

GEOMETRY Project 35

I wanna be like Escher

Maurits Cornelis Escher (1898–1972) was a Dutch graphic artist. Although his early studies focused on architecture, he soon turned to graphics. Until 1937 he drew and sketched mostly landscapes, but then concentrated on constructing images that exist only on paper or in abstract theory.

While his graphics may be grouped according to several different themes, the division of the plane is the focus of this project. A tiling design that covers a plane with no gaps or overlaps is called a *tessellation*. A *pure tessellation* is a design in which only one figure is used. A *regular tessellation* uses only one regular polygon to tile the plane. A *semiregular tessellation* is a design that covers the plane using two or more regular polygons. Escher created over 150 different tessellations in his drawings, yet he had no formal mathematical training.

Goal

Working individually, students will make a drawing similar to those Escher used to tile a plane. *Suggested time:* Three to four class periods.

Math Skills to Highlight

1. Defining and discussing tiling the plane, tessellations, including pure tessellations, regular tessellations, and semiregular tessellations.
2. Reviewing the names of polygons, including triangle, quadrilateral, rectangle, square, parallelogram, rhombus, and regular polygon.
3. Using the protractor to measure angles, or using the formula $[180(n-2)]/n$ to find the measure of each interior angle of a regular polygon. n stands for the number of sides.
4. Discussing transformations, including slides, reflections, glide reflections, and rotations.
5. Using technology in problem solving.

Special Materials/Equipment

Books containing Escher's graphics; protractors; scissors; envelopes to store patterns; rulers; transparent tape. *Optional:* Colored pencils or thin markers; computers and printers; Internet access for research.

Development

Show students examples of Escher's graphics in books about Escher. An excellent source is *Fantasy and Symmetry: The Periodic Drawings of M. C. Escher* by Caroline H. MacGillavry (New York: Abrams, 1976). Another is *M. C. Escher: His Life and Work* by J. L. Locher (New York: Abrams, 1992). Many other sources are probably in your local library. Numerous Web sites devoted to Escher and his work may be found by conducting a simple search using "M. C. Escher" or "tessellations."

- Begin the project by discussing pure, regular, and semiregular tessellations and the differences among them.
- Distribute copies of Student Guide 35.1, and review the information with your students. Note that the guide provides step-by-step instructions for students.
- Hand out copies of Data Sheet 35.2, "Polygon Patterns." Ask students to cut out the large regular triangle, square, and other regular polygons. Distribute an envelope to each student, and instruct students to keep all of their pieces in it to prevent the pieces from becoming lost. The small squares and triangles (the ones that have a 1-inch side) will be used only in the extension for this project. Do not cut them out yet.

- You may permit students to work in small groups to determine which regular polygons will make a regular tessellation. Remind students that only one shape may be used per design. Polygons may not overlap, and no spaces should be left between the tiles. Students should discover that only the regular triangle, square, and regular hexagon tile.
- Explore why some figures tile. The key here is the measurement of the angles. You may ask students to measure the angles of the regular polygons, or you may use the formula $[180(n - 2)]/n$ to determine the measure of an interior angle of a regular polygon. Students should discover that in order for a figure to tile, the sum of the angles around any point is 360 degrees. As an option, students may generalize that any triangle and quadrilateral will tile. They may require slides, reflections, slide reflections, or rotations.
- Distribute copies of Data Sheet 35.3, "Steps to Making an Escher-Like Drawing." These steps are illustrated with examples for clarity. Be sure your students understand the steps.
- Hand out copies of Worksheet 35.4, "Isometric Dot Paper." Students are to cover the worksheet by sliding, reflecting, sliding and reflecting, or rotating the shape. With details and color added, the drawings should resemble some of Escher's works.

Wrap-Up

Students should share their drawings with other members of the class. You may wish to display drawings in a central location.

Extensions

By using the smaller regular triangle, square, and other regular polygons, students can create semiregular tessellations through manipulating the patterns. Combinations may include:

- Octagon and square
- Hexagon, square, and triangle
- Hexagon and triangle
- Square and triangle

Students may also wish to make an Escher-like drawing, consisting of two figures.

STUDENT GUIDE 35.1

I Wanna Be Like Escher



Situation/Problem

Maurits Cornelis Escher (1898–1972) was a graphic artist. One of his most famous themes was tiling the plane. A tiling design that covers the plane with no gaps or overlaps is called a *tessellation*. Escher created over 150 different tessellations in his drawings. His designs are truly fascinating. In this project, you will create a tessellation of your own. When your drawing is complete, share it with your class.

Possible Strategies

1. Study examples of Escher's graphics on tiling in both print and online sources.
2. Determine which polygons will make a regular tessellation. List them.
3. Design a shape of your own by using a polygon that will tessellate.

Special Considerations

- From Data Sheet 35.2, choose a polygon that will form a regular tessellation. You may select a triangle, square, or hexagon.
- Refer to Data Sheet 35.3 for instructions on how to make an Escher-like drawing. Follow the suggestions carefully.
- Use Worksheet 35.4 for your drawing. Be creative.
- You may color your design.

To Be Submitted

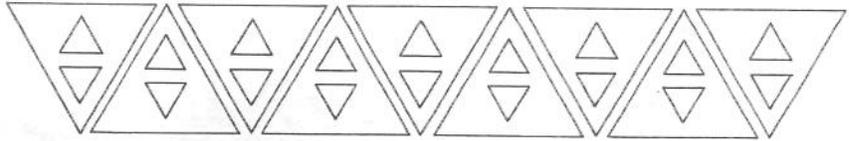
Your worksheet.

Name _____

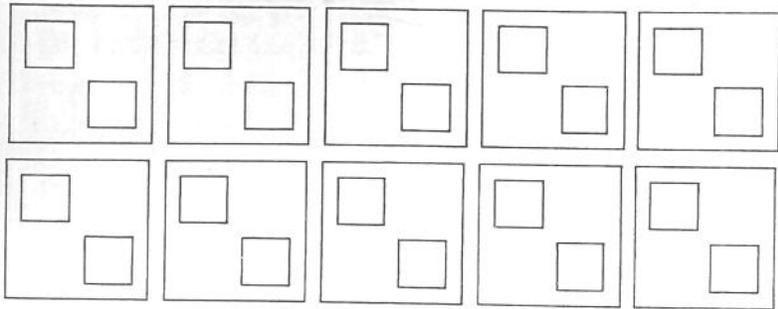
DATA SHEET 35.2

Polygon Patterns

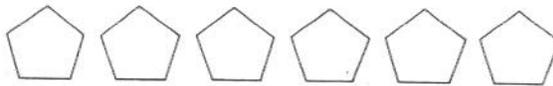
Regular Triangles



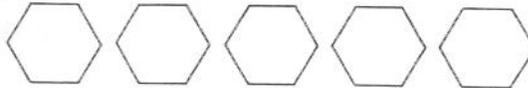
Squares



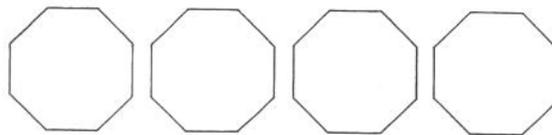
Regular Pentagons



Regular Hexagons



Regular Octagons

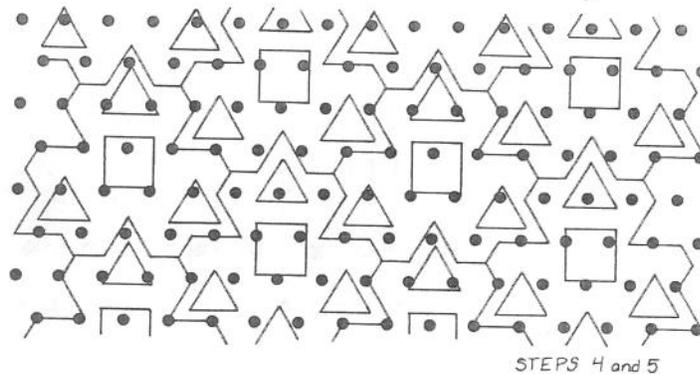
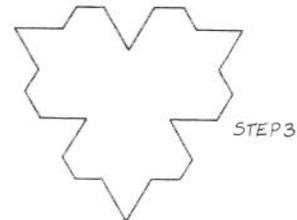
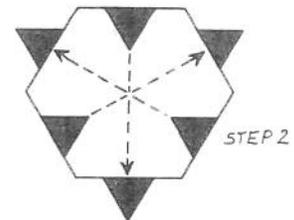


Name _____

DATA SHEET 35.3

Steps to Making an Escher-Like Drawing

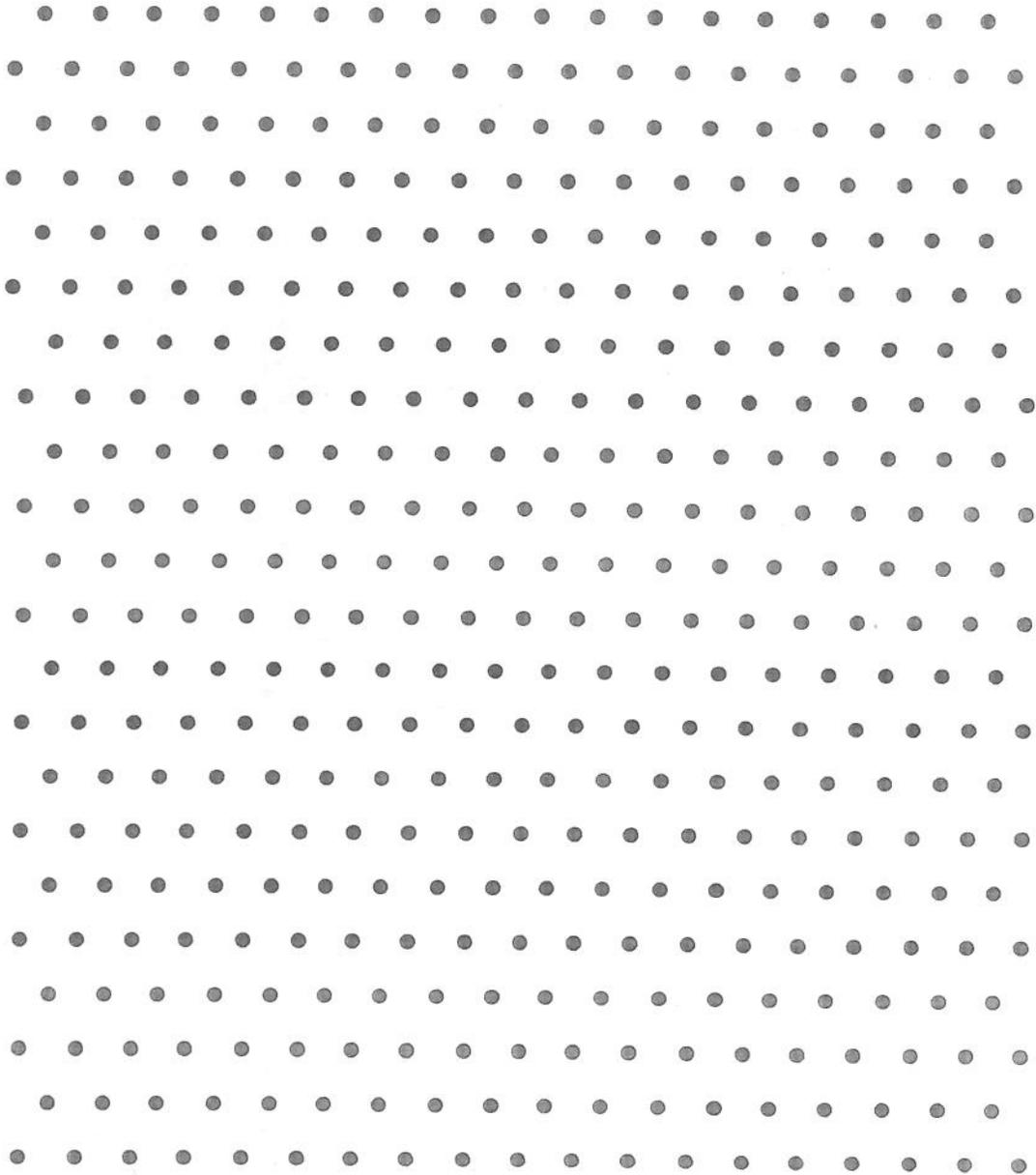
1. Start with a shape that will tessellate. A hexagon is used in the example.
2. Cut a portion of the figure on one side, slide it to the opposite side, and tape it. In the example, this was done three times.
3. What does the shape resemble? In this case, the shape resembles a snowflake.
4. Cover the paper by sliding, reflecting, sliding and reflecting, and/or rotating the shape.
5. Add details.



Name _____

WORKSHEET 35.4

Isometric Dot Paper



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