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!

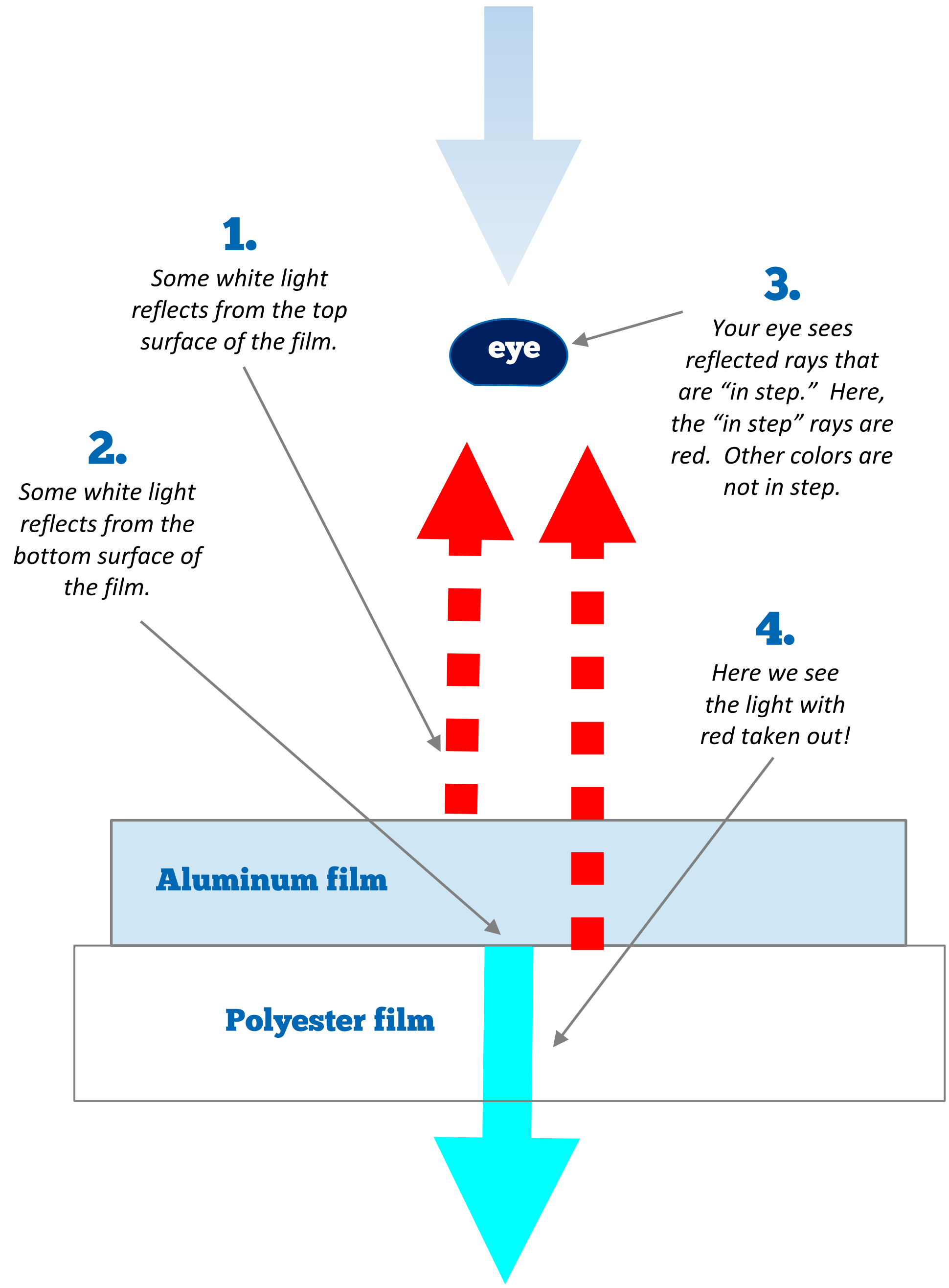
Look at a piece of white paper through one of the polyester bands. You will see blue! Reddish colors have been reflected, leaving the blue waves to pass through.

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



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**.

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.

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:

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.

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.

Magic Filter Kit (FIL-200)

This kit is designed to allow students to explore the wave nature of light and color mixing, as well as the concepts of reflection, transmission, and absorption. A special dichroic lens allows specific wavelengths of light to penetrate while reflecting back other wavelengths. It absorbs almost no light at all. The disk is a classic example of the principle of thin-film interference and can be studied as such. Thin-film interference is the same color interfering phenomenon seen in oil slicks or soap bubbles. Includes 1 plastic dichroic filter disk 7 cm dia., 1 mirror 8 x 8 cm, 8 squares of colored paper, and instruction manual with ideas for explorations.