3 -5 Physical Science
Southern Nevada Regional Professional Development Program

Kaleidoscopes

INTRODUCTION

A kaleidoscope creates beautiful images by using colored, translucent objects and reflective surfaces inside a long tube. Light waves enter the tube by first passing through colored objects and then are reflected inside the tube to create colorful patterns.

WHERE'S THE SCIENCE?

The kaleidoscope operates using two principles of science. The first principle is the *law of reflection*, which states that when a light hits a smooth and shiny surface at a certain angle, the light is **reflected** away from that surface at the same angle. In more technical terms, the law of reflection states that the angle of incidence equals the angle of reflection. In a kaleidoscope, the light waves reflect back and forth inside the tube allowing the creation of multiple images.

The second principle is that white light is a combination of all the visible colors of the rainbow: think ROY G. BIV, a memory aid where each letter stands for the visible colors. R equals red, O equals orange, Y equals yellow, G equals green, B equals blue, I equals indigo, and V equals violet. Not only does this memory aid help us remember the colors, but this aid helps us remember the colors in order that they appear in on the rainbow, with red the top band and blue the bottom.

When white light passes through colored objects that are **translucent**, most of the colors are absorbed by the object. But, one color is allowed to pass through the object and that is the object's color. So, in a kaleidoscope white light passes through colored objects, where most of the light is absorbed by the objects. With many colored objects in a kaleidoscope, many colors are transmitted into the tube.

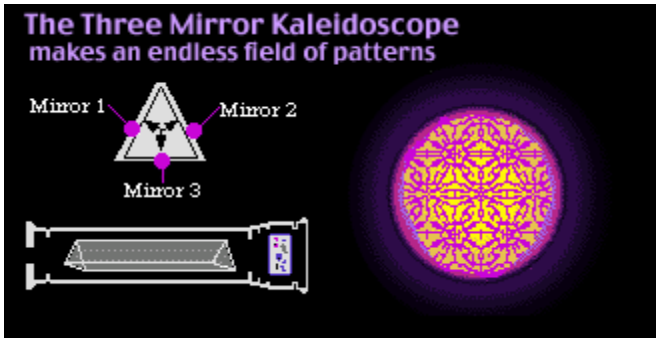

Figure 1. This image is from the Kaleidoscope Collector website found at http://www.kaleidoscopesusa.com/how.htm.

MATERIALS

- Toilet paper roll
- Plastic wrap
- Rubber band
- Small and colorful translucent beads (approximately 10)
- Aluminum foil
- Colorful contact paper
- Clear tape

PROCEDURES

1. Introduce the lesson by asking students if they have ever heard of a kaleidoscope. If you have a kaleidoscope, you may wish to share it with the class, but first introduce them to how the kaleidoscope operates and any safety concerns (e.g., if the kaleidoscope has glass parts warn the students to be careful in handling). Alternatively, you may wish to show students images of kaleidoscopes and the colorful patterns they make.

A good site for these images and information is at Wayne Schmidt's Favorite Kaleidoscope Links (http://www.waynesthisandthat.com/kallinks2.htm).

2. Have the students come up with ideas about how a kaleidoscope works. They should discuss the kaleidoscope in groups of two or three and then draw a diagram of they think it works in their science notebooks. Even though the students are working in groups, have them draw their diagrams individually and make sure they include labels in the diagrams.

3. Have the students then construct their own kaleidoscope. Posting the instructions in the front of the room will avoid confusion or missing steps.
    a. Cover toilet paper roll with contact paper.
    b. Cut a piece of aluminum foil the length of the toilet paper roll and 3 ½ inches wide.
    c. Smooth out aluminum foil, shiny side up.
    d. Fold the aluminum foil into a triangle, shiny side in, overlapping the last ½ inch. Tape the overlap down on the outside of the triangle.
    e. Slide the triangle into the toilet paper roll. Tape in place, at the top only, with small pieces of tape.
    f. Spread out a piece of clear, plastic wrap. Lay the beads in the center of the plastic wrap. Fold the wrap loosely, over the beads, so they don't fall out but can still slip around. Make sure that they aren't surrounded by too much plastic wrap and that the light can still pass through them.
    g. Place the beads across the bottom opening of the tube. Adjust the wrap so that the beads fit the circle of the opening. Trim the plastic wrap and tape it to the outside of the tube, pulling it tight enough so the beads will not slide out the sides.
    h. Look through the top opening of the tube while pointing the bottom toward the light. Turn the tube and

notice the colors of the beads reflected on the sides of the tube.

i. Make any adjustments to improve your kaleidoscope.

4. Now that the students have created their own kaleidoscopes, it is time to demonstrate some principles of reflection. A good demonstration involves a mirror and a laser pointer. Shine the laser pointer on a mirror with some angle and observe how the reflected angle is equal to the incidence angle. If the room is dark and you lightly shake some flour over the beam, it is more easily seen. You may need student assistance for this demonstration. Remember to use safety procedures when operating the laser pointer and do not shine the laser near anyone's eyes.

5. You should also demonstrate that white light is made up of many colors. Use a prism to split white light into its constituent colors. Also, discuss with the students how when white light passes through a translucent and colored object, all the colors are absorbed, except the color that is transmitted through the object.

6. With constructed kaleidoscopes and demonstrations about reflection and light colors, the students should revisit their ideas about how a kaleidoscope works. Have them discuss their modifications in their original groups and make new drawings. Guide the students during this modification to ensure that their models are scientifically accurate.

Additional Resources

1. Wayne Schmidt's Kaleidoscope site has lots of links to amateur's that construct their own kaleidoscopes. The site is found at http://www.waynesthisandthat.com/kallinks2.htm
2. The Kaleidoscope Painter is a cool website where students can create kaleidoscope-like patterns. You can access this site at http://www.permadi.com/java/spaint/spaint.html (note: the

site requires that the free Java™ software be loaded on the computer.

3. Kaleidoscope Heaven has a site that supports educators and they have an interesting article on how an elementary teacher has used kaleidoscopes to demonstrate math principles. The site is located at http://kaleidoscopeheaven.org/he00004.htm.

4. There is a very informative Delta Science Reader that discusses light and color. The title is Color and Light, ISBN-10: 1-59242-366-3, and more information can be found at http://www.deltaeducation.com

Vocabulary

Reflection: When light hits a surface and then bounces off.

Translucent: When an object permits some, but not all of the light that hits it to pass through. In the case of a colored, translucent object, all the colors, except the color of the object are absorbed and the light, which is the color of the object, passes through.

White light: Light that contains all the wavelengths of the visible spectrum, as in sunlight.

Nevada State Science Standard

P5C1 Students know light can be described in terms of simple properties (e.g. color, brightness, reflection). I/S

N5A3 Students know how to draw conclusions from scientific evidence. E/S

N5B3 Students know the benefits of working with a team and sharing findings. E/L

Safety Reminder

If you use do the demonstration with the laser pointer, remember to not shine the laser near anyone's eyes.