Title: The Beauty of Symmetry

Link to Outcomes:

- **Problem Solving** Students will work in a cooperative atmosphere and with manipulatives to see symmetry and reflection.
- **Communication** Students will use "numbered heads" to discuss the various outcomes produced by different angles. They will share their observations orally or through writing.
- **Reasoning** Students will make conjectures about the angles and the number of reflections.
- **Connections** Students will observe symmetry in art and nature.
- **Geometry and Spatial Sense** Students will demonstrate congruency, similarity, symmetry, and reflection and apply these concepts to the solution of the geometric problems.
- **Measurement** Students will measure and apply concepts of measurement using the protractor.
- **Patterns & Relationships** Students will recognize the relationship between angle size and number of reflections using mirrors.

Brief Overview:

This is a lesson dealing with the concepts of symmetry and reflection. The use of manipulatives and cooperative learning are necessary for the success of this project.

Grade/Level:

Grades 6-7

Duration/Length:

The lessons using mirrors and miras will last about 2 periods. The follow-up project of making the kaleidoscope will take about 3 days.

Prerequisite Knowledge:

The students should have knowledge of the following skills:

- using a protractor to measure angles,
- drawing a circle with a compass,
- working in cooperative learning groups, and
- working with a Mira.

Objectives:

- Find lines of symmetry.
- Complete drawings of symmetrical figures using a Mira.
- Count reflections using 1-3 mirrors.
- Observe and communicate findings both orally and in written form.
- Construct a simple kaleidoscope.

Materials/Resources/Printed Materials:

- Miras
- 3 Mirrors per group
- Protractors
- Rulers
- Worksheet #1 Lines of Symmetry
- Worksheet #2 Figure Completion
- Worksheet #3 Observing Symmetry and Reflections
- Pringles can plus extra lid
- 3" x 3" piece of 0.03 thick butyrate plastic
- 8" x 10" piece of 0.015 thick butyrate plastic
- 6" x 8-15/16" piece of white mat board
- 1/2" x 8-1/2" strip of corrugated cardboard
- Packing material (fabric, styrofoam, material)
- Objects for viewing (plastic beads & fragments, paper clips, etc.)
- Spray adhesive
- The Kaleidoscope Book by Sterling Clark
- Cube and cube corners (a cube corner is formed by slicing through the vertices of three adjacent faces of a cube).
- Murphy, Pat By Nature's Design: Chronicle Books, 1993

Development/Procedures:

- Procedure 1. Discuss what symmetry means and where you see it. Discuss point and line symmetry.

- Procedure 2. Distribute Worksheet #1 to each group and have the students complete the activities. Have a class discussion after the groups are finished.

  Possible Discussion Questions for Worksheet #1:

  1. Do any of the shapes have more than one line of symmetry? Why?
  2. Can you be sure they are lines of symmetry just by looking? In which ones?
  3. How can you prove the number of lines of symmetry? (Trace and fold the paper.)

- Procedure 3. Distribute Worksheet #2 and a MIRA to each group. Have the students complete the sheet. Discuss their findings.

- Procedure 4. Distribute Worksheet #3, a protractor, unlined paper, and three mirrors to each group. Have the students complete the work. Discuss their findings.

- Procedure 5. Demonstrate a mirrored kaleidoscope.

  A. A mirrored corner forms a three-dimensional "kaleidoscope." Observe how many images of your hand appear when you put it into the mirrored kaleidoscope.

  B. A "cube-corner" is formed by slicing through the vertices of three adjacent faces of a cube. Place one cube corner in the mirror kaleidoscope so that its right angles fit snugly in the corner. Observe what polyhedron appears in the kaleidoscope.

- Procedure 6. Construct a kaleidoscope with the following directions. Diagrams to assist the teacher are located after Worksheet #3.[1]

  - Cut out the bottom of the Pringles can with a can opener.
  - Decorate the outside of the can.
  - Make the eyepiece using one of the end caps, with a hole cut in the center the size of a dime. Cut a piece of the thinner piece of the plastic and tape it on the inside to cover the hole. Snap this lid on to one end of the tube. To create the mirrors, first spray the white side of the mat board with an even coat of adhesive. Then press the plastic on to it. Now cut into three equal rectangles each measuring 8-15/16" by 2."
  - To assemble the mirror system, lay the three mirrors, shiny side down, next to each other with 1/16 inch gaps between each long edge. Tape across with three 8 inch parallel strips of masking tape, so that you can fold the mirrors together and tape the last seam (Shiny side of mirrors inside, forming an equilateral triangle).
  - Wrap the mirror system with packing material until it fits snugly in the tube. Push it in until it fits flush with the eyepiece.
  - Create the object chamber by cutting a 2-3/4 inch diameter circle from the thicker plastic. Place it on top of the mirror system. Form the corrugated cardboard strip into a circle, and place it on top of the plastic disk.
  - Pour some objects loosely into this chamber (do not pack tightly).
  - Cover with the other plastic lid.
  - Look through the eyepiece as you rotate the tube, and watch the patterns change and enjoy the BEAUTY OF SYMMETRY!

Evaluation:

Circulate throughout the groups to monitor and assess the progress on the worksheets. Base assessment on group discussion and effort to complete the task. Give an individual grade on the construction of the kaleidoscope.

[1] Sterling Clark, The Kaleidescope Book (New York, NY: Sterling Publishing Company, Inc., 1992), pp. 66-67.

Extension/Follow Up:

Students will sketch the various designs formed by their kaleidoscope.
Students will write how symmetry is shown in these designs.
Students will share through writing three concepts they have learned from this project.

Authors:

Martha Dodge
John Paul Regional
Baltimore County

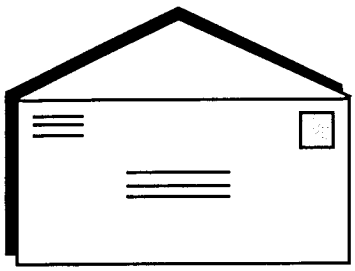
Sandra Margel
Trinity
Howard County

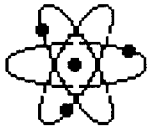
Martha DeCastro
Trinity
Howard County

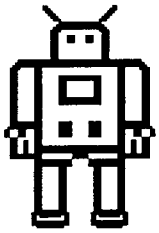
Worksheet #1

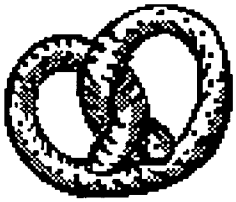
Lines of Symmetry

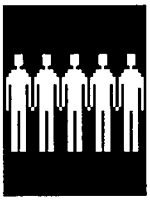
How many lines of symmetry can you find in the following shapes? Draw them.







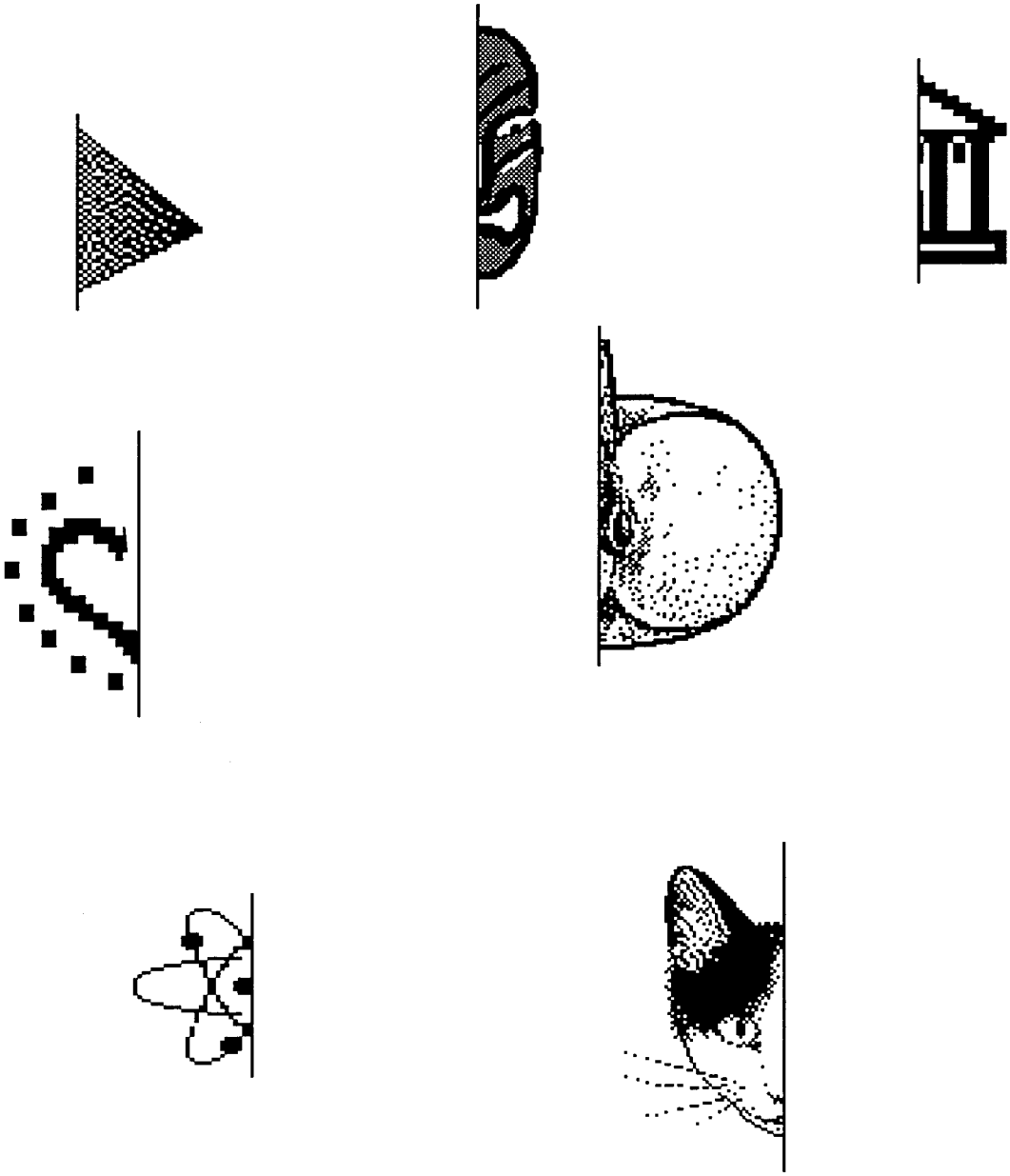




Worksheet #2

Figure Completion

Assuming the line is a line of symmetry, complete the following figures using a Mira.



Worksheet #3

Observing Symmetry and Reflections

1. Place object in front of a single mirror and describe what you see.

2. Use your protractor to draw angles with measures of 90°, 60°, and 45°. Place the mirrors on the rays of the angles. Place an object between the rays. Observe and record what you see in the chart below.

Measure of angle	Number of Reflections
90 °	
60 °	
45 °	

3. Do you see a pattern? Predict the number of reflections you will see with an angle measuring 30°. Verify.

4. Make a variety of triangles, including right, isosceles, scalene, and equilateral. Place an object in the center of each triangle. Do you see the same number of reflections in each triangle? Which is most pleasing to the eye? Why do think this is?