 180° while spinning? What changes in shape can be observed? Why do you think these changes occur?
- How does the speed of rotation influence the shape of the sphere? What changes can be observed as the speed increases or decreases?

Interference

Look closely at the thin bands. You will notice that the film bands reflect one color and transmit its complement. In other words (depending upon your angle of viewing) the reflection is from blue to green but the transmission is from red to yellow! This observation is a great way to introduce a lesson on interference.

You will also notice that the bands reflect different hues depending upon the color(s) near them. This observation offers your students many opportunities to figure out why this happens.

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)

Give the disk a spin and observe the hypnotic display of light and continually changing sound. The movement seems to go forever, spinning and precessing as it slowly transforms gravitational potential energy into kinetic. The concave mirror base provides an ideal reflective surface to see the visual effects. Amazing to use in a darkened room with a flashlight or laser. Includes magnetic holographic film.

The SpillNot (PHY-300)

The SpillNot is a fabulous solution to the ubiquitous problem of spills when carrying liquids. The fundamental laws of physics will easily and surprisingly keep the contents in the container! A very functional item that also graphically illustrates the effects of centripetal force. Your cup will not runneth over!

Euler's Disk (TOP-400)

Give the disk a spin and observe the hypnotic display of light and continually changing sound. The movement seems to go forever, spinning and precessing as it slowly transforms gravitational potential energy into kinetic. The concave mirror base provides an ideal reflective surface to see the visual effects. Amazing to use in a darkened room with a flashlight or laser. Includes magnetic holographic film.