Lights, Lasers, and Optics

Grades 6-8
Let's Make a Kaleidoscope

Summary: Students will extend the study of mirrors that was introduced in the Duck Under Kaleidoscope exhibit. They will explore the number of images produced when looking into a set of hinged mirrors.

NCTM Standards: Standard 12—Geometry

National Science Education Standards: Physical Science
Motion and Forces

Objectives:
To observe what mirrors do as they open and shut.
To explore how mirrors are related to a kaleidoscope.
To explore many of the geometric figures produced in a kaleidoscope.

Materials:
three 1/4" pieces cardstock backed with silver mylar
transparent tape
3/4 oz. plastic portion cup
brightly colored plastic beads
toilet paper tube
two pieces of paper towel

Procedures:
1. Use the transparent tape to put the three pieces of mirrored card stock together to form a triangular prism. (tape along the long edges)
2. Place a few of the colored beads into the portion cup and put it in one end of the tube. (beads should be in a variety of colors)
3. Next, wrap the triangular prism in the paper towel and fit it snugly into the center of the tube.
4. Point the completed kaleidoscope at a light source and rotate it as you look through the open end of the tube.
Background Information: Plane mirrors use light to produce a virtual image. A virtual image is an image at which the light rays appear to meet but actually do not; therefore, a virtual image does not appear on a screen placed at the image's position. A kaleidoscope consists of two or more mirrors set at angles that provide many virtual images of the same objects. The objects used to create the colorful reflections may be little bits of colored glass or sand.

Assessment: Informal assessment through questioning.


Submitted by Marienne Bell, Edna Coleman, Terri Shirley and Catherine Smith
Make A Kaleidoscope

Materials:
3 - 1" x 4" pieces card stock backed with silver mylar
translucent tape
3/4 oz. plastic portion cup
brightly colored clear plastic beads
toilet paper tube
2 pieces of paper towel

Procedure:
1. Join the 3 pieces of mirrored card stock to form a triangular prism using transparent tape along their long edges.

Try:

2. Then fold over to tape third side to first (mirrors face inward).

2. Place a small amount of mixed colored beads in the portion cup and secure the lid in place.
Position the filled portion cup in one end of the toilet paper tube.

3. Wrap the triangular prism in paper towel and place in tube so that it fits snugly in the center of the tube.

4. Point the tube toward a light source and rotate as you look through the open end of the tube. Behold a kaleidoscope!

5. Optional: Decorate the outside of the tube.
Cellophane Tape Kaleidoscope

Summary: Students will extend the "Duck Under Kaleidoscope" activity that was introduced in the IDEA Place by making a kaleidoscope to find out how it works.

NCTM Standards: Standard 1—Mathematics as Problem Solving

National Science Standards: Science as Inquiry
Abilities necessary to do scientific inquiry

Objectives:
To identify how a polarizing material affects a light's path.
To explore how light waves travel in all directions.

Materials:
polarizing material—2 squares
toilet paper tube—1
paper towel tube—1

felt tip pen
scissors
cheap cellophane tape

Procedure:
1. Place the smaller tube on one end of polarizing square and trace with felt tip pen. Cut out circle and tape onto end of tube with cellophane tape. Randomly cover with different-sized pieces of tape (the more, the better).
2. Place larger tube on one end of polarizing square and trace with felt tip pen. Cut out circle and tape onto end of tube with cellophane tape (form an X using two pieces of tape).
3. Place larger tube over smaller one, point kaleidoscope towards a light source, turn tube and observe.

Background Information: Plane mirrors use light to produce a virtual image. A virtual image is an image at which the light rays appear to meet but actually do not; therefore, a virtual image does not appear on a screen placed at the image's position. A kaleidoscope consists of two or more mirrors set at angles that provide many virtual images of the same objects. The objects used to create the colorful reflections may be little bits of colored glass or sand.

Assessment: Informal assessment through questioning.


Submitted by Teresia Nicholson & Charlotte Bowen
Making the Most with Mirrors

Summary: Students will examine the relationship of a hinged mirror and the resulting number of images. They will relate this activity to what they saw in the Duck Under Kaleidoscope activity.

NCTM Standards: Standard 12—Geometry
Standard 8—Patterns and Functions

National Science Education Standards: Physical Science
Motion and Forces

Objective:
To explore the relationship of the angle of a hinged mirror and the resulting number of images.

Materials: (per group)
one hinged mirror
1 protractor
a small object

Procedure:
1. Use a protractor to measure the angle in Figure A. Record the number of degrees in the table.
2. Predict the number of images that will appear in the mirrors. Record your prediction.
3. Place the hinged mirrors on the dotted lines. Count and record the number of images seen. (Hint: Include the object in your count.)
4. Repeat the process for each figure.
5. Look for patterns and relationships of angles and number of images.
6. Record generalizations from observations.

Background Information: Plane mirrors use light to produce a virtual image. A mirror reflects light to produce an image. Plane mirrors are used in homes and automobiles. Hinged mirrors are made by taping or fastening two or more plane mirrors together. The numerous images one sees are simply reflections of reflections. The number of images depends on how close or far away the mirrors are and the number of mirrors used.

Assessment: Informal assessment through questioning.
1. How does the relative size of the angle generally affect the number of images?
2. How does the number of images in an angle that is half as large compare?
3. If you were to write a mathematical statement to show the relationships, what would that statement be?

Submitted by Teresia Nicholson & Kathryn Boddie
Making The Most Of Mirrors

Place an object or picture in front of the mirrors. Predict how many images can be seen altogether.

Use two hinged mirrors... place the mirrors on the dotted lines.

Look into the mirrors. Count and record the total number of objects.

Observation: ________________________________
Making The Most Of Mirrors

Use a protractor to measure the angle of the hinged mirror in each figure...

Collect and organize data:

<table>
<thead>
<tr>
<th>Name of angle</th>
<th>No. of Degrees</th>
<th>Predicted No. of Images</th>
<th>Actual No. of Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fig. A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
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<td>C</td>
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<td></td>
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<td>D</td>
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</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusion: As the number of degrees in the angle becomes (less or greater) the number of images becomes (less or greater).

Look for a pattern and describe the relationship between the number of degrees and the numbers of images in related angles (angles that are proportional or multiples of each other).

Other relationships?
Discovering Reflection

Summary: Students will extend "hands-on" activity that was introduced in the Idea Place. Students will discover the way light behaves when it hits a reflective surface. Plane mirrors are flat surfaces that reflect light. Reflection can be defined as the bouncing of a wave off the surface it hits.

NCTM Standards: Standard 13: Measurement

National Science Standards: Physical Science Transfer of energy

Objective: To explore the relationship of the angle of a mirror and the resulting size of the images.

Materials: graph paper ruler plane mirror objects of various sizes

Procedure:
1. Stand the mirror on a straight line on the graph paper.
2. Place an object directly in front of the mirror.
3. Measure the distance the object is in front of the mirror.
4. Measure the distance the image is in back of the mirror.
5. Repeat steps 1 through 4 with each object.

Assessment: Informal assessment through questioning.

1. Are all the images the same distance behind the mirror as the object in front?
2. How does the size of the image compare to the size of the object?
3. Project this idea: Would the size of the mirror have an affect on the distance to the image or the size of the image?
4. Predict how big the mirror would have to be to see the entire image of an object?


Submitted by Edna Coleman
Investigating Refraction and Reflection

Summary: The students will continue their exploration of light refraction and reflection, begun in the IDEA Place, by investigating the behavior of light through various mediums.

NCTM Standards: Standard 1—Math as Problem Solving

National Science Standards: Science as Inquiry
Understandings about scientific inquiry

Objectives:
To investigate and record how light travels.
To describe what happens when light contacts an object.

Materials:
pennies
cups of water
one 2-liter bottle of water
aluminum foil
pencils
one shallow pan

Procedure:
1. Remove label, cap and base from 2-liter bottle.
2. Wrap aluminum foil around bottle, leaving pour spout open and small area at bottom of bottle (size large enough to fit top of flashlight in).
3. Fill bottle of water.
4. Turn flashlight on and hold up against opening in bottom of bottle.
5. In darkened room, tilt bottle with flashlight held securely in place and pour water into pan.
6. Notice the appearance of the light, as the water is poured out.
7. Pass out a penny and a cup, having the student tape the penny onto bottom of cup.
8. In groups of two, have one student bend down so that he/she can no longer see the penny. Another student will pour the water slowly into the cup.

Explanation: Light travels in what appears to be a straight line in the air. When it goes through water, it slows down and is bent. As water is poured into the bowl, the light will bend and more of the bottom is exposed. The coin appears. Reflection is defined as the bouncing of a wave off the surface it hits. Refraction is the change in direction of a wave as it moves from one material to another and the wave's speed changes.

Assessment: Teacher observations and discussions with the students.
Resource: Science activity sheets collected from the Louisiana Science Teachers Convention.
Submitted by Terri Shirley
Measuring Distance

Summary: The students will visualize distance by constructing a target. Students will discuss the depth of a space and write down the number of times they missed the target therefore forming a chart to display the effects. This is an extension of Can You Believe Your Eyes? Optical Illusion exhibit in the IDEA Place.

NCTM Standards: Standard 13—Measurement
Standard 7—Computation and Estimation

National Science Education Standards: Unifying concepts and processes
Systems, order, and organization

Objectives:
To estimate distance.
To explore eye and hand coordination.
To chart and compare difficulties from different angles.

Materials:
paper
a table
pencil

Procedure:
(prior to the activity discuss hand/eye coordination and the measuring of distance of an object.)
1. Make a point on a piece of paper and place it in front of you on the table.
2. Try to hit the point with a pencil held in your hand.
3. Repeat the same process but this time cover one of your eyes with one of your hands.
Background Information: This activity is an optical illusion. An optical illusion is something that looks different from what it really is. This particular optical illusion occurs because we have two eyes. Everyone has a blind spot in the right eye where the optic nerve cord leaves the eye, and no nerve cells register an image. When one looks with both eyes, the image from the left eye makes up for the blank in the right. The eyes gather impressions, but the brain interprets them. If the eyes see something that the brain can not figure out, our minds "correct" the picture automatically.

Assessment: Informal Assessment through observation and questioning. Formal Assessment through lab chart recording results.

Resources:

Submitted by Marienne Bell
Background Information: This activity is an optical illusion. An optical illusion is something that looks different from what it really is. This particular optical illusion occurs because we have two eyes. Everyone has a blind spot in the right eye where the optic nerve cord leaves the eye, and no nerve cells register an image. When one looks with both eyes, the image from the left eye makes up for the blank in the right. The eyes gather impressions, but the brain interprets them. If the eyes see something that the brain cannot figure out, our minds "correct" the picture automatically.

Assessment: Informal Assessment through observation and questioning. Formal Assessment through lab chart recording results.

Resources:

Submitted by Marienne Bell
Solar Cooker

Summary: This activity incorporates the concepts involved in concave mirrors and focal points. The students will locate a focal point that will attract the most heat to complete the assignment.

NCTM Standards: Standard 4—Mathematical Connections

National Science Standards: Physical Science
Transfer of energy

Objectives:
To identify the best location to place their solar cooker.
To observe the temperatures of the air and of the oven and record the data.
To use the cookers to cook various foods and record the times to cook each one.

Materials:
- various shaped containers
- adhesive tape
- thermometers
- numbered paper
- aluminum foil
- skewers
- watch
- marshmallows and other food items

Procedure:
1. Make different types of solar cookers by lining containers with foil, securing it with foil.
2. Place the ovens outside to preheat.
3. Have each group draw a number, determining the order that the cooker would be chosen.
4. After going outside, take the temperature of the air and the oven and record.
5. Put the marshmallow on the end of a skewer and begin cooking, allowing ten minutes as a time limit.
6. Record temperatures every two minutes during marshmallow cooking. Discuss.
7. Judge which marshmallow was cooked the best.

Assessment: Teacher observation and judging of the marshmallows.

Resource: Adapted from Science Activities, p. 60-62.

Submitted by Zettie Dorsey