Title: Terrific Tessellations

Brief Overview:

This activity integrates geometric transformations with art and design. Students will explore geometric transformations: slides, flips, and turns. They will communicate how these transformations modify a polygon. Students will also determine which geometric shapes tessellate. They will design a unit cell from a cluster of geometric shapes and repeat this design to form a tessellation. Students will alter a paper square with scissors to make a transformation (slide or glide reflection) and then create a tessellation design from their new shape. To assess performance, students will create a floor from their own tessellation design for the math lab and write a persuasive letter describing their design. Students will apply their knowledge of geometric transformations and tessellations as they use a rubric to evaluate their own design.

Link to Standards:

- **Problem Solving** Students will demonstrate their ability to solve problems in mathematics, including problems with open-ended answers, problems which are solved in a cooperative atmosphere, and problems which are solved with the use of technology.
- **Communication** Students will demonstrate their ability to communicate mathematically. They will read, write, and discuss mathematics with language and the signs, symbols, and terms of the discipline.
- **Reasoning** Students will demonstrate their ability to reason mathematically. They will make conjectures, gather evidence, and build arguments.
- **Connections** Students will demonstrate their ability to connect geometric concepts with art and designs in the real world. Students will demonstrate a positive attitude towards mathematics and will value and appreciate the role of mathematics in school, culture, and society.
- **Geometry & Spatial Sense** Students will demonstrate their ability to recognize, describe, and apply geometric relationships using two-dimensional objects. They will explore transformations of geometric figures.

Grade/Level:

Grades 4-5

Duration/Length:

This lesson will take 4 periods (45 min.).

Prerequisite Knowledge:

Students should be able to do the following:

- Recognize and identify polygons.
- Understand angle measurement (90, 180, 360 degrees).

Objectives:

Students will :

- work cooperatively in groups.
- demonstrate geometric transformations: slides, flips and turns.
- determine which shapes tessellate.
- design a unit cell from a cluster of geometric shapes and create a tessellation from this unit cell.
- alter a paper polygon with scissors to make a transformation (slide or glide reflection) and from this transformation make a tessellation design.
- use a rubric to evaluate a model.
- identify tessellations in real-world situations: mosaic designs, wallpaper, tiles, art.

Materials/Resources/Printed Materials:

- Pattern blocks
- Pattern block template or stickers (optional) for recording designs
- Crayons
- Scissors
- White paper
- 3" x 5" index cards or tag board for making squares and rectangles
- Masking tape
- Teacher resource sheets: Tessellations.TR, Tessellations.TR2, and Tessellations.TR3, Tessellations.TR4, Tessellations.TR5
- Student Resource Sheets : Tessellations.SR1, Tessellations.SR2, Tessellations.SR3, Tessellations.SR4
- Transparencies of student resource sheet: SR1, SR2, and SR3
- Overhead Projector
- Pattern blocks for the overhead projector
- Pictures of tile designs (tessellations) from books or magazines
- Sample art work that shows tessellations (M.C. Escher)

Development/Procedures:

Day 1:

- Hand out pattern blocks and Student Resource #1"Slides" to pairs of students.
- Using the overhead projector demonstrate and explore the concept of slides using the square and the rhombus. Have students demonstrate their understanding of this concept using the remaining pattern blocks on SR1.
- Ask students to explore other ways that the position of the rhombus can be changed. Allow students time to manipulate the rhombus to discover the flip and turn. Students should demonstrate their understanding of these concepts using SR2 and SR3.
- Discuss with students how these changes modify a polygon's position in space. (Introduce the term transformations, see TR1.)
- Have students demonstrate these transformations using classroom objects such as books, pencils, etc.
- Introduce concept of tiling using classroom floors, ceiling, walls, and various pictures from magazines or books.
- Ask students what all of these examples of tiling have in common. (The repetition of a single design without any gaps or overlaps)

- Lead students by demonstration to tiling using the rhombus. (See TR2 for example of single-shape tiling patterns.) Discuss how rotations, slides, and flips are used in tiling patterns by examining the original rhombus and the positioning of the added tiles.
- Introduce the term tessellation at this time. (See TR2.) Have students form tessellations using the other pattern block shapes. Students should discover that each pattern block, when repeated, forms a tessellation.

Day 2:

- Using overhead pattern blocks, demonstrate a "unit cluster" using a combination of pattern blocks. This unit cluster of pattern blocks should form a regular polygon or rectangle. (See TR3.) Show students how this unit cluster forms a tessellation. Ask students where they have seen examples of tessellations (bathroom, kitchen). Share some of the pictures that you have collected. Ask students to identify slides, flips, and turns of the original unit cluster.
- Working in pairs, have students first create a "unit cluster" and then use transformations of their unit cluster to make a tessellation. Students will discover that not all of their unit clusters tessellate. Elicit reasons from students to explain why some unit clusters will not tessellate.
- Have student pairs examine the tessellations of others by taking a "museum walk" around the room.
- Invite students to bring in pictures or drawings of tessellations. They may also recreate designs that they find in their homes (kitchens and bathrooms).

Day 3:

- Review the term *tessellation* and have children share samples of tessellations they have brought in.
- Discuss which shapes were found in their tessellations.
- Explain that today they will learn a method of modifying a rectangle so it will still tessellate.
- Hand out scissors, tape and index cards to pairs of students and model a vertical and horizontal slide(TR4). Work through this same process with students.
- Once the slides are complete, have the students examine and interpret their shape. Discuss how this type of slide differs from the slide concept of day one. Allow them to add details to their transformed shape.
- Trace the modified rectangle on the overhead and ask students if they think that your modified shape will tessellate. Ask them to come up and move the shape so that it will fit with the traced one. Continue having students come up to trace different positions of the shape to form a tessellation.
- Students should then trace and tessellate their own shapes. Details can be added.

Performance Assessment:

- After cutting a square for each student (from 3"x 5" cards), read the following vignette to the students:

  The principal has decided to retile the math lab. The design should combine math and art. You have been asked to submit a design which is a tessellation. Each of you will be given a square which you will transform into your own shape, using a vertical or horizontal slide, or both. You may slide, turn, or flip your shape to form your tessellation design for the new floor. Your design should be on large tagboard or paper and you may include decorations or details and color on your tessellation design.

  Write a persuasive letter to the principal explaining why your design should be selected for the math lab. Your letter should include a description of your design which describes how your square was transformed to create a new shape which tessellates. Your letter should also describe how your tessellation combines math and art in order to create a beautiful design for the math lab.

- Develop a rubric (See sample rubric TR5.) with the students for evaluating their tessellation.
- Have students work together to evaluate their tessellations based on the rubric developed by the students.

Extension/Follow Up:

- Have students research the art of M.C. Escher.
- Examine and discuss ancient mosaics and relate this art form to tessellations.
- Introduce students to computer program "Tesselmania" by MECC.
- Students can recreate their pattern block tessellations on a computer draw program.

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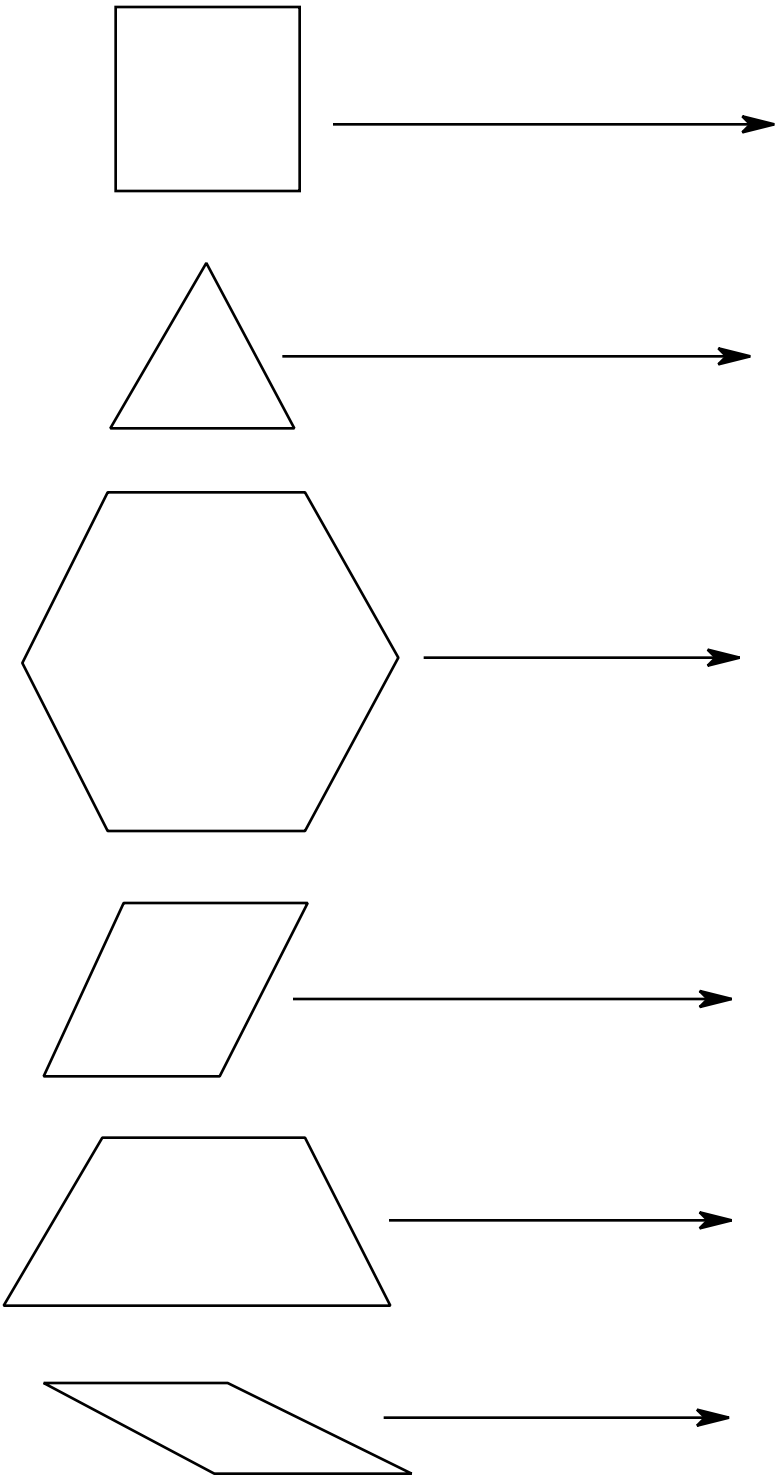
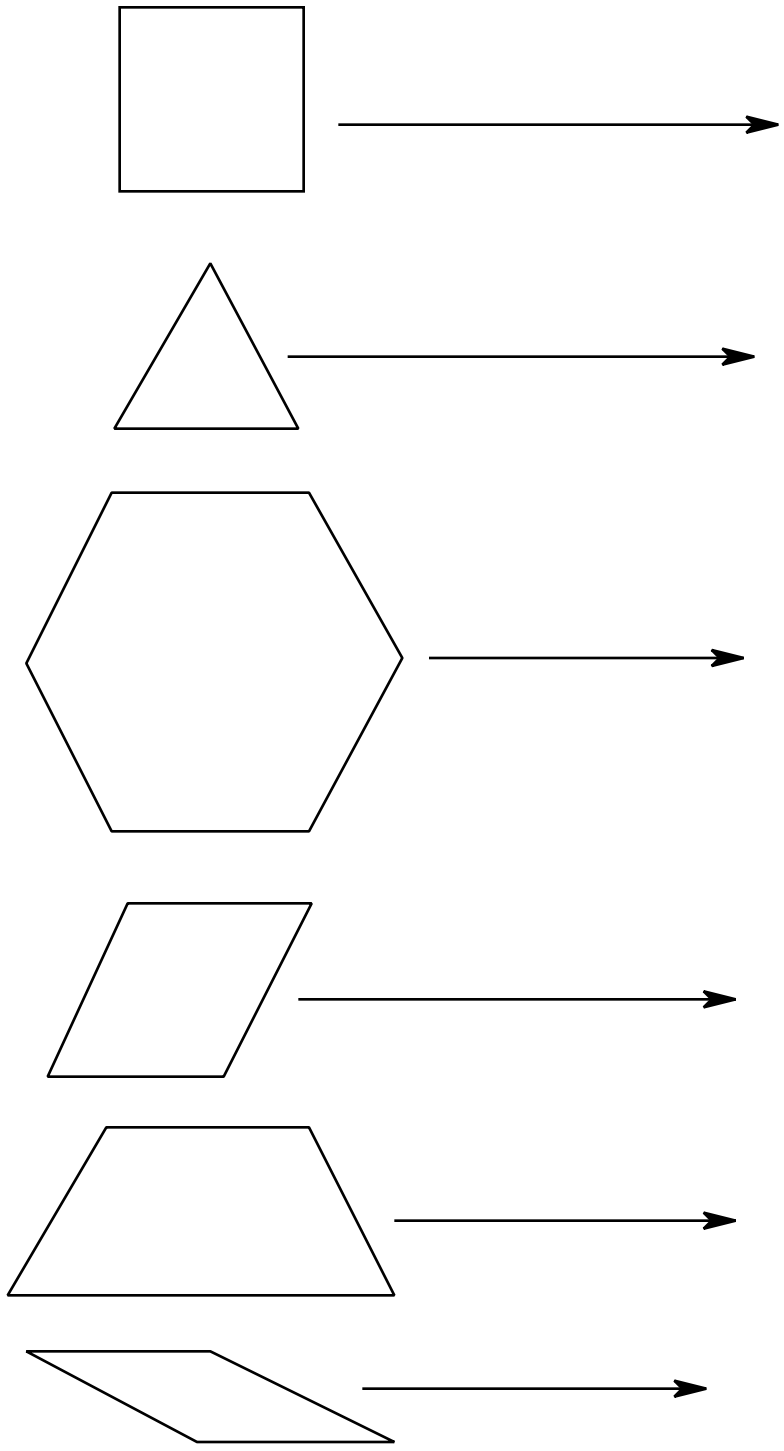
Slides

Directions: Cover each shape with pattern blocks. **Slide** each block horizontally to its new position. Record each shape after you slide it.



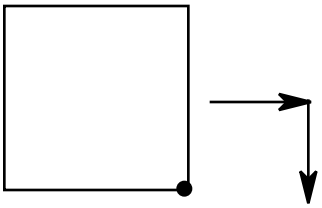
Flips

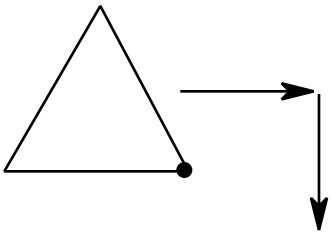
Directions: Cover each shape with pattern blocks. **Flip** each block to the right across the arrow to its new position. Record each shape after you flip it.

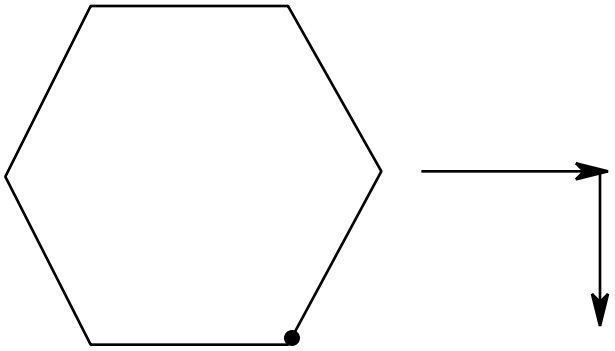


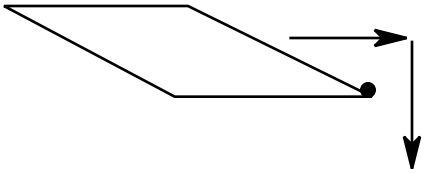
Turns

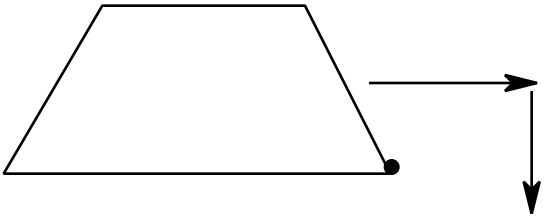
Directions: Cover each shape with pattern blocks. Turn each block 90 degrees around the point to its new position. Record each shape after you turn it.

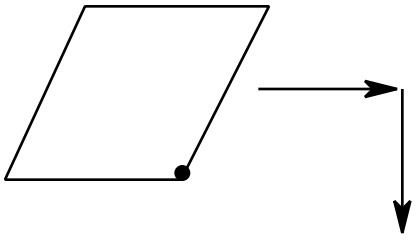












Vignette

The principal has decided to retile the math lab. The design should combine math and art. You have been asked to submit a design which is a tessellation. Each of you will be given a square which you will transform into your own shape, using a vertical or horizontal slide, or both. You may slide, turn, or flip your shape to form your tessellation design for the new floor. Your design should be on large tagboard or paper and you may include decorations or details and color on your tessellation design.

Write a persuasive letter to the principal explaining why your design should be selected for the math lab. Your letter should include a description of your design which describes what geometric shape you selected and how it was transformed to create a new shape which tessellates. Your letter should also describe how your tessellation combines math and art in order to create a beautiful design for the math lab.

Terms

Geometric Transformation - change or transform an original figure by using slides, flips, or turns.

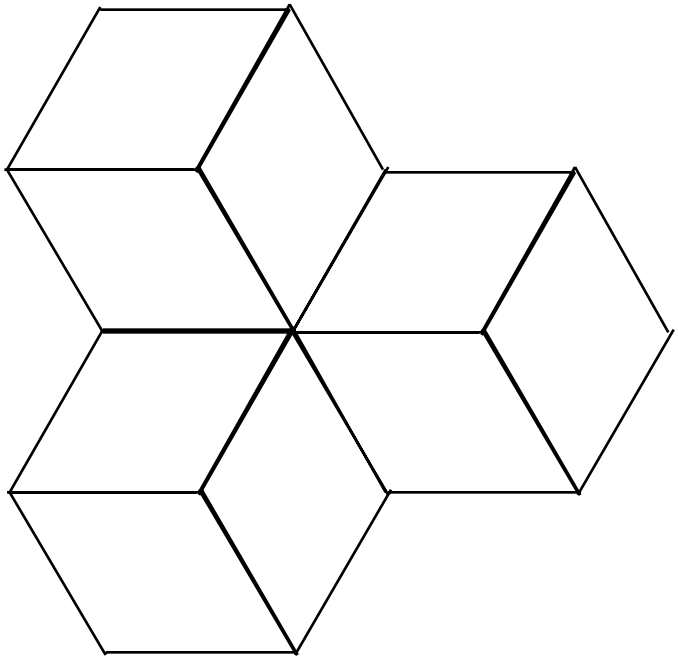
Slide (translation) - a horizontal or vertical movement into the same position across a plane.

Flip (reflection) - a movement of a figure over an imaginary line which results in a mirror image of the original figure. A flip can be across a row over a vertical line of symmetry or down a column over a horizontal line of symmetry.

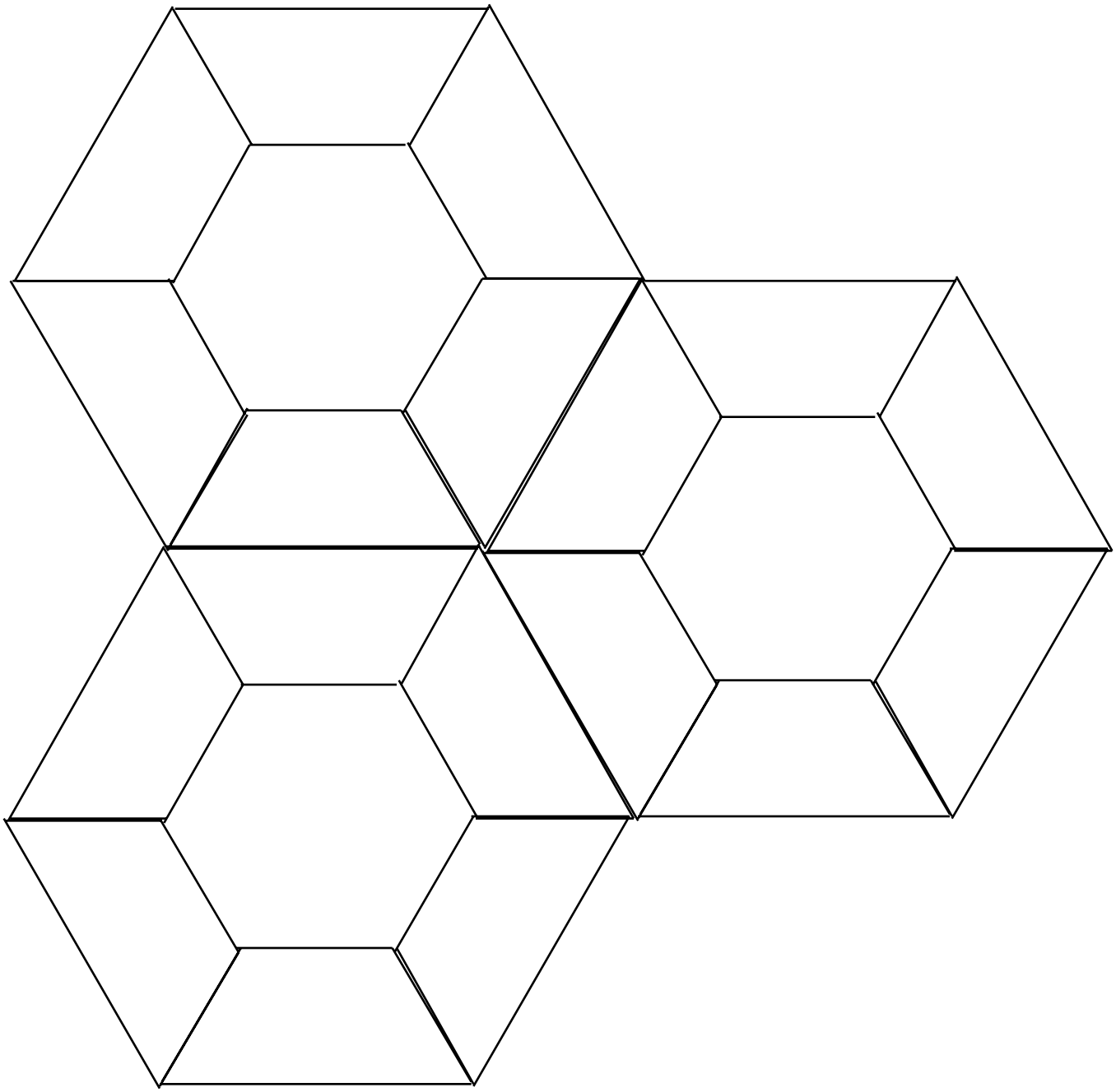
Turn (rotation) - a counterclockwise or clockwise movement of a figure across a plane.

Tessellation - the repeat of a design without any gaps or overlaps.

Tiling Using a Rhombus

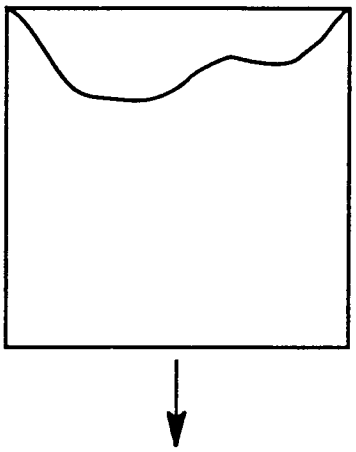


Unit Cluster Tessellation

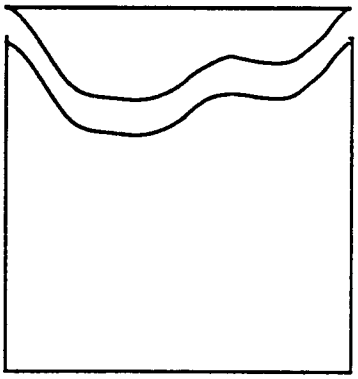


Vertical and Horizontal Slide (translation)

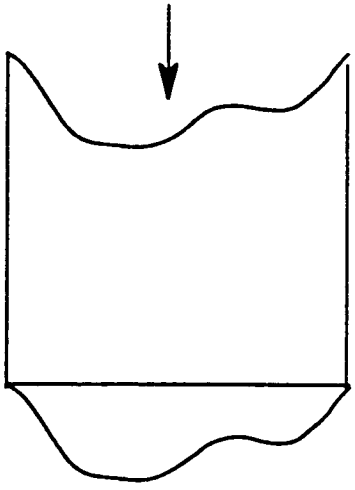
VERTICAL SLIDE



Draw a curved line from the upper left hand corner to the upper right hand corner of your polygon.

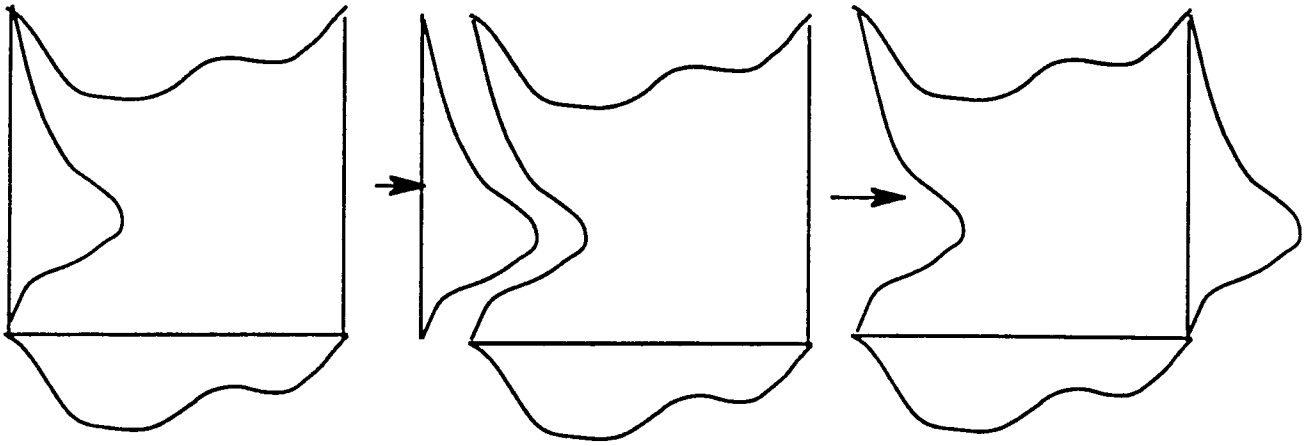


Take scissors and cut along the line drawn from corner to corner.



Slide the cut piece across the shape to the opposite side. Line the edges up and tape the two pieces together.

HORIZONTAL SLIDE

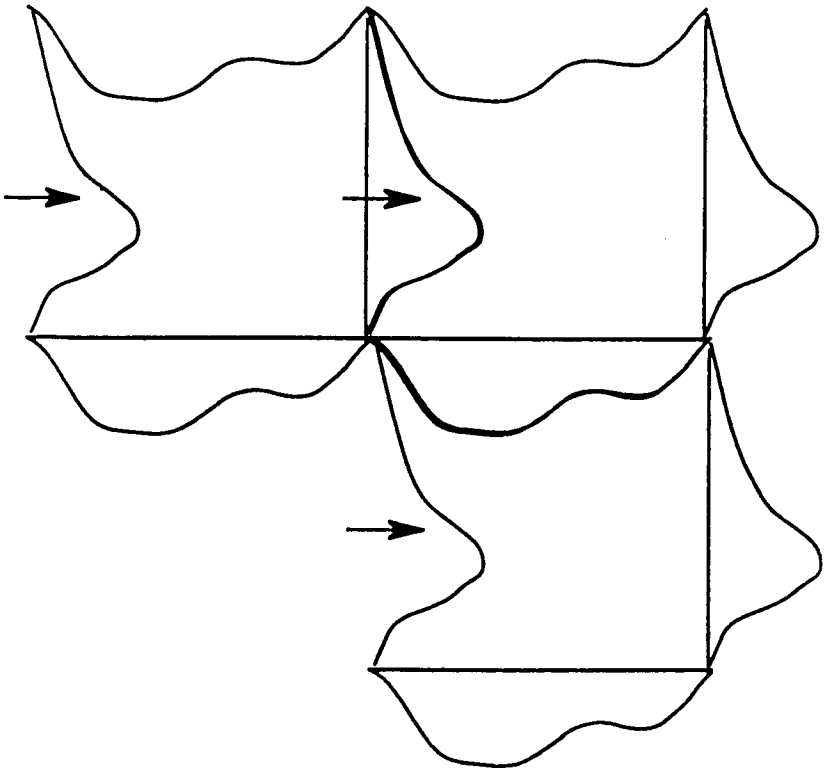


Perform a similar translation on the remaining sides of your transformed shape. Draw a line from the upper left corner to the lower left corner.

Cut along the line.

Slide the cut out piece horizontally to the opposite side. Line the edges up and tape the two pieces together.

Arrange your transformed shape into a tessellation.



RUBRIC

Questions to ask yourself while scoring a Response:

Persuasive Letter

- Does the student describe the geometric shape in the design and how the shape was transformed to create a new shape which tessellates?
- Does the student use mathematical terms when describing his/her picture?
- Does the student describe how his/her tessellation combines mathematics and art?
- Does the student list reasons why his/her design should be selected?

Tessellation

- Is the design composed of a transformed shape which tessellates?
- Does the design show slides and turns of a transformed shape?
- Is the design on large tagboard or construction paper?
- Does the design include decorations or details?

Scoring Rubric:

High Response:

A student would have included all the elements described above. The design is creative and made of a transformed shape which tessellates. The letter includes all the elements described above. The students should follow the proper form for a persuasive letter, including correct capitalization, punctuation, and grammar.

Medium Response:

A student would have included a minimum amount of the information listed above. The student may have some the required elements of transformations and tessellations, but not all of them. The student must have at least two of the four elements from each of the areas above.

Low Response:

The student would have one of the four requirement from each area. The student may have a beautiful picture, but not have met the expectations of a tessellation or the persuasive letter.