Ontario

A Guide to Effective Instruction in Mathematics

Grades 1 to 3

Geometry and Spatial Sense

Revised

2016

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Every effort has been made in this publication to identify mathematics resources and tools (e.g., manipulatives) in generic terms. In cases where a particular product is used by teachers in schools across Ontario, that product is identified by its trade name, in the interests of clarity. Reference to particular products in no way implies an endorsement of those products by the Ministry of Education.

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Introduction

This document is a practical guide that teachers will find useful in helping students to achieve the curriculum expectations outlined in the Geometry and Spatial Sense strand for Grades 1 to 3 in *The Ontario Curriculum, Grades 1–8: Mathematics, 2005*.

The expectations outlined in the curriculum documents describe the knowledge and skills that students are expected to acquire by the end of each grade. In *Early Math Strategy: The Report of the Expert Panel on Early Math in Ontario* (Expert Panel on Early Math, 2003), effective instruction is identified as critical to the successful learning of mathematical knowledge and skills, and the components of an effective program are described. As part of the process of implementing the panel's vision of effective mathematics instruction for Ontario, *A Guide to Effective Instruction in Mathematics, Grades 1 to 3* provides a framework for teaching mathematics. This framework includes specific strategies for developing an effective program and for creating a community of learners in which students' mathematical thinking is nurtured. The strategies focus on the "big ideas" inherent in the expectations; on problem solving as the main context for mathematical activity; and on communication, especially student talk, as the conduit for sharing and developing mathematical thinking. The guide also provides strategies for assessment, the use of manipulatives, and home connections.

Purpose and Features of This Document

This present document provides:

- an overview of each of the big ideas in the Geometry and Spatial Sense strand;
- three appendices (Appendices A–C), one for each of Grades 1 to 3, which provide learning activities that introduce, develop, or help to consolidate some aspect of each big idea;
- an appendix (Appendix D) that lists the curriculum expectations in the Geometry and Spatial Sense strand under the big idea(s) to which they correspond. This clustering of expectations around each of the five big ideas allows teachers to concentrate their programming on the big ideas of the strand while remaining confident that the full range of curriculum expectations is being addressed;
- a glossary that provides definitions of geometric terms used in this document.

"Big Ideas" in the Curriculum for Grades 1 to 3

In developing a mathematics program, it is essential to concentrate on important mathematical concepts, or "big ideas", and the knowledge and skills that go with those concepts. Programs that are organized around big ideas and focus on problem solving provide cohesive learning opportunities that allow students to explore concepts in depth.

> All learning, especially new learning, should be embedded in well-chosen contexts for learning – that is, contexts that are broad enough to allow students to investigate initial understandings, identify and develop relevant supporting skills, and gain experience with varied and interesting applications of the new knowledge. Such rich contexts for learning open the door for students to see the "big ideas", or key principles, of mathematics, such as pattern or relationship. This understanding of key principles will enable and encourage students to use mathematical reasoning throughout their lives. (Ontario Ministry of Education, 2005, p. 25)

Students are better able to see the connections in mathematics and thus to learn mathematics when it is organized in big, coherent "chunks". In organizing a mathematics program, teachers should concentrate on the big ideas in mathematics and view the expectations in the curriculum policy document for Grades 1 to 3 as being clustered around those big ideas.

The clustering of expectations around big ideas provides a focus for student learning and for teacher professional development in mathematics. Teachers will find that investigating and discussing effective teaching strategies for a big idea is much more valuable than trying to determine specific strategies and approaches to help students achieve individual expectations. In fact, using big ideas as a focus helps teachers see that the concepts represented in the curriculum expectations should not be taught as isolated bits of information but rather as a network of interrelated concepts. In building a program, teachers need a sound understanding of the key mathematical concepts for their students' grade level, as well as an understanding of how those concepts connect with students' prior and future learning (Ma, 1999). Such understanding includes the "conceptual structure and basic attitudes of mathematics inherent in the elementary curriculum" (p. xxiv) and how best to teach the concepts to children. Concentrating on developing this understanding will enhance effective teaching.

Focusing on the big ideas provides teachers with a global view of the concepts represented in the strand. The big ideas also act as a lens for:

- making instructional decisions (e.g., choosing an emphasis for a lesson or set of lessons);
- identifying prior learning;
- looking at students' thinking and understanding in relation to the mathematical concepts addressed in the curriculum (e.g., making note of the ways in which a student sorts two-dimensional shapes by properties);
- collecting observations and making anecdotal records;
- providing feedback to students;
- determining next steps;
- communicating concepts and providing feedback on students' achievement to parents[1] (e.g., in report card comments).

Teachers are encouraged to focus their instruction on the big ideas of mathematics. By clustering expectations around a few big ideas, teachers can teach for depth of understanding. This document provides models for clustering the expectations around a few major concepts and includes activities that foster understanding of the big ideas in Geometry and Spatial Sense. Teachers can use these models in developing other lessons in Geometry and Spatial Sense, as well as lessons in other strands of mathematics.

1. In this document, "(parent(s)" refers to parent(s) and guardian(s).

The “Big Ideas” in Geometry and Spatial Sense

> Spatial sense is necessary for understanding and appreciating the many geometric aspects of our world. Insights and intuitions about the characteristics of two-dimensional shapes and three-dimensional figures, the interrelationships of shapes, and the effects of changes to shapes are important aspects of spatial sense.
>
> (Ontario Ministry of Education, 2005, p. 9)

Overview

The Geometry and Spatial Sense strand of the Ontario mathematics curriculum involves investigations about shapes, structures, and spatial relationships. Geometry and Spatial Sense is a relevant area of mathematics for young children, who are naturally curious about their physical world. Learning experiences in the primary grades should provide students with opportunities to explore geometric and spatial concepts, and to relate them to real-life situations.

By the time children enter school, they have already developed significant notions about shape and space – the result of everyday experiences in moving about in their environment and in interacting with the objects around them (Clements, Swaminathan, Hannibal, & Sarama, 1999). Classroom experiences can build on what students already understand about geometry and can help students:

- recognize and appreciate geometry in the world;
- develop reasoning and problem-solving skills related to geometric thinking;
- apply geometric ideas in other strands of mathematics (e.g., measuring lengths, perimeters, and areas of shapes; using concrete materials, such as square tiles, to represent numerical ideas; creating and extending geometric patterns);
- apply geometric ideas in other subjects (e.g., creating two- and three-dimensional works in the arts, developing map skills in social studies, building structures in science and technology).

This section focuses on the three big ideas that form the basis for the curriculum expectations in Geometry and Spatial Sense for Grades 1 to 3. An understanding of these big ideas assists teachers in providing instructional and assessment opportunities that promote student learning of important concepts in Geometry and Spatial Sense.

The big ideas in Geometry and Spatial Sense are the following:

- geometric properties of two-dimensional shapes and three-dimensional figures
- geometric relationships
- location and movement

Teachers should recognize that these big ideas are conceptually related and interdependent, and that many instructional experiences reflect more than one of the big ideas. For example, an activity in which students construct models of three-dimensional figures provides opportunities for students to learn about the geometric properties of three-dimensional figures and about the geometric relationships between three-dimensional figures and their two-dimensional faces.

The discussion of each big idea in this section includes:

- an **overview**, which provides a general discussion of the big idea in the primary grades, an explanation of some of the key concepts inherent in the big idea, and in some instances additional background information on the concepts for the teacher;
- **grade-specific descriptions** of (1) characteristics of learning evident in students who have been introduced to the concepts addressed in the big idea, and (2) instructional strategies that will support those learning characteristics.

General Principles of Instruction

The following principles of instruction are relevant in teaching Geometry and Spatial Sense in the primary grades:

- **Student talk is important.** Students need to talk about and talk through mathematical concepts, with one another and with the teacher.
- **Representations of concepts promote understanding and communication.** In Geometry and Spatial Sense, concepts can be represented in various ways (e.g., using manipulatives, familiar objects, illustrations, diagrams). As students investigate geometric ideas, it is important that they manipulate concrete materials and do not simply view pictures and diagrams of two-dimensional shapes and three-dimensional figures. As well, students should be encouraged to make their own representations of mathematical ideas using concrete materials, pictures, and diagrams.

- **Students learn through problem solving.** Problem-solving situations provide opportunities for students to reason about mathematical ideas and to apply concepts and skills in meaningful contexts.
- **Students need frequent experiences using a variety of learning strategies (e.g., playing games, using movement, sorting, classifying, constructing) and resources (e.g., using models of two-dimensional shapes and three-dimensional figures, geoboards, pattern blocks, or tangram pieces).** A variety of learning strategies should be used in instruction to address the learning styles of all children.
- **Teachers can help students acquire mathematical language by using correct mathematical vocabulary themselves.** Teachers should model appropriate mathematical terminology as they discuss geometric ideas with their students. They should encourage students to use mathematical vocabulary that will allow them to express themselves clearly and precisely.

Kindergarten Mathematics: Characteristics of Learning and Instructional Strategies

When making connections across Kindergarten to Grade 3 (e.g., during professional learning conversations; across the learning continuum), the following references can be referred to from *The Kindergarten Program* (2016):

- Pedagogy in a play- and inquiry-based learning environment (pp. 75–85);
- Overall expectations, conceptual understandings, and specific expectations related to the concepts (pp. 216–248);
- How Kindergarten children demonstrate their understanding through what they say, do, and represent;
- Educators' Intentional Interactions – noticing and naming, responding, extending, and challenging;
- Educator reflections in professional learning conversations.

Geometric Properties of Two-Dimensional Shapes and Three-Dimensional Figures

Overview

Preschool children learn to recognize two-dimensional shapes and three-dimensional figures by their appearance. When shown a rectangle and asked to identify it, children might say, "It's a rectangle, because it looks like a door." Early in the development of their geometric thinking, children have little understanding of geometric properties – the characteristics that define a shape or figure. They do not rationalize, for example, that the shape is a rectangle because it has four sides and four right angles.

Research (Clements et al., 1999) indicates that children ages 4 to 6 years begin to recognize and describe properties of shapes. Their explanations of shapes are incomplete, but they have developed some notions about them. For example, children might explain that a shape is a square because "it has four sides".

Students learn about geometric properties as they view, handle, and manipulate objects (Copley, 2000). At first, students describe objects using vocabulary related to observable attributes: colour, size (e.g., big, small, long, thin), texture (e.g., smooth, rough, bumpy), movement (e.g., slide, roll), material (e.g., wood, plastic). Instruction in the primary grades helps to focus students' attention on geometric features of two-dimensional shapes and three-dimensional figures so that students begin to think about the properties that make a rectangle a rectangle or a cylinder a cylinder. The emphasis in instruction, however, is on developing students' ability to analyse and describe the geometric properties of shapes and figures, not on their ability to learn the definitions.

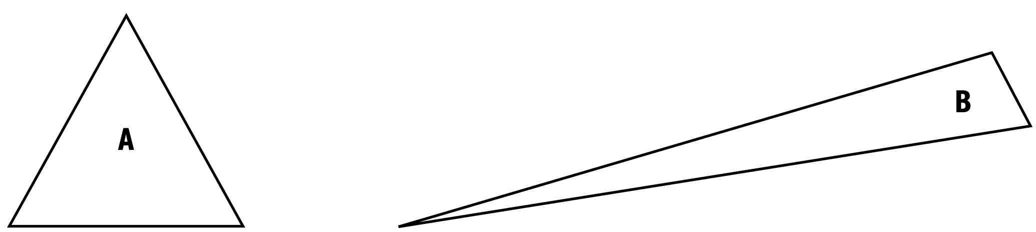
The following key points can be made about geometric properties of two-dimensional shapes and three-dimensional figures in the primary grades:

- Two-dimensional shapes and three-dimensional figures have properties that allow them to be identified, compared, sorted, and classified.
- Experience with two-dimensional shapes and three-dimensional figures, represented in a variety of forms, sizes, and orientations, allows students to understand those properties.

Identifying, comparing, sorting, and classifying shapes and figures according to their properties

An understanding of the geometric properties of two-dimensional shapes and three-dimensional figures allows students to identify, compare, sort, and classify shapes and figures, not only by their general appearance but also by their geometric characteristics. Students learn to focus on geometric properties by observing and experimenting with specific parts of shapes and figures.

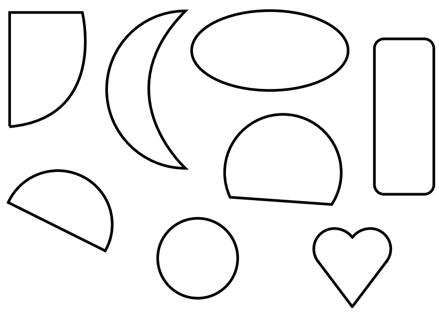
Identifying shapes and figures: Young students identify a shape, such as a triangle, by its appearance as a whole. For example, students might identify shape A (below) as a triangle because it resembles their mental image of what a triangle should look like. They might not think that shape B is a triangle, arguing that the shape looks "too long" or "too thin" to be a triangle. As children's understanding of geometric properties emerges, they begin to apply this knowledge to analysing and identifying shapes. With an understanding of the properties of a triangle, children will conclude that shape B is a triangle because it, like shape A, has three sides.



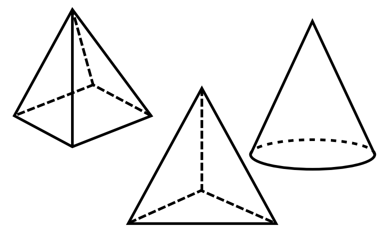
Before young students learn the names of three-dimensional figures, they often identify them, incorrectly, by the names of two-dimensional shapes. For example, it is not uncommon for a young student to call a sphere a "circle" or to name a cube a "square". It is important that teachers model the correct names of three-dimensional figures and that they encourage their students to use the proper terminology.

Comparing shapes and figures: Asking students to compare two-dimensional shapes or three-dimensional figures helps students focus on specific parts and builds students' knowledge of the distinguishing properties of shapes and figures. Teachers can show two shapes or figures and have students explain the ways in which the shapes or figures are alike and different. Asked to compare a triangular prism and a square-based pyramid, for example, students can observe that both figures have triangular faces. The figures usually differ, however, in the shapes of other faces and always differ in the number of edges and the number of vertices.

Sorting shapes and figures: Opportunities to sort two-dimensional shapes and three-dimensional figures by their geometric properties allow students to observe that different shapes or figures can be alike in some way. Initially, students' sorting criteria are informal, based on their own observation of shapes and figures.

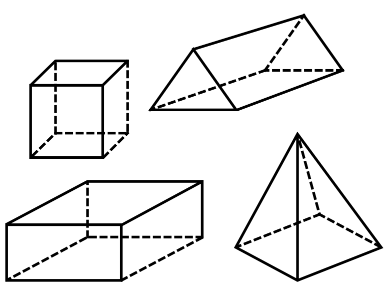


These shapes have curved sides.

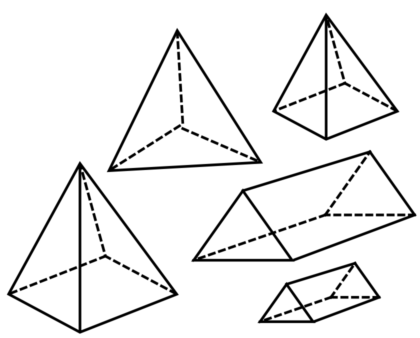


These figures are pointed.

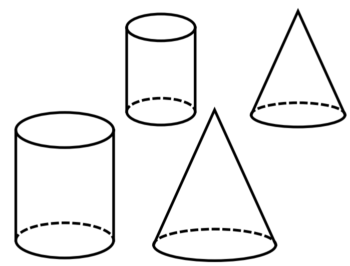
Teachers can also suggest sorting criteria that draw students' attention to geometric properties. Students might, for example, sort two-dimensional shapes according to the number of sides or the number of vertices. Three-dimensional figures might be sorted according to the shapes of their faces.



Figures With Rectangular Faces



Figures With Triangular Faces



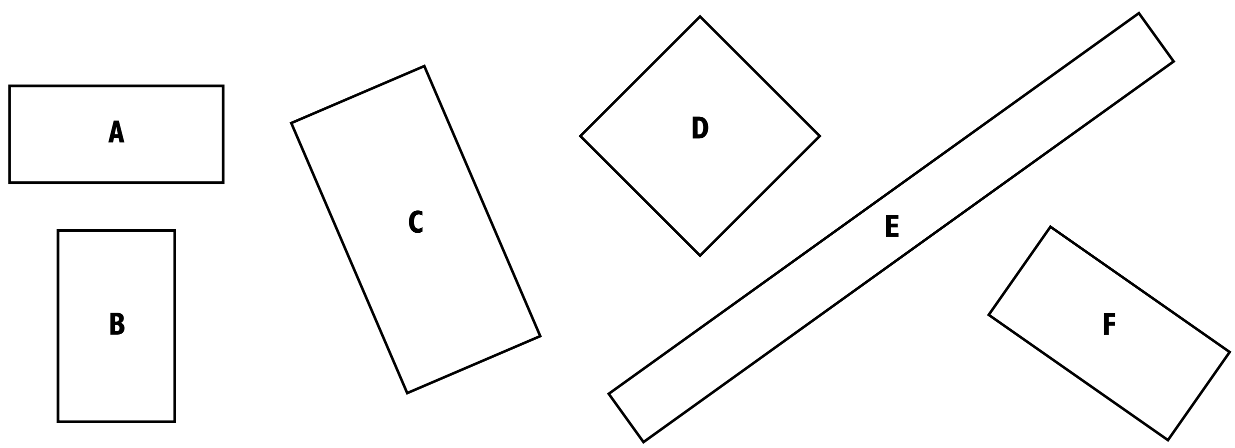
Figures With Circular Faces

Discussions between teachers and students during and after sorting activities are critical in helping students think about geometric properties. To encourage reflection about geometric properties, teachers might ask students such questions as:

- "What is your sorting rule?"
- "How are all the shapes/figures in this group the same?"
- "Why did you not include this shape/figure in this group?"
- "Is there another way to sort the shapes/figures into groups?"

In these conversations, teachers can model the mathematical language that students need to express ideas about properties clearly and precisely.

Classifying shapes and figures: When students classify two-dimensional shapes and three-dimensional figures, they need to think about the distinguishing properties of shapes or figures in a category. For example, students can deduce that since all of the following shapes have four sides and four square corners, they are all rectangles. This type of rationalization allows students to include non-traditional or "strange-looking" shapes or figures (e.g., shape E) in a category to which they might otherwise not appear to belong.

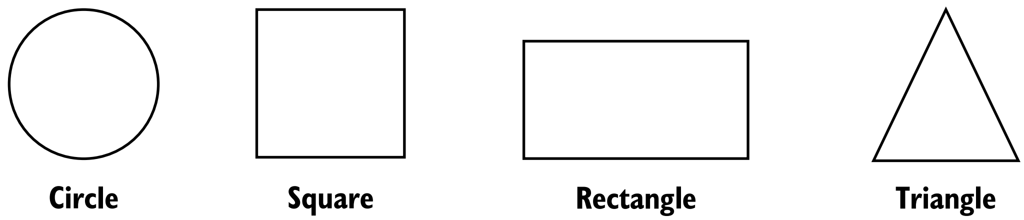


Discussions between students and teachers following classification activities can emphasize the properties that are common to *all* shapes or figures within a category and those that are shared by *some* of the shapes or figures. Here are examples of "all" and "some" statements:

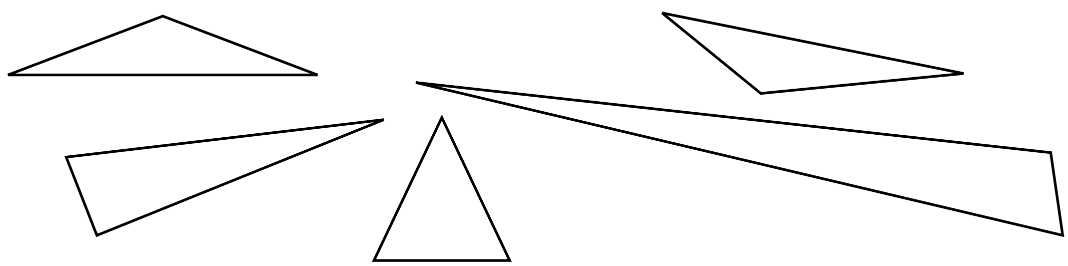
- "All" triangles have three sides; "some" triangles have two sides of equal length.
- "All" rhombuses have four equal sides; "some" rhombuses have square corners.
- "All" pyramids have a base; "some" pyramids have a square base.
- "All" prisms have rectangular faces; "some" prisms also have triangular faces.

Experiencing various representations of shapes and figures

The preschool experiences of most students provide opportunities for them to identify circles, squares, rectangles, and triangles. Young students develop some fixed notions of what these shapes look like, mainly because the examples that they are shown usually portray each type of shape in the same form and orientation, as illustrated below.

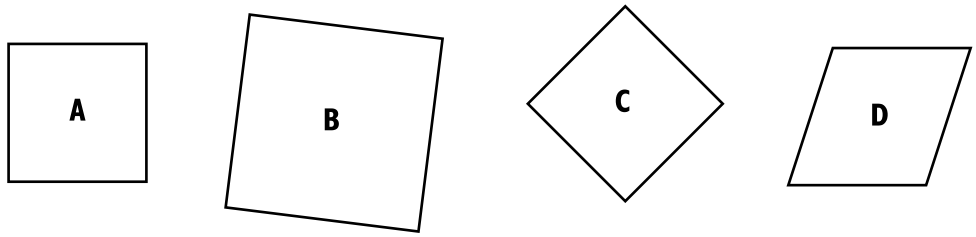


To deepen students' understanding of the properties of different types of shapes, teachers should ensure that students have opportunities to view, manipulate, and discuss many different examples of a type of shape (Clements, 1999; Hannibal, 1999). Observation of the following shapes might challenge students' thinking about what a triangle looks like. A discussion would help students conclude that all the shapes have three sides and, therefore, all are triangles.



Viewing and discussing a variety of shapes of different sizes and forms and in different orientations helps students to understand the properties of shapes. Using the preceding examples of triangles, students learn to recognize that even a shape with a non-traditional form is a triangle if it possesses the properties of a triangle (e.g., three sides). Discussion with students can help them to develop their understanding of the properties of different shapes. For example, students and teachers can examine other characteristics of triangles and conclude that triangles not only have three sides but also have three corners as well.

At first, students' understanding of the properties of some shapes may be incomplete. They may know, for example, that a square has four sides of equal length and may recognize that shapes A, B, and C, below, are squares. If students have yet to learn about right angles, they may have difficulty deciding whether shape D is also a square.



As in their work with two-dimensional shapes, students should have opportunities to explore a variety of three-dimensional figures. For example, an investigation of cylinders can include familiar forms, such as soup cans, as well as less obviously cylindrical objects, such as candles and glue sticks. By examining and discussing figures of different sizes and forms and in various orientations, students learn that figures can be identified by their geometric properties rather than by their general appearance alone.

Levels of Geometric Thinking

Pierre van Hiele and Dina van Hiele-Geldof researched the increasingly complex levels of understanding that can be attained as students continue to learn geometric concepts. These researchers proposed a model of five levels of geometric thinking (van Hiele, 1959/1985):

- **Level 0: Visualization.** Students recognize and identify two-dimensional shapes and three-dimensional figures by their appearance alone, often comparing them to a known prototype (e.g., a shape is a circle if it looks like the sun). Children at this level judge a shape holistically, without analyzing its properties. For example, a student might believe that all triangles must look like an equilateral triangle sitting flat on its base. If the horizontal base is on top with the vertex pointing down, the student may see this as an "upside-down" triangle. Level 0 is typical of students in the early primary grades.
- **Level 1: Analysis.** Students recognize the geometric properties of two-dimensional shapes and three-dimensional figures. They understand that all shapes or figures within a class share common properties (e.g., all rectangles have four sides, with opposite sides parallel and congruent); however, they do not yet see how these properties can overlap. For example, to them a square is a square; it cannot possibly be a rectangle too. Level 1 represents the geometric thinking of many students in the later primary and the junior grades.

- **Level 2: Informal deduction.** Students understand the relationships between properties and between figures and they use informal, logical reasoning to deduce geometric properties of two-dimensional shapes and three-dimensional figures (e.g., if one pair of opposite sides of a quadrilateral is parallel and congruent, then the other pair of opposite sides must be parallel and congruent). Level 2 represents the geometric thinking required in mathematics programs at the intermediate and secondary levels.
- **Level 3: Deduction.** Students use deductive reasoning to make conclusions about abstract geometric principles. Level 3 represents the geometric thinking, such as constructing proofs, required in senior and post-secondary mathematics courses.
- **Level 4: Rigour.** Students compare different geometric theories and hypotheses. Level 4 represents the geometric thinking required in advanced mathematics courses.

Although most levels in the model of geometric thinking do not pertain to students in Grades 1 to 3, it is important for teachers of primary grades to consider the following:

- Progression from one level to the next is less dependent on students' age or maturation than on learning experiences that promote reasoning about geometric ideas. Teachers of primary students need to provide the kinds of instructional activities that help students move beyond merely recognizing two-dimensional shapes and three-dimensional figures (Level 0) to understanding the properties of shapes and figures (Level 1).
- The levels are sequential, and success at one level depends on the development of geometric thinking at the preceding level. If students' level of thinking does not progress beyond Level 0 (visualization), it is likely that they will struggle with geometric concepts at higher levels.

What Geometric Properties Should Students Learn About?

Learning about geometric properties allows students to develop the concepts and language they need to analyse and describe two-dimensional shapes and three-dimensional figures with precision. As students' understanding of properties grows, their informal language (e.g., "This pyramid has triangles") gives way to descriptions that reflect a deeper understanding of shapes and figures (e.g., "The pyramid has a square base and four triangular faces").

The following explanations reflect ideas that students and teachers might discuss in conversations about the geometric properties of two-dimensional shapes and three-dimensional figures. It is inappropriate to expect students to memorize definitions that delineate the properties of different shapes and figures.

Geometric properties of two-dimensional shapes

The following properties are significant in identifying and describing two-dimensional shapes:

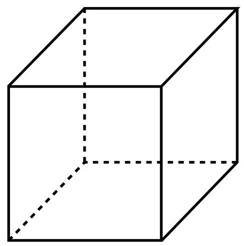
- **Number of sides:** One of the first properties students learn to consider is the number of sides a shape has. This information allows students to identify triangles, quadrilaterals, pentagons, hexagons, heptagons, and octagons.
- **Number of vertices:** Young students refer to the "corners" in some two-dimensional shapes. In Grades 2 and 3, students learn that the point at which two sides meet is called a vertex. With experiences in counting the vertices in a shape, students recognize that the number of vertices is the same as the number of sides.
- **Length of sides:** Students learn that the length of sides is an important property in many two-dimensional shapes. They recognize that the sides of squares and rhombuses are of equal length and that the lengths of opposite sides of rectangles and parallelograms are equal.
- **Size of angles:** Students in the primary grades are capable of understanding basic ideas about angles (Clements, 2004a). Teachers can demonstrate to students that angles are formed where two lines meet and can ask students to indicate the angles of various polygons. Without learning measurement procedures, students can compare the sizes of angles visually and can express the comparisons using "bigger", "smaller", or "equal".

  A property of rectangles is that they have four right angles. In the primary grades, students develop the concept of a right or 90° angle. Teachers and students may use informal expressions (e.g., square corners, square angles) to refer to right angles.
- **Parallel lines:** The notion of parallel lines can be introduced informally to primary students as "two lines that run side by side in the same direction and remain the same distance apart". Finding examples of parallel lines in the classroom (e.g., the top and bottom edges of a bulletin board, the opposite sides of a book cover) helps students recognize and describe parallel lines in parallelograms.

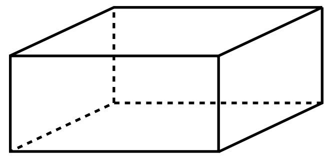
Geometric properties of three-dimensional figures

By Grade 3, students should be able to describe the following geometric properties of three-dimensional figures. Their description of these properties may be incomplete – a reflection of their emerging understanding of three-dimensional geometry.

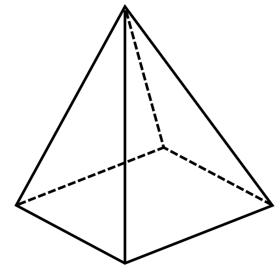
Number and shapes of faces: The properties of a polyhedron (a three-dimensional figure that has polygons for its faces) can best be described according to the number and shapes of its faces. For example, a cube has six square faces, a rectangular prism has six rectangular faces, and a square-based pyramid has one square face and four triangular faces.



Cube

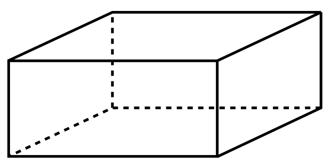


Rectangular Prism

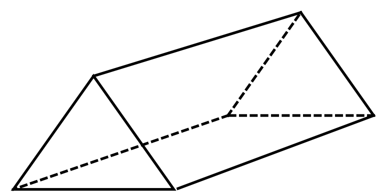


Square-Based Pyramid

In Grade 3, an examination and discussion of various prisms leads students to understand that the structures of all prisms resemble one another – that each prism is composed of two congruent, parallel faces with rectangles forming its other faces. A prism takes its name from the shape of the congruent and parallel faces.

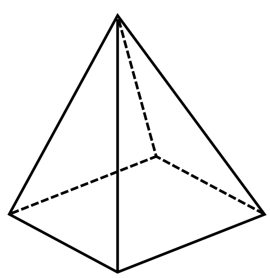


Rectangular Prism

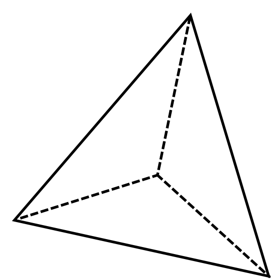


Triangular Prism

Students also learn that pyramids have a polygon for a base and that the other faces are triangles. The shape of the base determines the name of the pyramid.

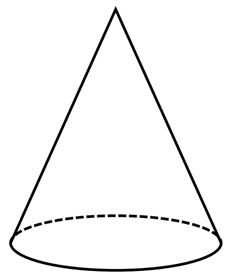


Square-Based Pyramid

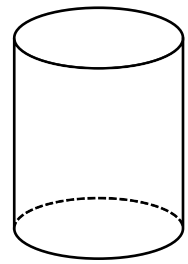


Triangle-Based Pyramid

Describing the properties of spheres, cones, and cylinders in terms of their faces is not as clear as for polyhedra (plural of polyhedron). Much discussion has occurred among mathematics teachers as they attempt to answer such questions as "How many faces does a cylinder have?" and "Does a cone have one or two faces?"



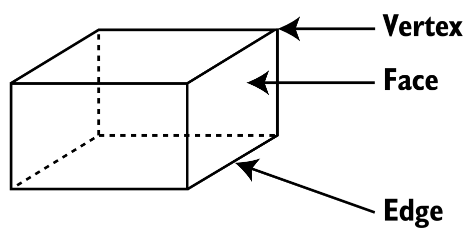
Cone



Cylinder

Some teachers may argue that a cylinder has two faces because only two surfaces are flat. Others may contend that a cylinder has three faces including the curved surface. The debates about the number of faces a cylinder and a cone have can continue at length without anyone arriving at a conclusion. What matters in students' development of geometric thinking is not the learning of exact definitions of three-dimensional figures but the development of skill in analysing and describing geometric figures in meaningful ways.

Number of edges or vertices: In addition to "face" and "surface", such words as "edge" and "vertex" allow students to describe three-dimensional figures and their properties. The purpose of teaching such terms to students is to provide them with the language to express ideas about geometry, not to provide definitions that students are expected to memorize.



Characteristics of Student Learning and Instructional Strategies by Grade

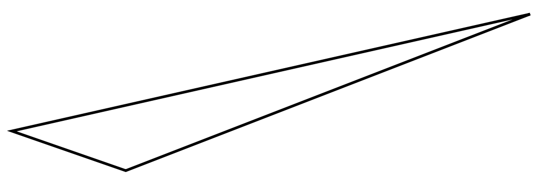
Grade 1

Characteristics of Student Learning

In general, students in Grade 1:

- identify concrete and pictorial examples of two-dimensional shapes (circles, triangles, quadrilaterals) of any form, size, or orientation. Some students may mistakenly identify shapes that resemble circles, squares, triangles, and rectangles. For example, some students might think that the following shapes are rectangles:

- describe geometric properties of two-dimensional shapes. Although their descriptions may be incomplete and demonstrate an emerging understanding of geometric terminology, students explain some of the important features of shapes (e.g., "A square has four equal sides");
- recognize non-traditional triangles and rectangles and apply their basic knowledge of shapes to verify their thinking. For the following figure, a student might say, "It's a long and thin, weird-looking shape, but it's still a triangle because it has three sides";



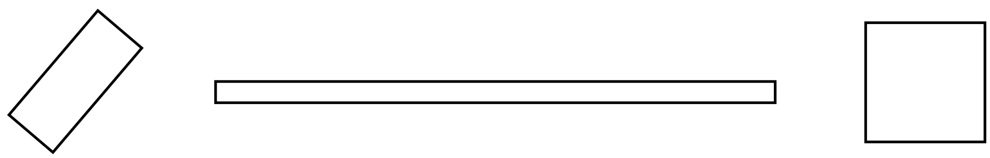
- visualize circles, squares, triangles, and rectangles, although their mental image will be of traditional shapes. Students can respond to "Think of a rectangle. What do you see?";
- identify concrete and pictorial examples of three-dimensional shapes (e.g., cube, cone, sphere, rectangular prism), and describe their attributes (a sphere is round all over and it rolls, a prism has flat sides and it stacks).

Instructional Strategies

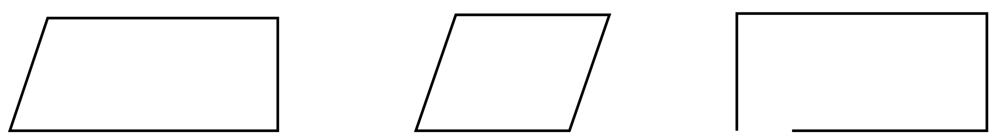
Students in Grade 1 benefit from the following instructional strategies:

- providing opportunities to manipulate, draw, construct, and represent (e.g., on a geoboard) two-dimensional shapes;
- discussing examples and non-examples of two-dimensional shapes. Discussions of such questions as the following encourage students to focus on the geometric properties of two-dimensional shapes and promote the development of appropriate geometry language:

  Why are these rectangles?

  Why are these not rectangles? What could be done to each shape to make it a rectangle?

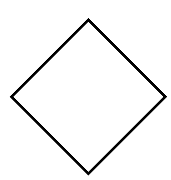
  Note: When discussing examples and non-examples of rectangles, include squares as examples of rectangles. If students say, "That's not a rectangle because it's a square," respond by stating that a square is a special kind of rectangle and explaining that a square is also a rectangle because a square has four sides and four square corners. Although it is premature to expect students to explain the relationship between rectangles and squares, avoid giving misinformation, such as, "That's a square, not a rectangle";
- discussing the characteristics of two-dimensional shapes so that students develop the concepts and language that allow them to explain why a shape belongs to a certain category (e.g., "All of these shapes are rectangles because they all have four sides and four square corners");
- using games that focus students' attention on the geometric properties of two-dimensional shapes and three-dimensional figures. For example, students might play "Guess My Shape/Figure" in which students listen to a description of a two-dimensional shape or a three-dimensional figure and try to identify it. For example, the teacher might say, "My figure has a square on it. It has a point on it. Guess my figure!";

- providing opportunities to measure, fold, and cut two-dimensional shapes to investigate and identify their properties (e.g., fold a square to observe that all sides are equal);
- providing experiences in constructing and manipulating shapes on a computer (e.g., using the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- providing opportunities to locate and describe examples of two-dimensional shapes and three-dimensional figures in the environment;
- providing many experiences in sorting and classifying two-dimensional shapes and three-dimensional figures according to a variety of observable attributes, and in discussing why a shape or figure belongs or does not belong to a certain category;
- having them describe the similarities and differences between two two-dimensional shapes or two three-dimensional figures;
- discussing the properties and attributes of three-dimensional figures. For example, students can explain that a cone has a circular face (property) and that it rolls on its curved surface (attribute);
- providing experiences in building structures using concrete materials (e.g., building blocks, construction sets) and in discussing the two-dimensional shapes and three-dimensional figures in the structure;
- providing experiences in constructing models of three-dimensional figures (e.g., making a cube using modelling clay);
- allowing them to hear teachers use and explain correct geometric terminology, even if students are not expected to use the vocabulary themselves. For example, the teacher might say, "Yoko called this shape a squished rectangle. This shape is a quadrilateral because it is a shape with four sides."

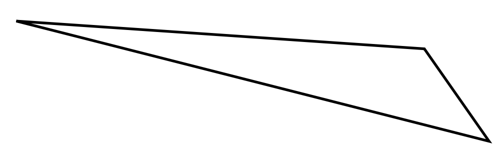
Grade 2

In general, students in Grade 2:

- identify concrete and pictorial examples of squares, rectangles, and triangles, regardless of form, size, or orientation (e.g., the following square and triangle);



The shape looks like a diamond, but it is a square because it has four equal sides and four square corners.



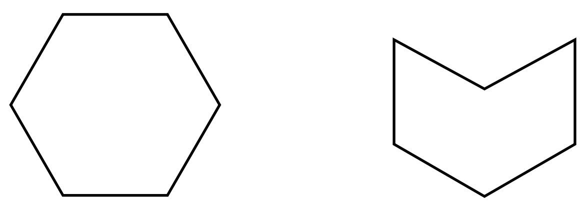
The shape is long and thin, but it is a triangle because it has three sides.

- describe geometric properties of two-dimensional shapes (e.g., a rectangle has four sides and four square corners) and three-dimensional figures (e.g., a cone has a curved surface and a circular face);
- identify two-dimensional shapes (triangle, quadrilateral, pentagon, hexagon, heptagon, octagon) by counting the number of sides or the number of vertices;
- identify and describe concrete and pictorial examples of three-dimensional figures (cube, cone, cylinder, sphere, prism, pyramid);
- identify and describe the faces and surfaces of three-dimensional figures.

Instructional Strategies

Students in Grade 2 benefit from the following instructional strategies:

- providing opportunities to manipulate, draw, construct, and represent (e.g., on a geoboard) two-dimensional shapes;
- providing experiences in constructing and manipulating shapes on a computer (e.g., using the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- having them identify triangles, quadrilaterals, pentagons, hexagons, heptagons, and octagons by counting the number of sides or the number of vertices. Examples should include regular and irregular polygons;



Regular Hexagon **Irregular Hexagon**

- discussing characteristics of two-dimensional shapes and three-dimensional figures so that students develop the concepts and language related to geometric properties;
- providing opportunities to locate and describe examples of two-dimensional shapes and three-dimensional figures in the environment;
- providing many experiences in sorting and classifying two-dimensional shapes (e.g., according to number of sides or vertices) and three-dimensional figures (e.g., according to the shapes of faces), and in discussing why a shape or figure belongs or does not belong to a certain category;
- having them describe the similarities and differences between two two-dimensional shapes or two three-dimensional figures;

- providing experiences in constructing models of three-dimensional figures using materials (e.g., modelling clay, cardboard cut-outs, and Polydron pieces), and in describing the two-dimensional faces of three-dimensional figures;
- providing experiences in constructing the skeletons of prisms and pyramids using such materials as drinking straws and toothpicks;
- using games that focus students' attention on the geometric properties of two-dimensional shapes and three-dimensional figures. Examples of games include:
  - Guess My Shape/Figure. In this game, students listen to a description of a two-dimensional shape or a three-dimensional figure and try to identify it. For example, a teacher might use this description: "My figure has two circular faces and a curved surface. What is my figure?"
  - Guess My Rule. After the teacher or a student has sorted a collection of two-dimensional shapes or three-dimensional figures, students observe the sorted shapes or figures and try to determine the sorting rule.

Grade 3

Characteristics of Student Learning

In general, students in Grade 3:

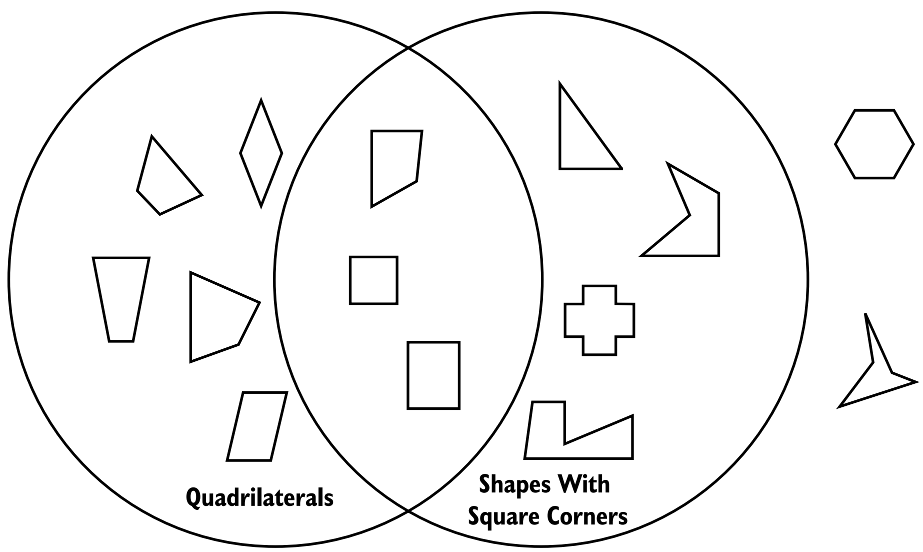
- recognize a variety of two-dimensional shapes (e.g., hexagons, rhombuses, parallelograms) of any form, size, or orientation. Students verify their identification of a shape by analysing properties (e.g., side lengths, parallelism, angle size); for example, the following shape has four sides, and opposite sides are parallel, so the shape is a parallelogram:

- describe geometric properties of two-dimensional shapes (e.g., a rhombus has four sides of equal length) and three-dimensional figures (e.g., a pentagonal prism has two faces that are pentagons and five rectangular faces);
- name prisms and pyramids by the shape of their base (e.g., triangular prism, square-based pyramid). As well, students identify and describe the shapes of the other faces of prisms and pyramids (e.g., the faces of a triangular prism are two triangles and three rectangles);
- identify angles in two-dimensional shapes (e.g., a triangle has three angles, a rectangle has four right angles).

Instructional Strategies

Students in Grade 3 benefit from the following instructional strategies:

- providing opportunities to manipulate, draw, construct, and represent (e.g., on a geoboard) two-dimensional shapes;
- providing experiences in constructing and manipulating shapes on a computer (e.g., using the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- discussing characteristics of two-dimensional shapes and three-dimensional figures so that students develop the concepts and language related to geometric properties;
- providing many experiences in sorting and classifying two-dimensional shapes and three-dimensional figures according to two or more properties. Venn diagrams allow students to sort shapes and figures and to find shared properties. The following Venn diagram shows a way to sort some shapes;



- having them describe the similarities and differences between two two-dimensional shapes or two three-dimensional figures;
- providing experiences in constructing and taking apart three-dimensional figures (e.g., using cardboard cut-outs, connecting plastic shapes), and in describing the faces and surfaces of the three-dimensional figures;
- providing experiences in constructing rectangular prisms from nets;
- providing opportunities to describe and compare angles in two-dimensional shapes (e.g., "This triangle has a right angle and has two angles that are smaller than a right angle").

Geometric Relationships

> The most important connection for early mathematics development is between the intuitive, informal mathematics that students have learned through their own experiences and the mathematics they are learning in school. All other connections – between one mathematical concept and another, between different mathematics topics, between mathematics and other fields of knowledge, and between mathematics and everyday life – are supported by the link between the students' informal experiences and more-formal mathematics. Students' abilities to experience mathematics as a meaningful endeavor that makes sense rests on these connections.
>
> (National Council of Teachers of Mathematics, 2000, p. 132)

Overview

In Geometry and Spatial Sense, as in all areas of the mathematics program, there are many relationships that teachers should highlight with their students during learning experiences. It is important that students grasp connections between geometric concepts and that they see how geometry is relevant in other subjects and in real-life situations. Some relationships are particularly important in students' development of geometric understanding, and teachers need to provide their students with many learning activities that focus on these geometric relationships throughout the primary grades.

The following are key points that can be made about geometric relationships in the primary years:

- Two-dimensional shapes and three-dimensional figures can be composed from or decomposed into other shapes and figures.
- Relationships exist between two-dimensional and three-dimensional geometry (e.g., the two-dimensional faces of three-dimensional figures).
- Relationships exist between categories of two-dimensional shapes (e.g., rectangles are also quadrilaterals, squares are also rectangles).
- Congruence is a special geometric relationship that is shared by shapes having the same shape and the same size.

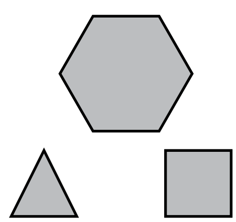
Composing and decomposing two-dimensional shapes and three-dimensional figures

On entering school, most students are able to locate examples of shapes in their environment. They also recognize that the shapes they identify rarely occur in isolation but that many shapes are components of larger shapes or objects. Asked to find rectangles in the classroom, for example, students might identify a window or the lid of a box. They might also observe that the window is composed of rectangular panes of glass and that the lid is part of a box with "rectangles on the sides and bottom".

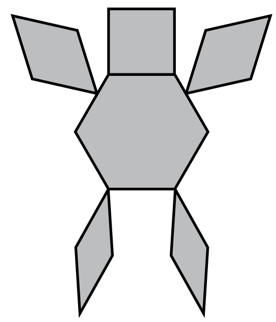
Classroom instruction needs to emphasize more than the identification of isolated examples of two-dimensional shapes and three-dimensional figures. Rather, instruction should help students understand the physical relationships between shapes and figures when they are combined (composed) or taken apart (decomposed). Experiences in building structures with geometric forms, in arranging shapes (e.g., pattern blocks, tangram pieces) to create pictures and designs, and in separating shapes and figures into parts allow students to understand how shapes and figures can be composed or decomposed to create other shapes and figures. These experiences allow students to think about how shapes and figures fit together for functional purposes (e.g., designing a machine) and aesthetic purposes (e.g., creating a design).

Picture-making by combining shapes is beneficial in promoting student reflection and discussion about two-dimensional geometry. Young children move through developmental stages (outlined below) in combining shapes to make composite shapes (Clements, 2004b). Although approximate ages are provided for each level, progression through these stages is largely the result of experience. Teachers play an important role in providing picture-making activities and in demonstrating to students how shapes can be combined in increasingly complex ways.

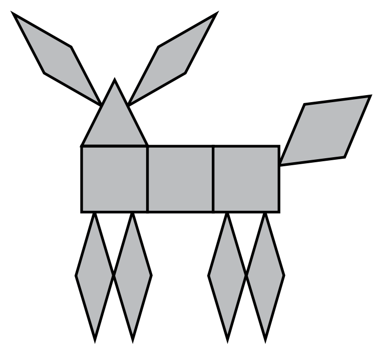
Precomposer (approximate age: 3 years). Children use individual shapes to represent objects or persons but are unable to combine them to compose a larger shape. For example, children might use three separate shapes to represent the sun, a slide, and a sandbox.



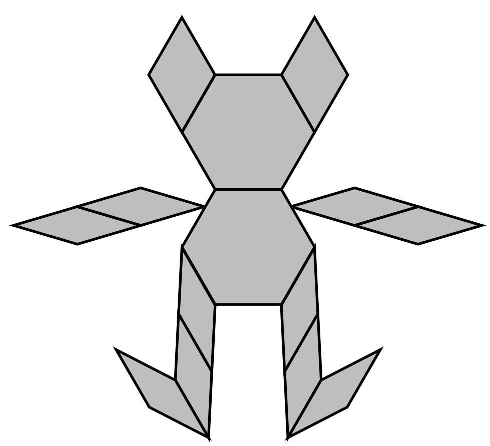
Piece assembler (approximate age: 4 years). Children combine shapes to make a picture in which each shape represents a part of an object or a person (e.g., a rhombus is used for a leg). Like the precomposer, the piece assembler perceives shapes only as wholes and sees few geometric relationships between shapes or parts of shapes.



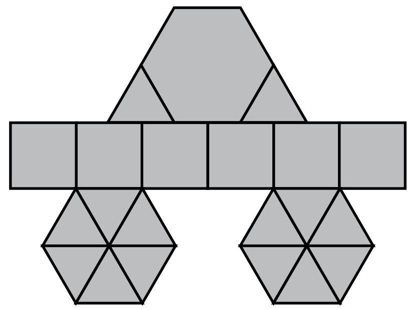
Picture maker (approximate age: 5 years). Children combine shapes to form pictures in which several pieces are used to represent parts of an object (e.g., three squares for a body). Children use trial and error to create new shapes.



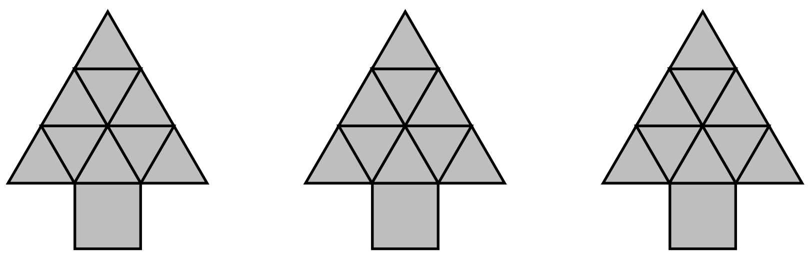
Shape composer (approximate age: 5 years). Children combine shapes intentionally, knowing how shapes will fit together.



Substitution composer (approximate age: 6 years). Children form composite units of shapes and are able to substitute some shapes for others (e.g., six green triangles for a yellow hexagon when using pattern blocks).



Shape composite repeater (approximate age: 7 years). Children construct a composite unit of shapes and intentionally repeat the unit.



Relationships between two-dimensional and three-dimensional geometry

Opportunities to manipulate, construct, and take apart three-dimensional objects allow students to see the relationships that exist between three-dimensional figures and their two-dimensional faces (e.g., a cube is composed of square faces). When students understand the two-dimensional shapes that are components of three-dimensional figures, they are able to interpret objects in their environment, assemble objects of their own, and represent objects in pictures and diagrams.

Sorting three-dimensional figures focuses students' attention on the two-dimensional faces of those figures. In early sorting experiences, using criteria of their own or criteria suggested by the teacher, students discover that figures can have parts described as "flat", "round", or "curved". This discovery leads to an understanding of the faces of three-dimensional figures.

Constructing models of three-dimensional figures, such as prisms and pyramids, is another valuable learning experience that helps students understand three-dimensional figures in terms of their two-dimensional parts. When students build a model using modelling clay, for example, they need to think about the form of the model – that is, the shapes of its different surfaces. In the later primary grades, when students use cut-out shapes or commercial building sets, they need to visualize the specific shapes that are needed to build the model and to think about the positions of the shapes in the overall structure of the model.

Relationships between categories of two-dimensional shapes

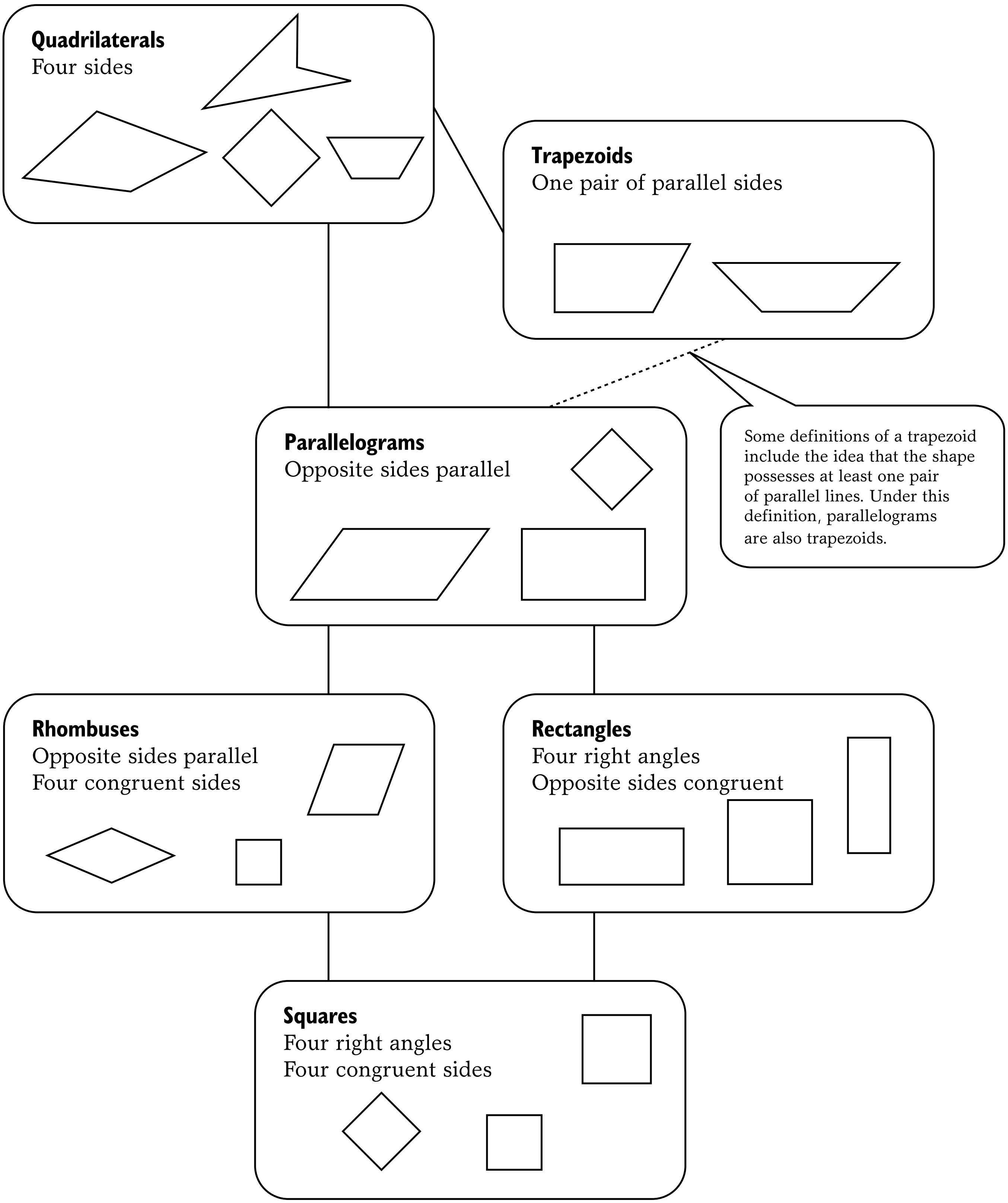
Another important geometric relationship refers to the connections that can be made between different categories of shapes. In the primary grades, students learn the properties that define a rectangle, a square, a quadrilateral, and other geometric shapes. As students' understanding of these properties develops, they learn that some categories of shapes are subsets of other categories. For example, they learn that:

- rectangles are also quadrilaterals because rectangles have four sides;
- squares are also rectangles because squares have four sides and four right angles;
- rectangles are also parallelograms because rectangles have opposite sides that are parallel.

Although it is premature to expect students in the primary grades to fully comprehend and explain the relationships between categories of shapes, teachers need to be careful that they do not classify shapes rigidly and do not communicate misinformation that students will need to "unlearn" later (Clements, 1999; Copley, 2000). For example, it is inappropriate for a teacher to state, "No, that is not a rectangle. That is a square." The grade-by-grade instructional strategies that follow provide advice on how to help students begin to learn relationships between categories of shapes.

The diagram on the next page illustrates the relationship between categories of quadrilaterals. Since opposite sides of parallelograms are parallel, rhombuses, rectangles, and squares are all, by definition, parallelograms. As well, the diagram shows that squares are both rhombuses (opposite sides parallel, four congruent sides) and rectangles (four square corners, opposite sides congruent). **This information is for teachers' reference and does not represent content to be learned by students in the primary grades.** (Refer to the Glossary for definitions of the different quadrilaterals in the diagram.)

Classification of Quadrilaterals



Congruence

Congruence is a special relationship between two-dimensional shapes that are the same size and the same shape. An understanding of congruence develops as students in the early primary grades explore shapes and discover ones that "look exactly the same". Students might superimpose congruent shapes to show how one fits on top of the other. By Grade 3, students should use the term "congruent" and be able to describe "congruence" by referring to matching sides and angles of shapes.

Students encounter concepts related to congruence in many areas of geometry. They observe, for example, that:

- the faces of a three-dimensional figure may be congruent (e.g., the faces of a cube are congruent squares);
- many geometric patterns, especially tiling patterns, are composed of congruent shapes;
- translations (slides), reflections (flips), or rotations (turns) result in a shape that is congruent to the original shape.

The concept of congruence can also be applied to three-dimensional geometry. Three-dimensional figures are congruent if they are identical in form and dimensions. To verify whether two figures are congruent, students can match the figures' faces to determine whether the parts of the figures are the same size and the same shape.

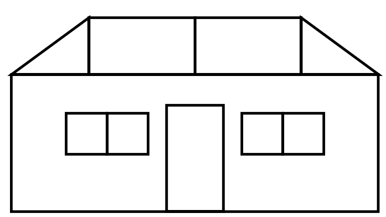
Characteristics of Student Learning and Instructional Strategies by Grade

Grade 1

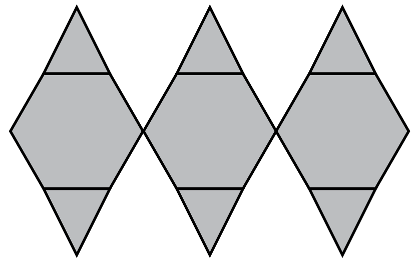
Characteristics of Student Learning

In general, students in Grade 1:

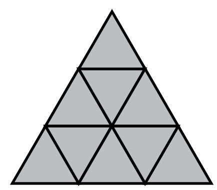
- compose pictures using two-dimensional shapes (e.g., paper cut-outs, stickers, pattern blocks). Most students put several shapes together to make one part of the picture (e.g., triangles and rectangles to make a roof);



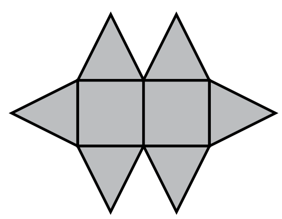
- compose designs and patterns using two-dimensional shapes (e.g., pattern blocks). Students consider side lengths and angles to determine how the shapes fit together (e.g., combining triangles and hexagons to make a pattern with rhombuses);



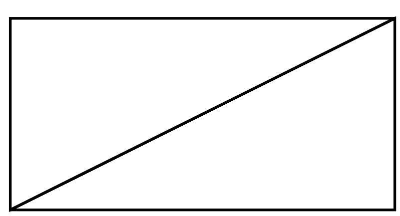
- compose a larger shape using smaller shapes (e.g., using smaller triangles to make a larger triangle);



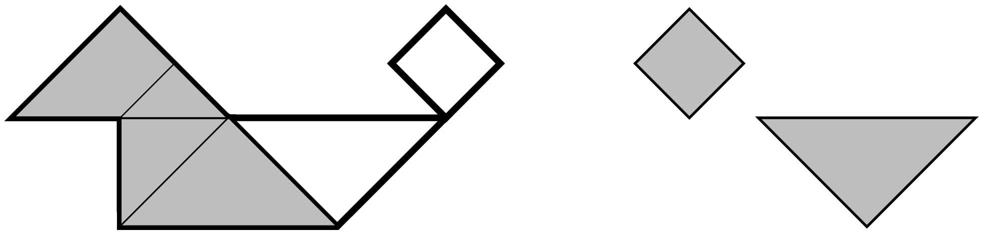
- describe relationships of shapes within a larger shape. For example, students might describe the following shape as composed of two squares with triangles "around the outside". Some students may observe that the two squares form a rectangle;



- decompose two-dimensional shapes into other two-dimensional shapes (e.g., cut a rectangle into two triangles);



- cover outline puzzles, in which only the contour of each puzzle is given, with two-dimensional shapes (e.g., pattern blocks, tangram pieces, attribute blocks). Students use trial and error or intuition (anticipating that a shape will fit a space) to complete the puzzles;

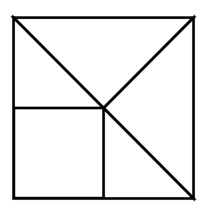


- build structures using three-dimensional figures and describe the two-dimensional shapes and three-dimensional figures in the structures.

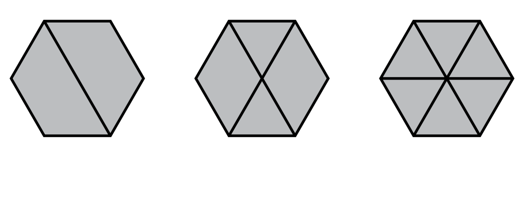
Instructional Strategies

Students in Grade 1 benefit from the following instructional strategies:

- providing opportunities to create pictures using two-dimensional shapes (e.g., paper cut-outs, stickers, pattern blocks);
- providing experiences in creating designs and patterns using two-dimensional shapes (e.g., pattern blocks), and in discussing how the shapes are put together;
- providing puzzles in which students cover an outline with shapes (e.g., pattern blocks, tangram pieces, attribute blocks) without leaving gaps;
- having them respond to "What do you see?" activities. Teachers show a simple design (e.g., the shape shown below) for a few seconds and then ask students to describe or draw what they saw;



- discussing how smaller shapes have been put together to make larger shapes and how larger shapes have been taken apart to make smaller shapes;
- providing experiences in composing larger shapes by putting together smaller shapes (e.g., using pattern blocks to make a hexagon in different ways);



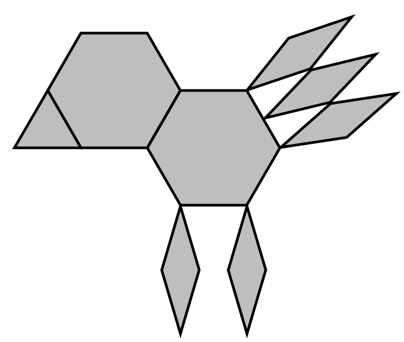
- providing opportunities to compose shapes on a computer (e.g., using the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- providing opportunities to build structures using materials (e.g., cardboard containers, building blocks, construction sets) and to discuss the two-dimensional shapes and three-dimensional figures in the structure.

Grade 2

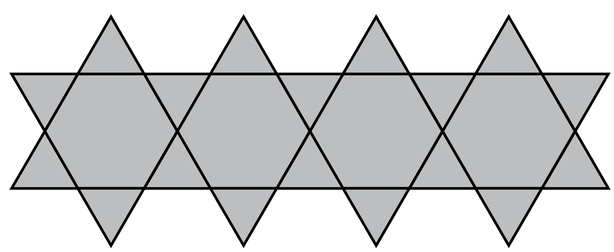
Characteristics of Student Learning

In general, students in Grade 2:

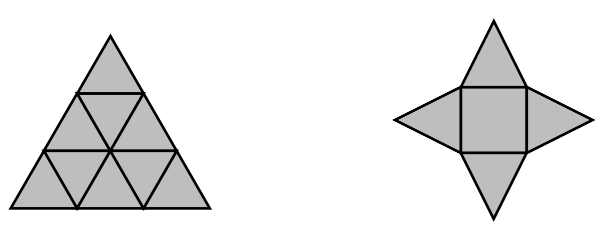
- begin to explain relationships between different categories of shapes (e.g., rectangles and quadrilaterals; squares and rectangles);
- compose geometric pictures and designs using two-dimensional shapes. Most students combine shapes intentionally, knowing how sides and angles of shapes fit together;



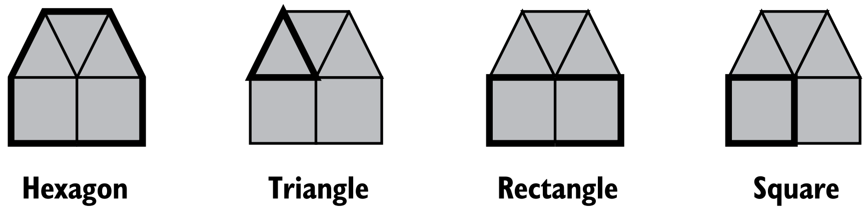
- compose patterns in which units (shapes made from other shapes) are repeated (e.g., repeated units made from hexagons and triangles);



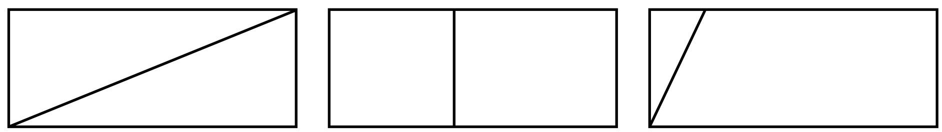
- compose a larger shape using smaller shapes (e.g., using smaller triangles to make a larger triangle; using a square and four triangles to make an octagon);



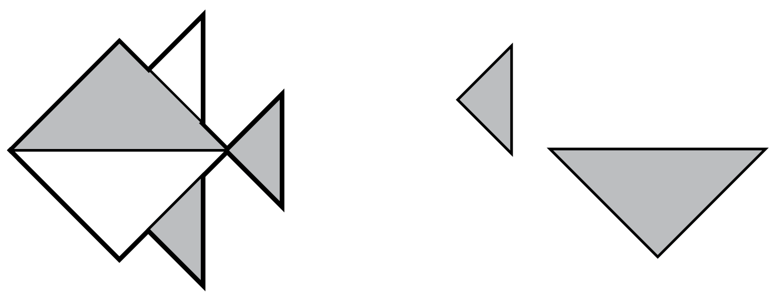
- decompose (take apart physically or visually) shapes flexibly. In the following example, a triangle, a rectangle, a square, and other shapes can be found in the same hexagonal shape;



- decompose two-dimensional shapes into other two-dimensional shapes (e.g., cut a rectangle to make two triangles; a square and a rectangle; or a triangle and a trapezoid);



- cover outline puzzles, in which only the contour of each puzzle is given, with two-dimensional shapes (e.g., pattern blocks, tangram pieces, attribute blocks). Students use trial and error or intuition (anticipating that a shape will fit a space) to complete the puzzles;

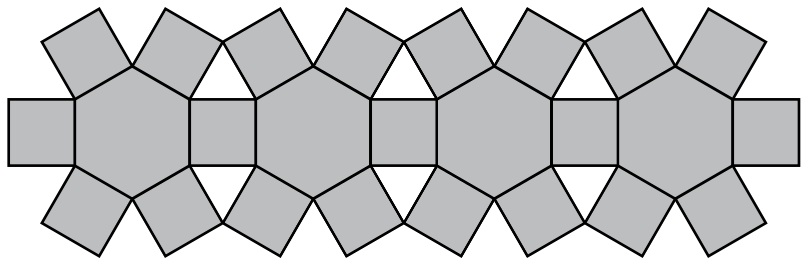


- build structures using three-dimensional figures, and describe the two-dimensional shapes and three-dimensional figures in the structures;
- construct models of three-dimensional figures, and describe their two-dimensional faces.

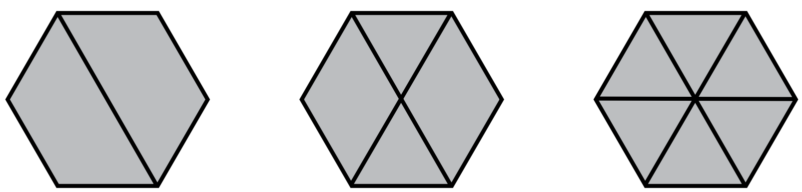
Instructional Strategies

Students in Grade 2 benefit from the following instructional strategies:

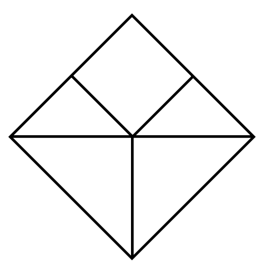
- discussing and demonstrating relationships among quadrilaterals, rectangles, and squares (e.g., a rectangle is a quadrilateral because a rectangle has four sides; a square is a rectangle because a square has four sides and four square corners);
- providing experiences in creating pictures and designs using two-dimensional shapes (e.g., pattern blocks, paper cut-outs, stickers);
- providing opportunities to create patterns using two-dimensional shapes (e.g., pattern blocks), including patterns in which units (shapes composed of other shapes) are repeated (e.g., repeated units made from hexagons and squares);



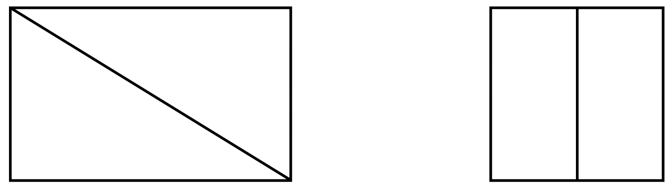
- providing experiences in composing larger shapes by putting together smaller shapes (e.g., using pattern blocks to make a hexagon in different ways);



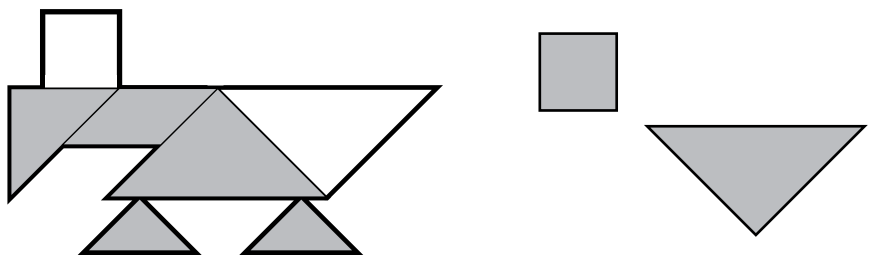
- having them respond to "What do you see?" activities. Teachers show a simple design (e.g., the shape shown below) for a few seconds and then ask students to describe or draw what they saw;



- providing opportunities to compose shapes on a computer (e.g., using the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- providing experiences in decomposing two-dimensional shapes into other shapes (e.g., decomposing a rectangle into two triangles; decomposing a square into two rectangles);



- providing puzzles in which students cover an outline with shapes (e.g., pattern blocks, tangram pieces, attribute blocks);



- providing opportunities to build structures using materials (e.g., cardboard containers, building blocks, construction sets) and to discuss two-dimensional shapes and three-dimensional figures in the structures;
- providing opportunities to construct models of three-dimensional figures using materials (e.g., modelling clay, cardboard cut-outs, drinking straws, pipe cleaners) and to describe the two-dimensional faces of the figures.

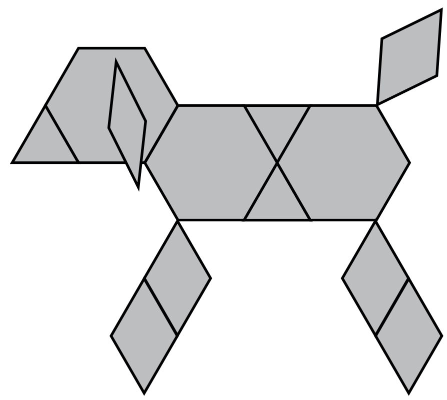
GRADE 3

Characteristics of Student Learning

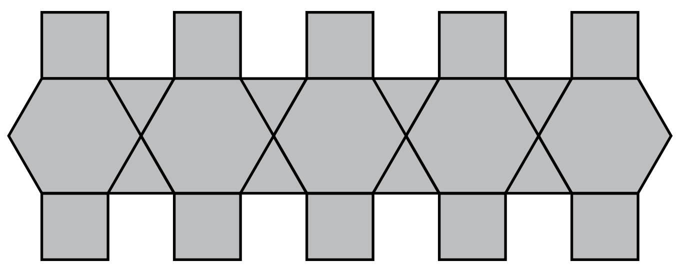
In general, students in Grade 3:

- explain relationships between different categories of shapes (e.g., rectangles and quadrilaterals; squares and rectangles);

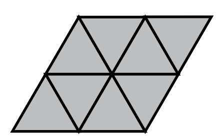
- compose pictures and designs using two-dimensional shapes. Most students combine shapes intentionally, knowing how sides and angles of shapes fit together;



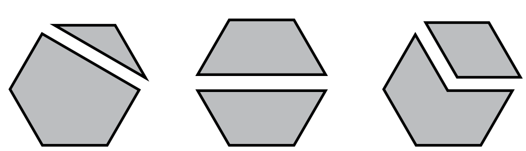
- compose patterns in which units (shapes made from other shapes) are repeated (e.g., repeated units made from hexagons, squares, and triangles);



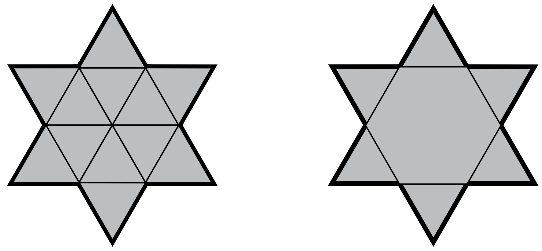
- compose shapes using other shapes (e.g., compose a rhombus using triangles);



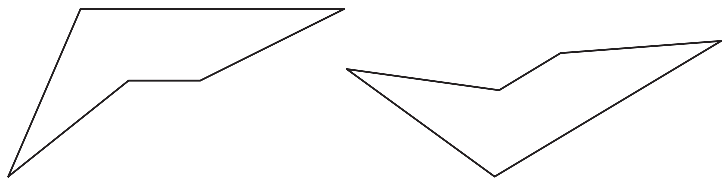
- decompose shapes flexibly to create other shapes (e.g., cut apart regular hexagons to make such shapes as a triangle and a pentagon; two trapezoids; and a rhombus and a hexagon);



- cover outline puzzles in different ways (e.g., complete the same outline puzzle using the greatest number of pattern blocks and the smallest number of pattern blocks);



- recognize congruent shapes, and verify congruence by superimposing shapes (e.g., the two pentagons shown);



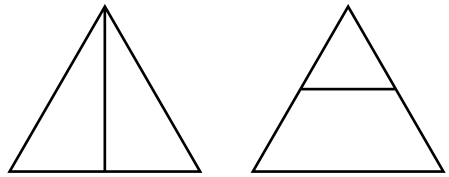
- compose and decompose three-dimensional figures, and identify the two-dimensional faces of the figures;
- describe the two-dimensional shapes and three-dimensional figures in a structure;
- describe the two-dimensional faces of three-dimensional figures.

Instructional Strategies

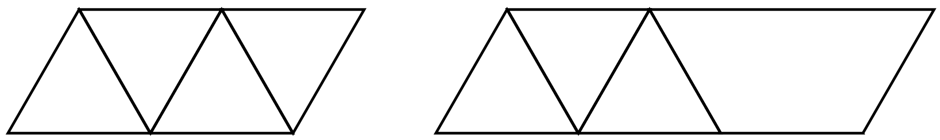
Students in Grade 3 benefit from the following instructional strategies:

- discussing and demonstrating relationships among quadrilaterals, rectangles, and squares (e.g., a rectangle is a quadrilateral because a rectangle has four sides; a square is a rectangle because a square has four sides and four square vertices/corners);
- providing opportunities to create designs and patterns using two-dimensional shapes (e.g., pattern blocks), including patterns in which units (shapes composed of other shapes) are repeated;

- providing experiences in decomposing two-dimensional shapes to make other shapes (e.g., decomposing a triangle into two triangles or into a triangle and a trapezoid);



- providing experiences in composing shapes by putting together other shapes (e.g., using pattern blocks to make parallelograms in different ways);



- providing opportunities to compose shapes on a computer (e.g., using the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- providing puzzles in which students cover an outline with different combinations of shapes;
- providing opportunities to build structures using materials (e.g., cardboard containers, building blocks, construction sets) and to discuss two-dimensional shapes and three-dimensional figures in the structures;
- providing experiences in composing and decomposing three-dimensional figures (e.g., using cardboard cut-outs, construction sets) and in describing the faces and surfaces of three-dimensional figures;
- providing opportunities to construct rectangular prisms from nets;
- identifying congruent two-dimensional shapes and showing congruence by matching sides and angles or superimposing shapes;
- identifying congruent three-dimensional figures and showing congruence by matching parts of the figures.

Location and Movement

Overview

Through everyday activities, preschool children learn to describe their positions relative to objects or other people. Such terms as "on"," below", "beside", "under", and "next to" allow them to express these spatial relationships. Children also develop language that expresses how a person or an object moves to another location (e.g., "towards", "away from", "back and forth", "backwards").

In the primary grades, teachers encourage students to continue to use spatial language to describe their own location and movement, as well as the locations and movements of other persons or objects. Teachers also show students how to represent locations and movements on rectangular grids. Students' understanding of movement is further developed as they learn about transformations: translations (slides), rotations (turns), and reflections (flips).

The following are key points that can be made about location and movement in the primary years:

- The location of an object can be described in terms of its spatial relationship to another object or in terms of its position on a grid.
- Transformational geometry involves translations (slides), reflections (flips), and rotations (turns).
- Symmetry can be used to analyse and create shapes in which one half is a reflection of the other.

Location

From an early age, children perceive the spatial relationships among themselves, other people, and objects, and develop language to describe these spatial relationships. Generally, students in Grade 1 observe the spatial relationships of objects in their environment well enough to create simple concrete maps of familiar places (Clements, 1999). For example, students might create a concrete map of their classroom by using blocks to represent furniture and placing the blocks in positions that match the arrangement of furniture in the classroom. The creation and observation of concrete maps help students to develop concepts about paper maps, including the notion that pictures and symbols on a map represent actual objects. In Grade 2, students describe the location of objects on a map using such expressions as "beside" and "to the right of".

Movement

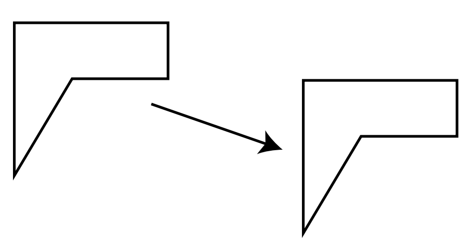
Transformational geometry in the primary grades involves three types of movement: translations (slides), rotations (turns), and reflections (flips). Young children learn to perform these movements through play activities (e.g., sliding a toy across the floor, flipping cards to see what is on the other side, turning an object to make it fit inside a box). Learning activities at school help students to understand the nature of these movements so that they can be used intentionally to solve problems.

In Grade 1, students describe the relative location of objects or people using positional language, such as "up/down", "to the right of/to the left of", "inside/outside", and this includes when they appear on concrete maps of the classroom. In Grade 2, students can draw maps of familiar settings and describe the relative location of objects on them. In Grade 3, students can describe movement from one location to another on a grid map.

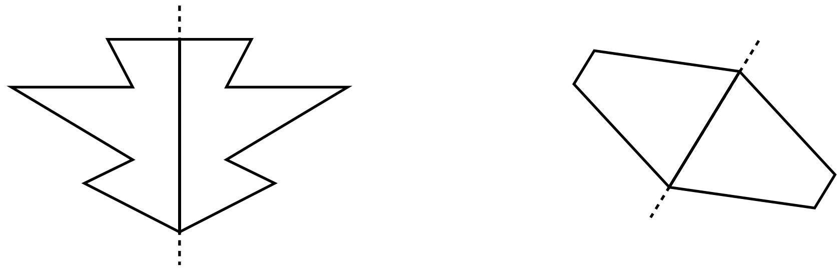
In Grades 1 and 2, students may use and hear such words as "slide", "flip", and "turn" to describe movements; however, the study of these movements is not formalized. In Grade 3, learning activities with manipulatives and computer programs focus on the nature of the three movements and how they can be performed.

Although teachers model, and encourage students to use, geometric terminology (translation, reflection, rotation) to describe movement, students may continue to use more informal expressions (slide, flip, turn). Students develop an understanding of the following concepts:

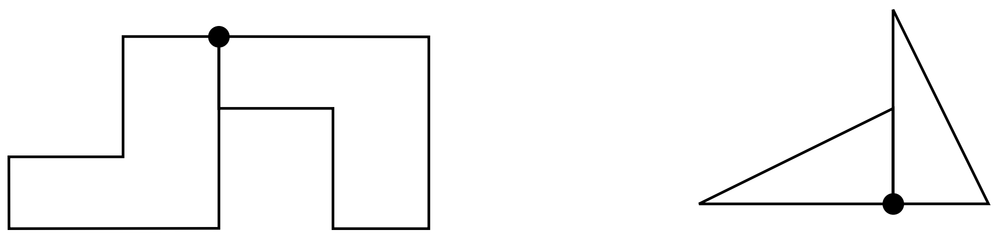
- A translation involves movement in a straight line across a surface; the orientation of the shape does not change – it always "faces the same direction".



- A reflection involves a flip over a line. A reflection results in a shape that is the mirror image of the original shape.



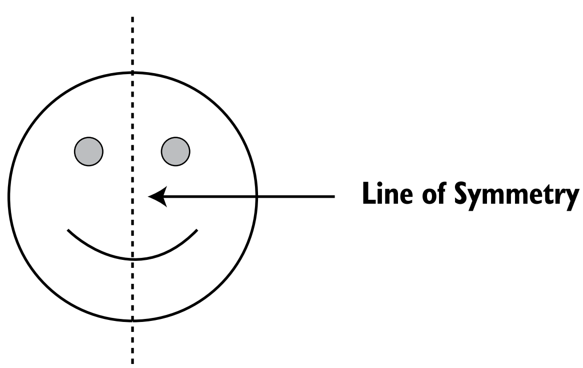
- A rotation involves turning a shape around a point.



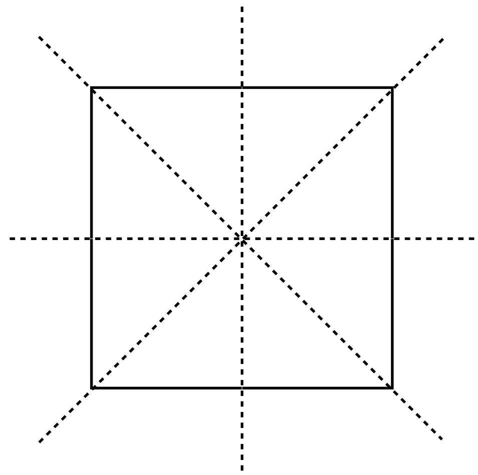
Effective instructional activities involve students in using transformations to solve spatial problems and in communicating the movements they performed. Students' descriptions of these movements become more precise as they learn to specify the directions of translations (up, down, to the left, to the right), the direction of rotations (clockwise, counterclockwise), and the degree of rotations (quarter turn, half turn, three-quarter turn, full turn).

Symmetry

A shape has line symmetry if it can be divided into two congruent parts, each part a reflection of the other. A line that separates one mirror image from the other is called a line of symmetry.



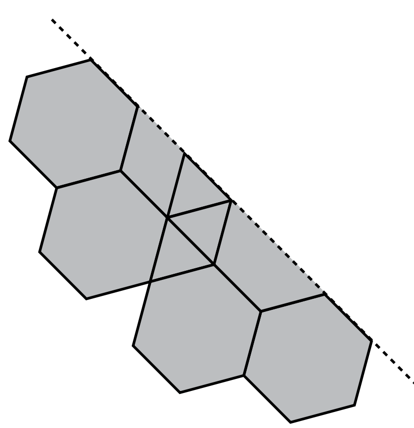
Some shapes have more than one line of symmetry. A square, for instance, has four lines of symmetry.



There are numerous examples of symmetry in the environment – in nature (e.g., leaves, butterflies, snowflakes), art, architecture, and the objects people use in their daily lives. The abundance of symmetry in the world makes it of natural interest to students. Instructional experiences should help students recognize, analyse, and describe symmetrical shapes, and develop an appreciation of the beauty and order that symmetry brings to our world.

In Grades 1 and 2, students explore symmetry by creating and describing symmetrical designs and pictures using concrete materials (e.g., pattern blocks, tangrams, paper and pencil) and a variety of tools (e.g., paper for folding and Miras).

This understanding of symmetry is extended in Grade 3, when students complete symmetrical designs and pictures given half of the image on one side of a vertical, horizontal, or diagonal line of symmetry. For example, students might be asked to complete a symmetrical design by placing pattern blocks on one side of the following line of symmetry.



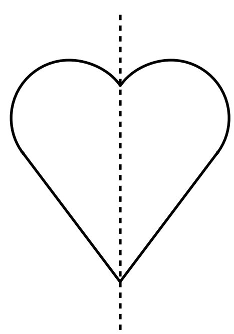
Characteristics of Student Learning and Instructional Strategies by Grade

Grade 1

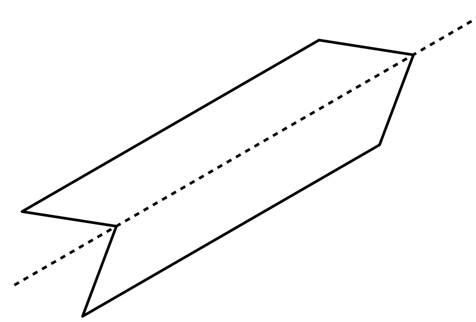
Characteristics of Student Learning

In general, students in Grade 1:

- describe spatial relationships using positional language (e.g., "We could put the paper scraps that are **in front** of the door **into** a garbage bag");
- describe how a person or an object moves from one position to another using such words and expressions as "towards", "backwards", "back and forth", "away from";
- follow directions to move or place an object in relation to another object (e.g., "Put your pencil **beside** your book");
- describe the path to go from one place to another (e.g., from the classroom to the gym);
- draw shapes by following a sequence of oral directions;
- learn "left" and "right";
- recognize symmetry in the environment, especially examples of vertical symmetry;



Vertical Symmetry



Non-vertical Symmetry

- create symmetrical shapes using concrete materials and drawings;
- create concrete maps of familiar settings (e.g., the classroom, student's bedroom) using small objects to represent larger objects (e.g., small cubes to represent desks).

Instructional Strategies

Students in Grade 1 benefit from the following instructional strategies:

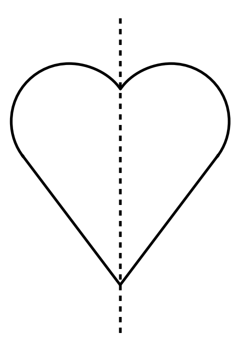
- providing instructions (e.g., classroom routines) involving positional language (e.g., "Empty cubes from the container **onto** your desk");
- asking them to describe the relative positions of objects and people (e.g., "The books are **on** the shelf that is **next** to the closet");
- asking them to explain how to get from one location to another;
- giving oral directions on how to print numerals and letters and draw simple shapes;
- using games involving position and movement (e.g., Simon Says);
- providing puzzles in which students manipulate pieces to fit them into frames;
- providing puzzles in which students cover simple outlines with shapes (e.g., pattern blocks, tangram pieces, attribute blocks);
- having them locate and discuss examples of symmetry in the environment;
- providing opportunities to create symmetrical designs and pictures;
- providing opportunities to create simple physical maps of familiar places (e.g., making a concrete map of the classroom by using small objects, such as cubes or tiles, to represent furniture).

Grade 2

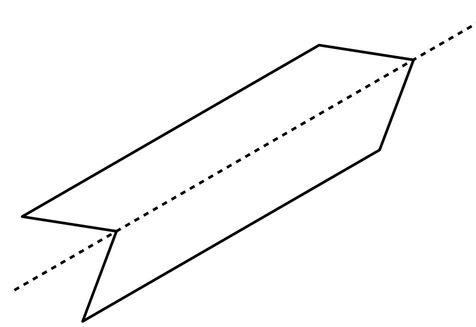
Characteristics of Student Learning

In general, students in Grade 2:

- create patterns using two-dimensional shapes (e.g., pattern blocks), and describe what they did using positional language (e.g., "I placed a green triangle **above** each orange square");
- draw and construct shapes from oral directions;
- recognize symmetry in the environment, including examples of non-vertical symmetry;



Vertical Symmetry



Non-vertical Symmetry

- create symmetrical shapes using concrete materials and drawings;
- determine lines of symmetry for two-dimensional shapes. Students readily recognize vertical lines of symmetry but may have difficulty recognizing non-vertical lines of symmetry;
- describe the specific locations of objects on a map (e.g., beside, to the right of);
- draw simple maps of familiar settings.

Instructional Strategies

Students in Grade 2 benefit from the following instructional strategies:

- giving directions on how to draw or construct simple shapes;
- using games involving position and movement (e.g., Simon Says);
- providing puzzles in which students cover simple outlines with shapes (e.g., pattern blocks, tangram pieces, attribute blocks);
- having them locate and discuss examples of symmetry in the environment, including shapes with non-vertical symmetry and shapes with more than one line of symmetry;
- providing opportunities to create symmetrical designs and pictures;
- having them find the line of symmetry of simple shapes by using paper folding and reflections in a transparent mirror (a Mira);
- using games that involve describing the location of objects on maps (e.g., finding a hidden treasure on a map by asking such questions as "Is the treasure in the top left corner?" and "Is the treasure beside the pond?");
- providing opportunities to draw simple maps of familiar settings (e.g., the classroom, the student's bedroom);
- providing opportunities to describe the locations of objects on a map (e.g., "The pet store is **to the right of** the park").

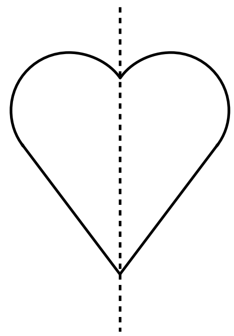
Grade 3

Characteristics of Student Learning

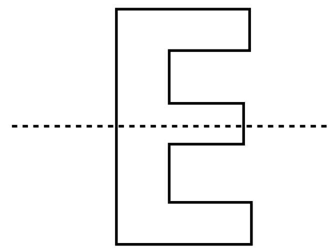
In general, students in Grade 3:

- perform translations, reflections, and rotations using concrete materials and computer programs. Students may be able to visualize the effect of a translation before performing it physically or virtually but may have more difficulty predicting the result of a reflection or rotation;
- create and analyse patterns using two-dimensional shapes (e.g., pattern blocks), and describe how translations, reflections, and rotations are used in the patterns;

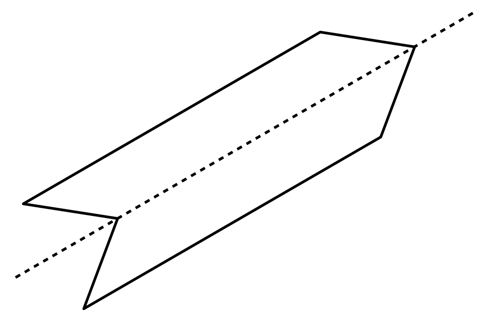
- draw and construct shapes from verbal directions;
- recognize symmetry in the environment, including examples of non-vertical (horizontal and diagonal) symmetry;



Vertical Symmetry



Horizontal Symmetry



Diagonal Symmetry

- create symmetrical shapes using concrete materials and drawings;
- determine lines of symmetry for two-dimensional shapes;
- solve two-dimensional geometric puzzles (e.g., with pattern blocks, tangram pieces);
- describe how to get from one location to another on a grid (e.g., two squares right followed by two squares up);
- draw simple maps, and describe the locations of objects on maps.

Instructional Strategies

Students in Grade 3 benefit from the following instructional strategies:

- giving directions on how to draw or construct simple shapes;
- providing opportunities to solve geometric puzzles (e.g., creating a square with tangram pieces) and to describe what they did using geometric language;
- having them locate and discuss examples of symmetry in the environment, including shapes with vertical, horizontal, and diagonal symmetry and shapes with more than one line of symmetry;
- providing opportunities to create symmetrical designs and pictures;
- having them find the lines of symmetry of simple shapes by using paper folding and reflections in a transparent mirror (a Mira);
- providing opportunities to perform translations, reflections, and rotations of simple figures using concrete materials and computer programs (e.g., the "Notepad" and "Pattern Blocks" learning tools at Mathies.ca);
- providing opportunities to perform and describe rotations using concrete materials (e.g., turn to the right/turn to the left)

- having them identify the movement (translation, reflection, rotation) that was performed on a shape to move it from one position to another;
- asking them to predict the outcome of translations, reflections, and rotations on two-dimensional shapes;
- providing problems using maps and grids, including how to get from one location to another on a grid (e.g., two squares right then two squares up) and describing the specific locations of objects;
- providing opportunities to draw simple maps of familiar settings (e.g., the classroom).

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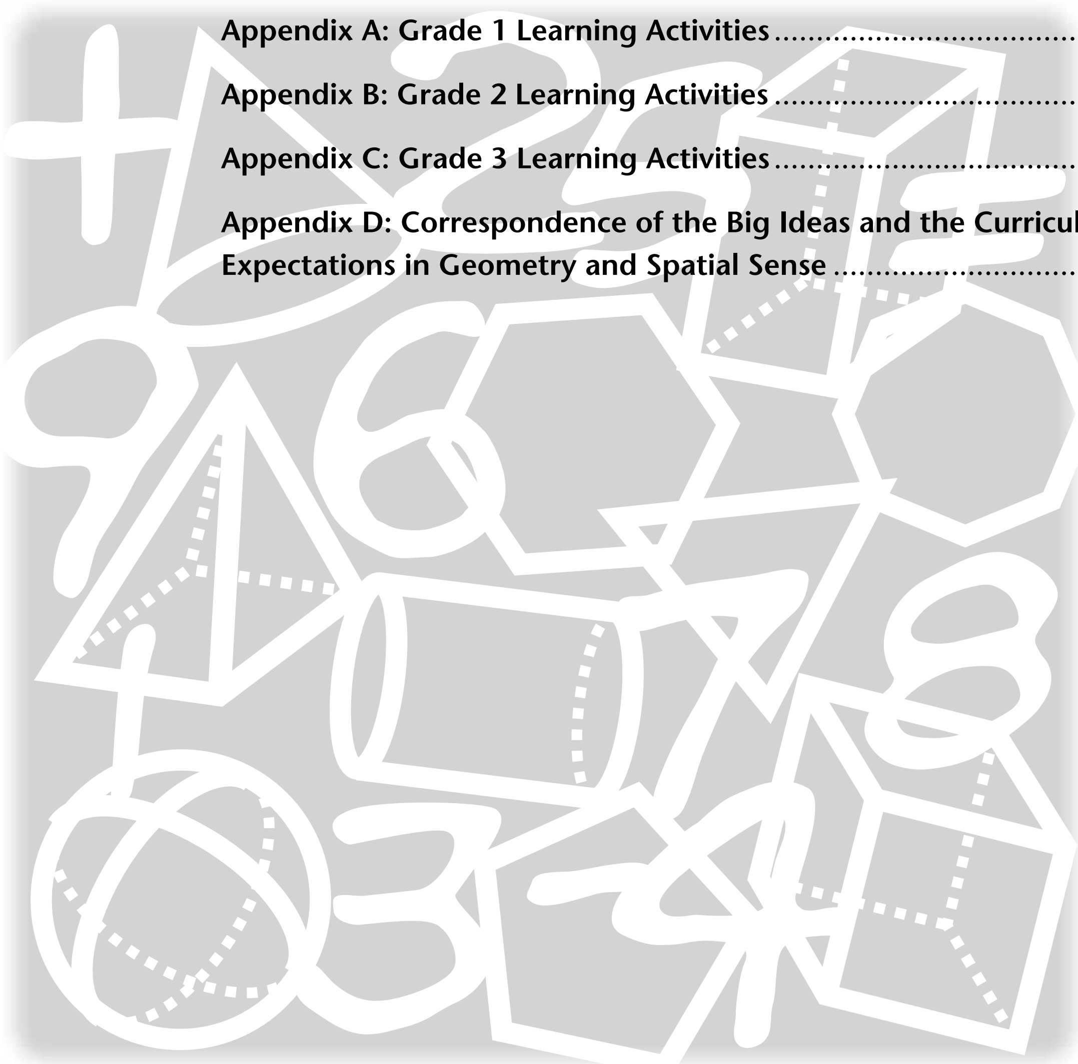
Learning Activities for Geometry and Spatial Sense

Contents



Introduction

The following three appendices (Appendices A to C) include learning activities that are practical applications of the big ideas in Geometry and Spatial Sense for Grades 1 through 3, respectively. For each grade, four activities are included to address the three big ideas. The first big idea has two activities: one dealing with two-dimensional shapes and one dealing with three-dimensional figures. Thus, the activities for each grade address geometric properties of two-dimensional shapes, geometric properties of three-dimensional figures, geometric relationships, and location and movement. The learning activities do not address all the key concepts for each big idea. The activities provide a starting point for classroom instruction related to the big ideas; however, students need multiple experiences throughout the school year to build an understanding of each big idea.

Each learning activity is organized as follows:

- **CURRICULUM EXPECTATIONS:** The curriculum expectations are indicated for each activity. Students will engage all the mathematical processes in doing the activities and tasks. In some tasks certain process expectations are highlighted because they are made visible in the student demonstrations of learning.
- **MATERIALS:** A materials list is included. Materials for optional parts of a learning activity are tagged as optional. The list applies only to the learning activity, not to the learning connections, which have their own materials lists.
- **ABOUT THE MATH:** Background mathematical information that connects the learning activity to the big idea is provided. In some instances, reference is made to some of the important prior learning that should precede the activity.
- **GETTING STARTED:** This section provides the context for the learning activity, activates prior knowledge, and introduces the problem or task.
- **WORKING ON IT:** In this part, students work on a mathematical task, often in small groups or with a partner. The teacher interacts with students by providing prompts and asking questions.

- **REFLECTING AND CONNECTING:** This section usually includes a whole-class debriefing time that allows students to share strategies related to the mathematical processes of reflecting and connecting and that provides an opportunity to emphasize mathematical concepts.
- **ADAPTATIONS/EXTENSIONS:** These are suggestions for ways to meet the needs of all learners in the classroom.
- **MATH LANGUAGE:** Vocabulary that is important to this activity and to communicating the concepts presented is included under this heading. The vocabulary is important to the mathematical process of communicating.
- **SAMPLE SUCCESS CRITERIA:** This section provides sample success criteria that can be used to monitor student learning (including learning connections) and develop descriptive feedback to guide student progress.
- **HOME CONNECTION:** This section is addressed to parents or guardians and includes a task connected to the mathematical focus of the learning activity for students to do at home.
- **LEARNING CONNECTIONS:** These are suggestions for follow-up activities that either consolidate the mathematical focus of the lesson or build on other key concepts for the big idea.
- **BLACKLINE MASTERS:** These pages are referred to and used throughout the activities.

A. Grade 1 Learning Activities

Appendix Contents

Explore-a-Shape

BIG IDEA ***Geometric Properties of Two-Dimensional Shapes***

CURRICULUM EXPECTATIONS

Students will:

- identify and describe common two-dimensional shapes (e.g., circles, triangles, rectangles, squares) and sort and classify them by their attributes* (e.g., colour; size; texture; number of sides), using concrete materials and pictorial representations (e.g., "I put all the triangles in one group. Some are long and skinny, and some are short and fat, but they all have three sides.").

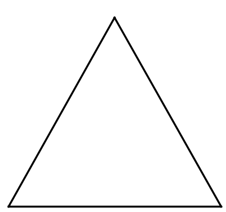
*For the purposes of student learning in Grade 1, "attributes" refers to the various characteristics of two-dimensional shapes and three-dimensional figures, including geometric properties

MATERIALS

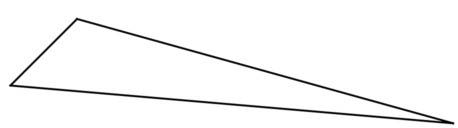
- Prop2D1.BLM1a-b: Shapes
- Paper or cloth bags containing shapes from Prop2D1.BLM1a-b: Shapes (1 bag per pair of students)
- one bag with 1 shape for each student
- Prop2D1.BLM2: Match Me Game Board (1 per student)
- counters (8 per student)
- Prop2D1.BLM3a-g: Assorted Shapes
- sorting circles, hoops, or masking tape circles on the floor (3 or 4 per group)
- Prop2D1.BLM4: Shapes at Home (1 per student)

ABOUT THE MATH

Young students learn to identify two-dimensional shapes by their general appearance. For example, students will recognize that Shape A illustrated below is a triangle because "It looks like a triangle". They do not think about the properties of the shape (e.g., three sides and three vertices) as they identify it. For this reason, young students will be less likely to identify Shape B as a triangle, because it does not match their image of what a triangle looks like.



Shape A



Shape B

Identification of shapes based on their properties, rather than on their general appearance, represents an important development in students' geometric thinking: the progression from Level 0 (visualization) to Level 1 (analysis), according to the van Hiele model of geometric thinking (see p. 14). This development is characterized by a growing ability to analyse and draw conclusions about the appearance of shapes (e.g., "This shape has three sides, so it must be a triangle").

The following tasks provide students with experiences in investigating different shapes. Because they touch the shapes without seeing them, students focus on the characteristics of the shapes (e.g., number of sides) and use these characteristics to identify the shapes.

GETTING STARTED

Before this task, put a variety of shapes from Prop2D1.BLM1a-b: Shapes into a paper or cloth bag.

Have students sit in a circle. Show students the bag and ask them to predict the contents of the bag. Ask students, "How might you figure out what the hidden contents in the bag are?" or "What senses could you use to help you figure out what the hidden objects in the bag are?" (connection to Science & Technology).

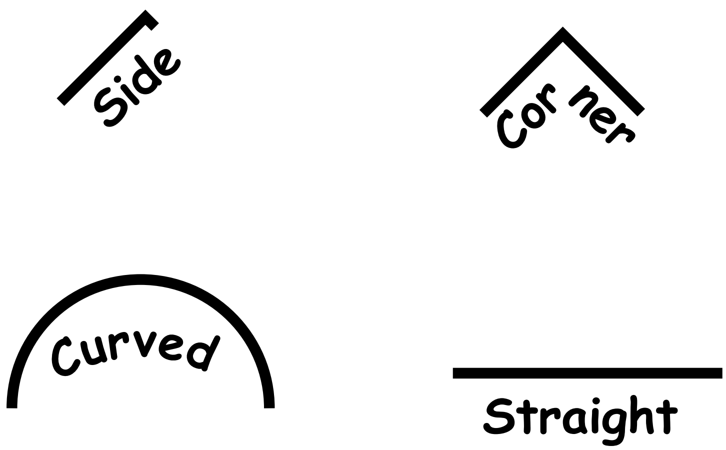
When a student suggests using the sense of touch, allow a few students to reach inside the bag one at a time and feel the hidden objects. After students determine that the bag contains shapes, ask a student to reach into the bag and select and manipulate one shape without looking at it. Ask the student to name the shape and to explain how he or she is able to identify the shape by touch alone (e.g., "I think the shape is a triangle because I feel three sides").

After several students have had opportunities to identify shapes in the bag using only their sense of touch, empty the contents of the bag. Ask students to describe the shapes by asking questions, such as:

- "What is the name of this shape? How do you know?"
- "How many sides does this shape have?"
- "How many corners does this shape have?"
- "Are any of the shapes alike? How are they alike?"
- "Choose two different shapes. How are they different?"

As students discuss the shapes, record relevant vocabulary (for posting on the word wall) and drawings about shapes on chart paper. Allow students to refer to the chart paper as needed during subsequent tasks.

Words About Shapes



WORKING ON IT

The following tasks will help students to develop an understanding of the characteristics of two-dimensional shapes.

Task 1: What's in the Bag?

Before this task, prepare a bag with a variety of shapes from Prop2D1.BLM1a-b: Shapes. Ensure that the bag contains one shape for every student.

Invite students to sit in a circle. Demonstrate how to reach into the bag, select a shape, remove it from the bag, and quickly place it behind your back without looking at it. Pass the bag around the circle, and have each student select a shape, hide it behind his or her back, and use only his or her fingers to explore what shape it is. Ask students to describe their mystery shape: "My shape has three sides", "My shape has pointy corners", "My shape feels like a triangle".

If students have difficulty verbalizing what they are touching, ask them questions, such as the following:

- "Do you feel a straight side?"
- "How many sides are there?"
- "Are all the sides the same length?"
- "How many corners does it have?"
- "Are there any curved sides?"

Conclude the task by having students turn to a partner and describe the shape each has behind his or her back. Have students guess what shape their partner is hiding.

Task 2: Match Me

Have students play Match Me with a partner. Provide each pair of students with a bag containing a variety of shapes from Prop2D1.BLM1a-b: Shapes. Give each student a copy of Prop2D1.BLM2: Match Me Game Board and eight counters.

Tell students to take turns reaching into the bag, touching a shape, describing it to their partner, and naming it. After students identify the shape, have them remove it from the bag and verify that they are correct. If students are correct, tell them to place a counter on a matching picture on their game board. Have students return the shape to the bag after each turn. Instruct students to return a shape to the bag if the shape they remove already has counters on both matching pictures. The game is finished when one player covers all the spaces on his or her game board.

Task 3: All Alike

Arrange students in groups of three or four. Provide each group with a collection of shapes from Prop2D1.BLM3a-g: Assorted Shapes. To begin the task, ask a group member to select any shape from the collection. Then ask another group member to select a second shape that is like the first in some way (*e.g.*, both shapes have the same number of sides, both shapes have a square corner) and state the sorting rule he or she used. Next, ask the group to find all the other shapes in the collection that are like the first and second shapes, according to the same rule. Have the group repeat the task by taking turns selecting different shapes and using different sorting rules.

Task 4: Shape Sort

Provide each group of three or four students with a collection of shapes from Prop2D1.BLM3a-g: Assorted Shapes. Instruct students to sort the shapes in various ways and to discuss their sorting rules. Allow students to use sorting circles, hoops, or masking tape circles on the floor to help them organize their sorts.

REFLECTING AND CONNECTING

After students have completed the task, pose questions that focus on the characteristics of two-dimensional shapes:

- “What is this shape? How do you know?”
- “How do you identify a shape? How do you know that this shape is a ____________?”
- “How would you describe a triangle (square, rectangle) to an alien?”
- “How are these shapes the same? How are they different?”
- “What is special about a triangle? a square? a rectangle?”

ADAPTATIONS/EXTENSIONS

Some students may have difficulty identifying the shapes hidden in the bag. Have these students manipulate and describe shapes while looking at them. Ask questions such as, "How many sides does the shape have", or "Does the shape have any corners?" to help the students to focus in on the attributes of the shape.

In the Match Me game (Task 2), challenge students by having them select a shape on the game board and try to find the corresponding shape in the bag without looking.

MATH LANGUAGE

- triangle
- circle
- rectangle
- square
- property
- side
- corner
- straight
- curved or round
- two-dimensional shape

SAMPLE SUCCESS CRITERIA

- describes two-dimensional shapes using attributes (e.g., number of sides) and appropriate vocabulary
- sorts and classifies two-dimensional shapes using attributes
- identifies two-dimensional shapes by their attributes (e.g., number of sides)

HOME CONNECTION

Send home Prop2D1.BLM4: Shapes at Home. This Home Connection task provides opportunities for students and their parents/guardians to find and discuss two-dimensional shapes at home.

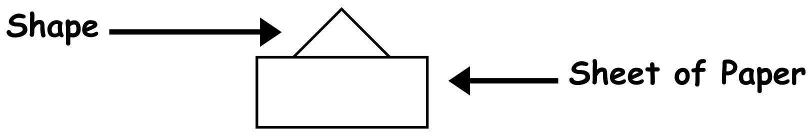
LEARNING CONNECTION 1

What Shape Could It Be?

Materials

- 4 shape manipulatives (triangle, square, rectangle, circle)
- overhead projector
- 1 sheet of paper
- Prop2D1.BLM5: What Shape Could It Be? (1 per student)

Place a shape manipulative on the overhead projector, and cover it with a sheet of paper. Turn on the overhead projector and slide the paper to expose a small part of the shape. Ask students to try to identify the shape by looking at only a part of it. Have them explain their thinking. For example, in the diagram below, the shape could be a triangle, square, or rectangle.



As you continue to expose more of the shape, have students make new conjectures about what the shape could be.

You could also have students draw on Prop2D1.BLM5: What Shape Could It Be? as the shape is partly, then fully, exposed. In the first two spaces, ask students to draw what they think the hidden shape looks like, based on the part of the shape they can see. After the shape has been fully exposed, have students draw the shape in the third space.

Repeat the task until the four shapes are revealed (triangle, square, rectangle, circle).

LEARNING CONNECTION 2

Stretch-a-Shape

Materials
- geoboards (1 per student)
- geobands (elastic bands) (1 per student)

Ask students to use geoboards and geobands to create shapes while listening to oral instructions:
- "Make the largest (triangle, square, rectangle) possible."
- "Make the smallest (triangle, square, rectangle) possible."
- "Make a shape with one (two, three, four) pin(s) inside it."
- "Make a shape that looks like a stop sign (kite, house)."
- "Make a shape that looks like a circle." (This one will be tricky! Talk to students about why this is so (circles don't have corners, and the pegs make corners).
- "Make the thinnest (triangle, rectangle) possible."
- "Make a shape with three (four, five, six) sides."
- "Make a shape with three (four, five, six) corners."
- "Make a shape with a square corner."
- "Make a shape that has two (three, four) equal sides."
- "Make a triangle that points up (down, sideways)."

After students have created a shape in response to an instruction, choose two geoboard examples, show them to the class, and ask students to compare the two shapes. For example, students might say, "Both shapes have three corners", "Both shapes have two pins inside", "Both shapes have sides with different lengths".

Have students display the shapes to classmates by holding their geoboards above their heads. Ask students to look at the various shapes and to describe ways in which the shapes are alike and different.

LEARNING CONNECTION 3

Secret Rule

Materials
- a variety of shapes from Prop2D1.BLM3a-g: Assorted Shapes
- 3 sorting circles, hoops, or masking tape circles on the floor

Ask students to watch as you sort shapes into two groups (e.g., shapes that have three sides and shapes that do not). Explain to students that you used a secret rule to sort the shapes and that they need to figure out the rule you used. Encourage students to explain the sorting rule. Test each sorting rule proposed by students by holding up one shape at a time and asking whether it matches the rule. For example, ask, "Does this shape have three sides? Is it placed in the correct group?"

Sort the shapes in different ways and ask students to determine the sorting rules. Include sorts that involve three groups (e.g., only straight sides, both straight and curved sides, only curved sides).

Have students work with a partner. Explain that one student will sort a variety of shapes from Prop2D1.BLM3a-g: Assorted Shapes according to a secret rule. The other student will try to determine the rule. Then have the partners switch roles.

LEARNING CONNECTION 4

Show Your Shape

Materials
- Prop2D1.BLM3a-g: Assorted Shapes (1 shape for each student)

Arrange students in a circle. Provide each student with a shape from Prop2D1.BLM3a-g: Assorted Shapes. Tell students to hold up their shape if it matches the statement you make. Provide statements, such as the following:
- "Show your shape if it has three sides."
- "Show your shape if it has a curved side."
- "Show your shape if it is a triangle."

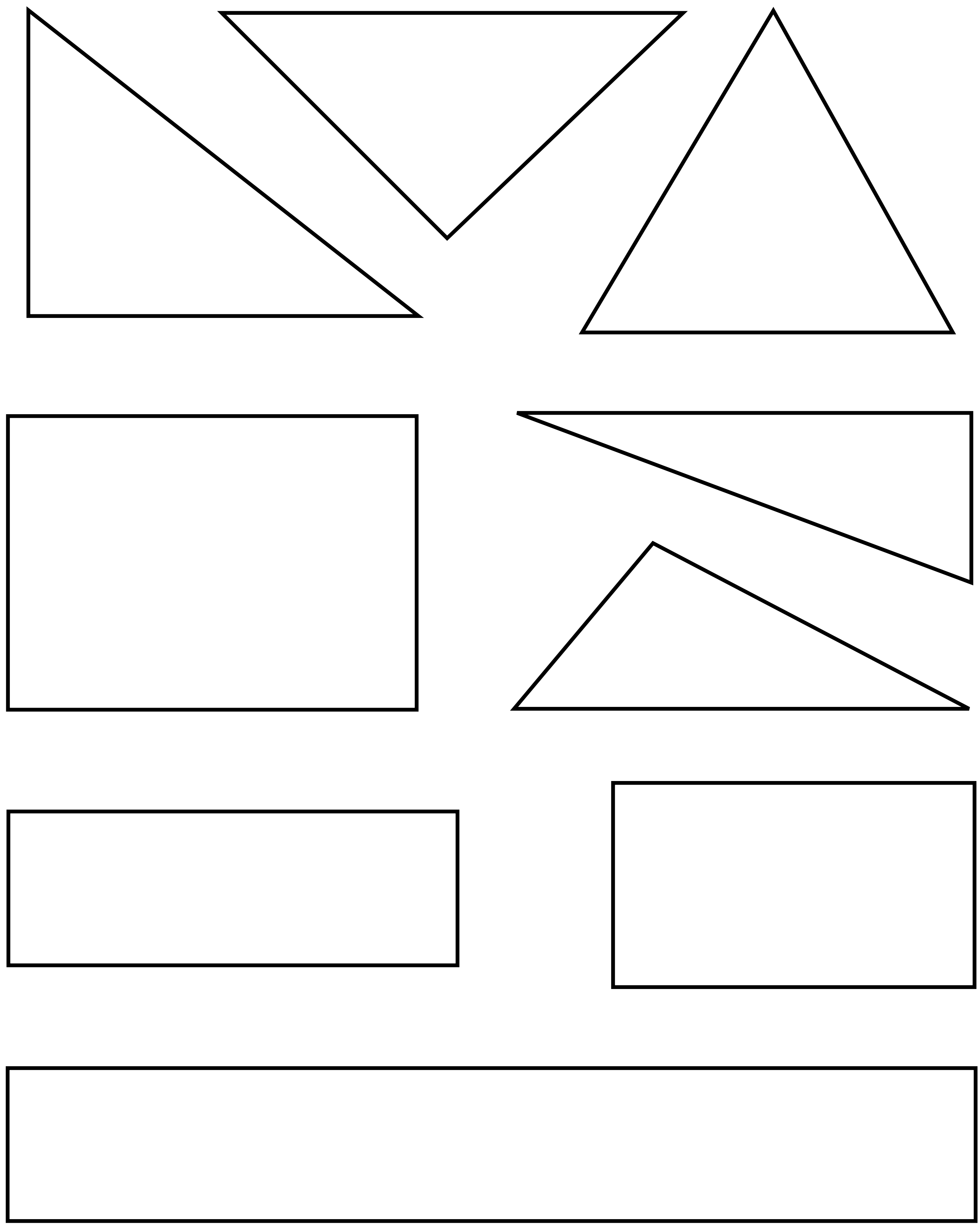
- "Show your shape if it has a square corner."
- "Show your shape if it has two long sides and two short sides."

For some statements, such as "Show your shape if it is a triangle", ask students to explain why their shape matches the statement. For example, a student might say, "My shape is a triangle because it has three sides".

For some statements, two or more students will hold up their shapes. When this happens, encourage students to compare these shapes by asking, "How are these shapes the same? How are they different?"

Shapes

Shapes can be photocopied onto card stock or cut from foam core, plastic, or wood.



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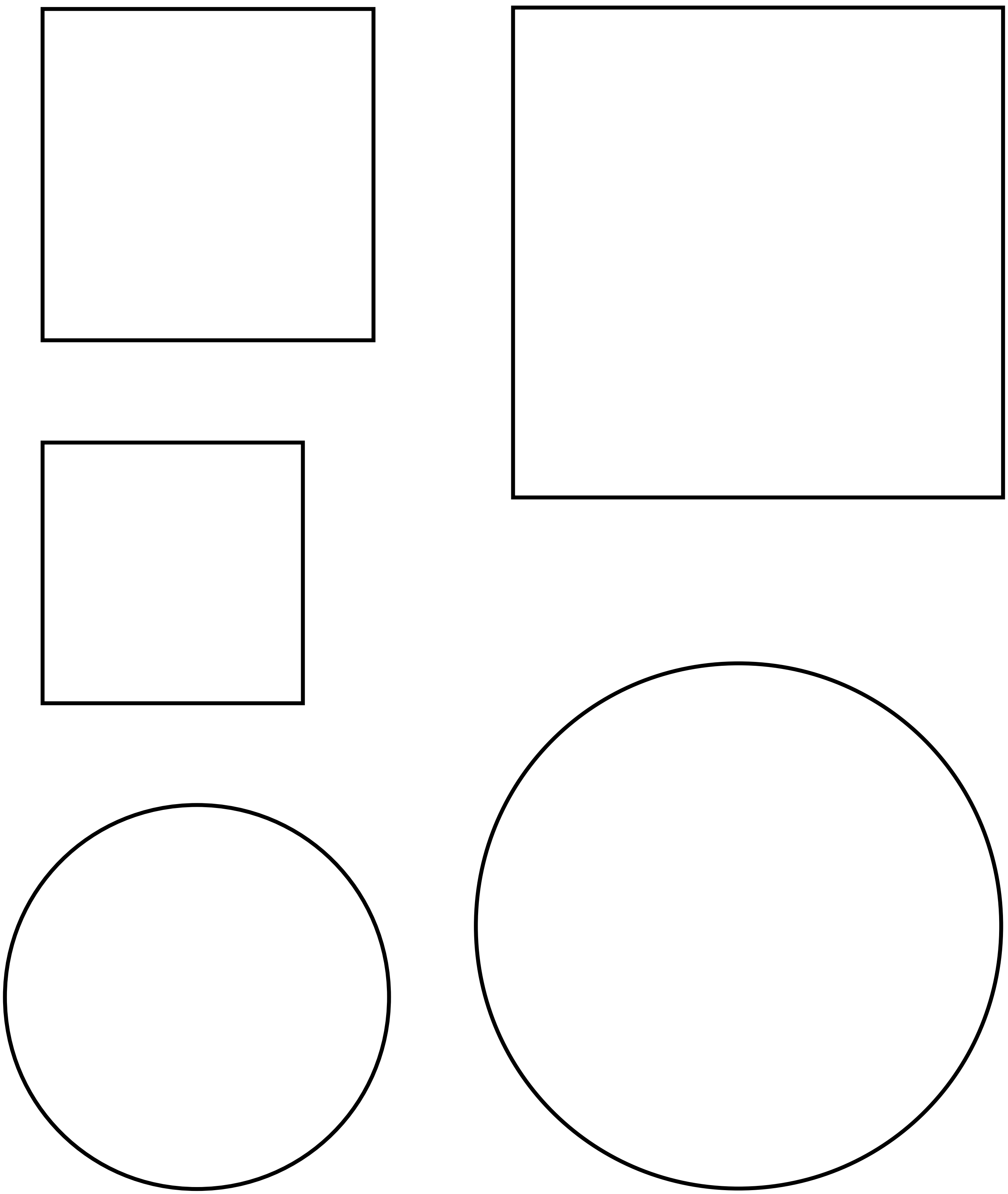
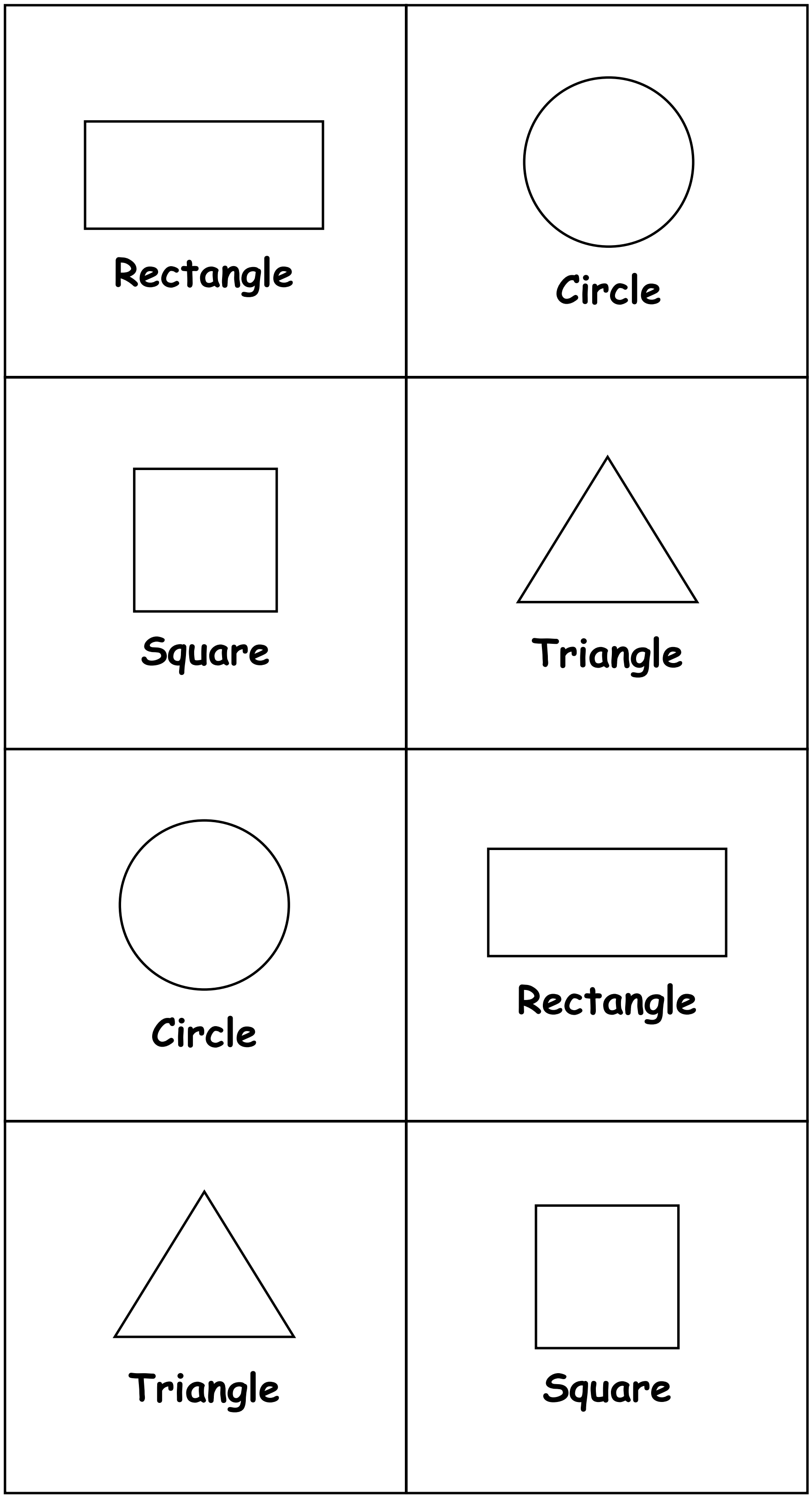
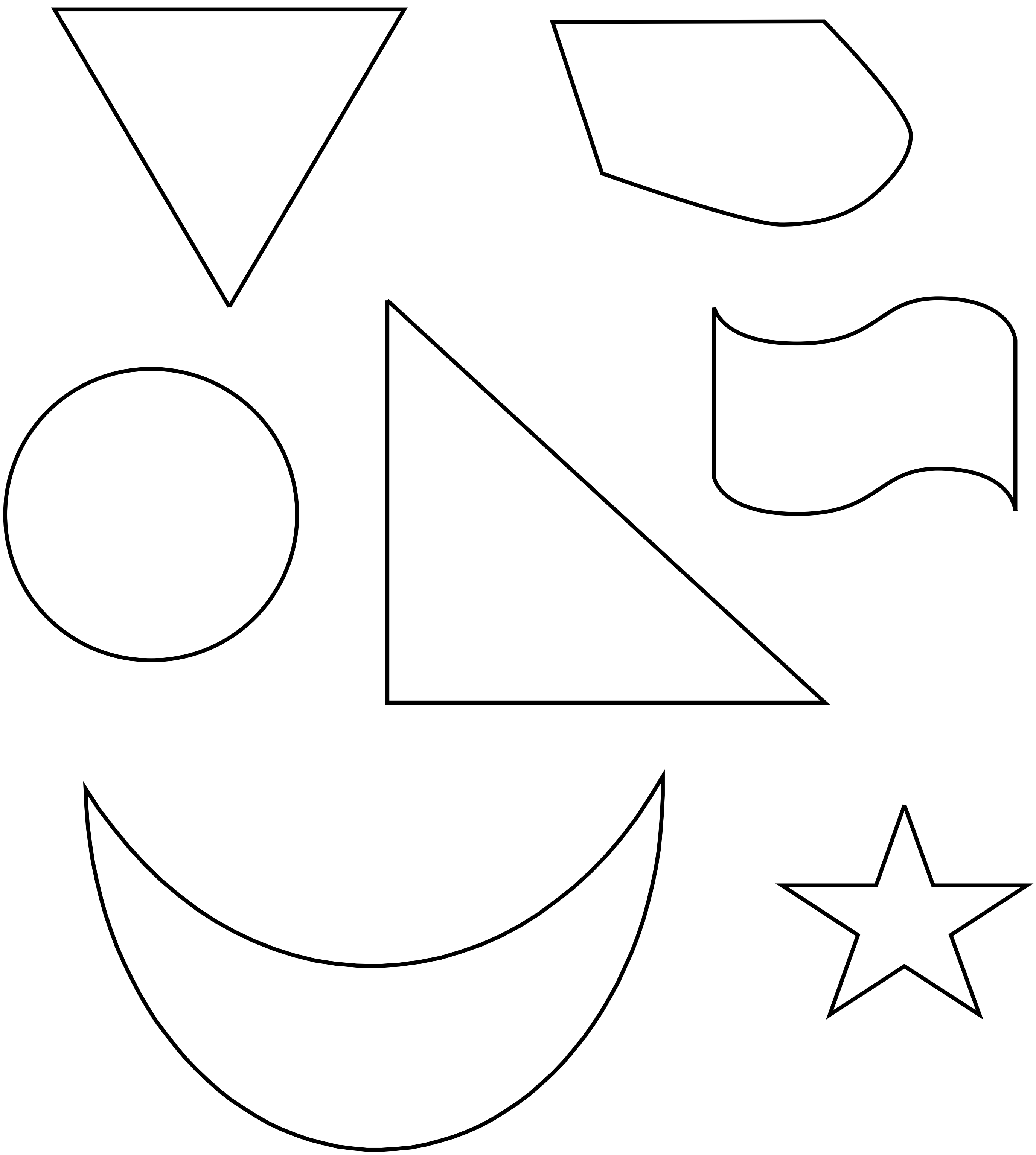


Match Me Game Board



Assorted Shapes

Shapes can be photocopied onto card stock or cut from foam core, plastic, or wood.



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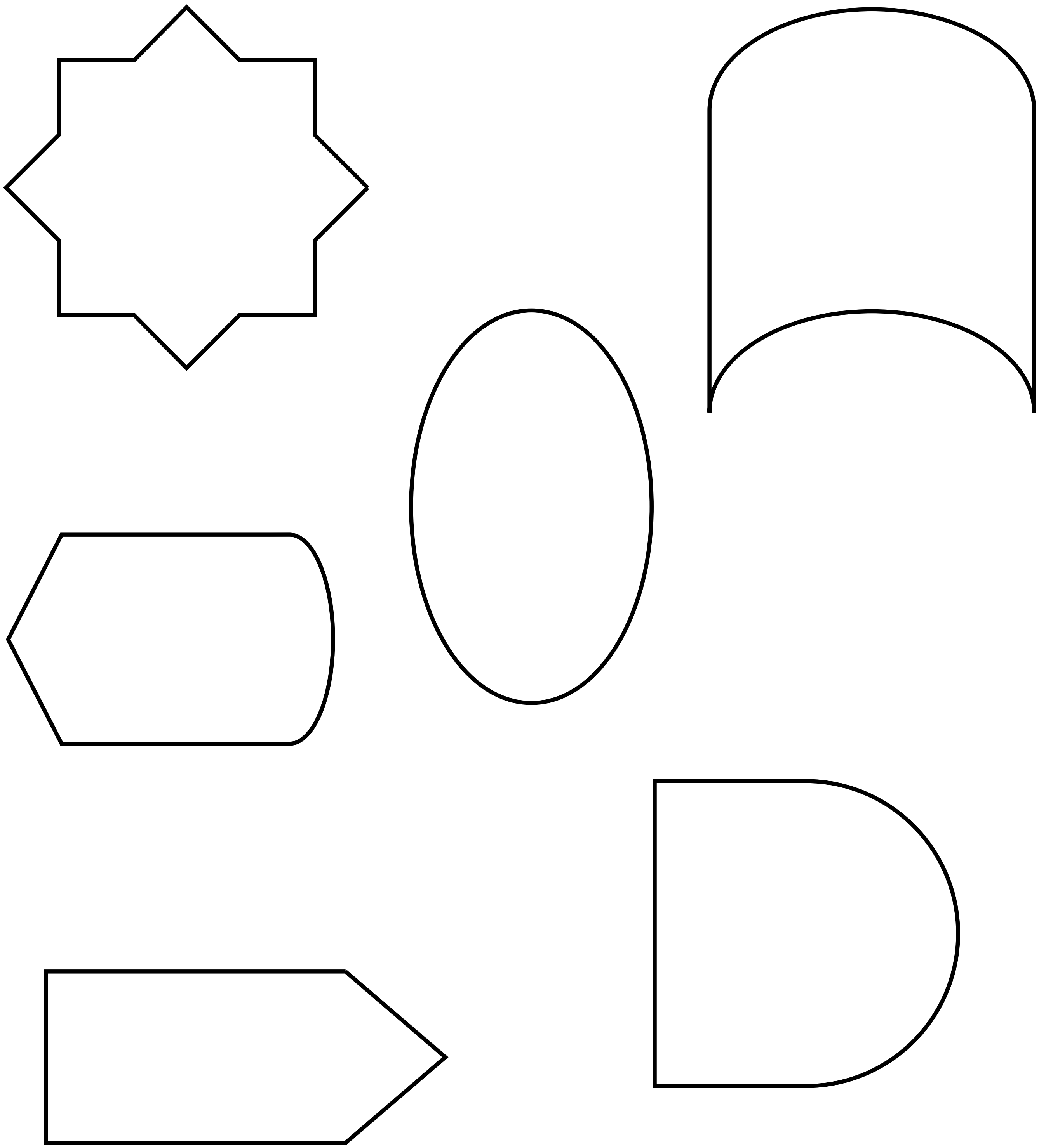

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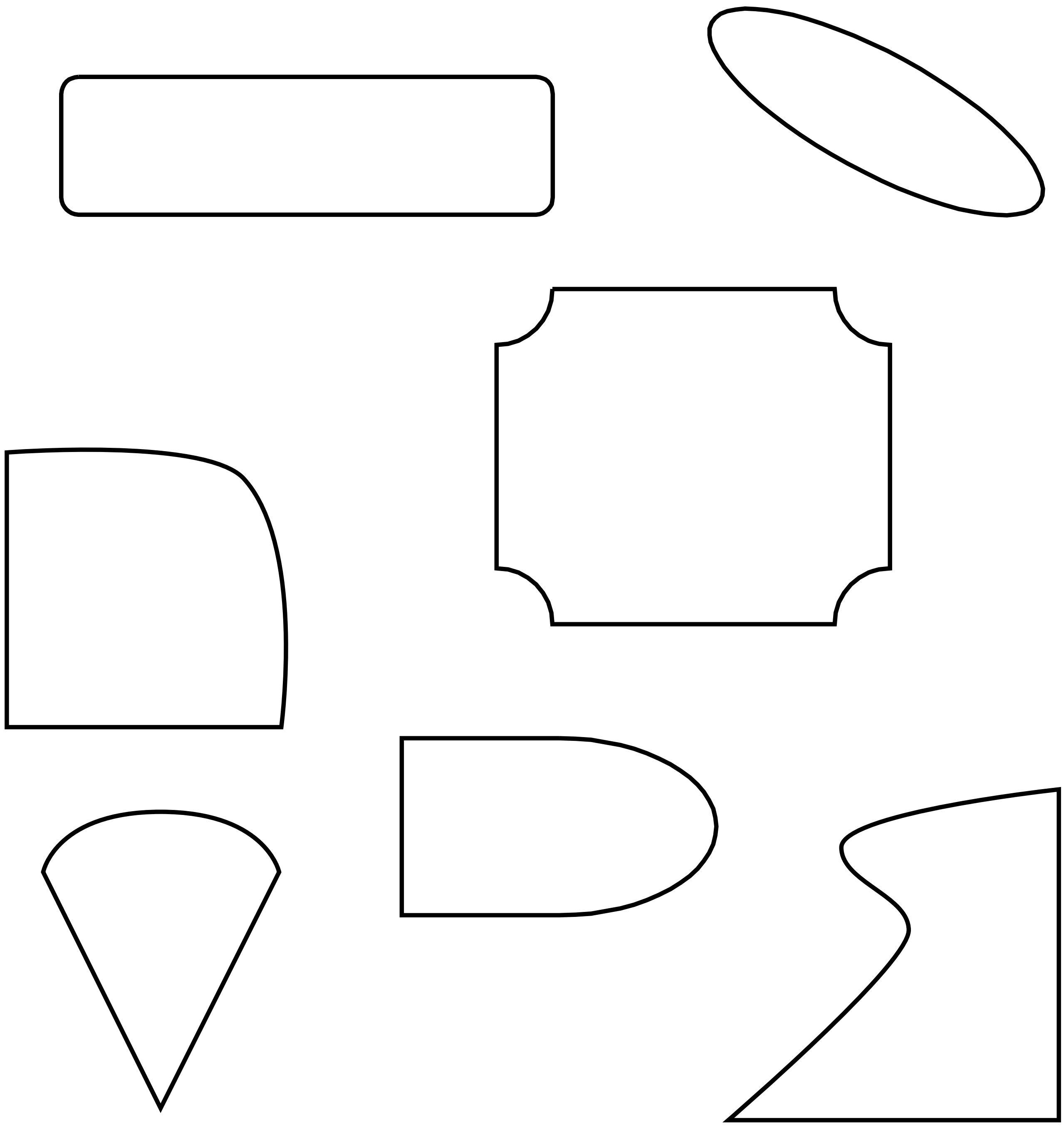

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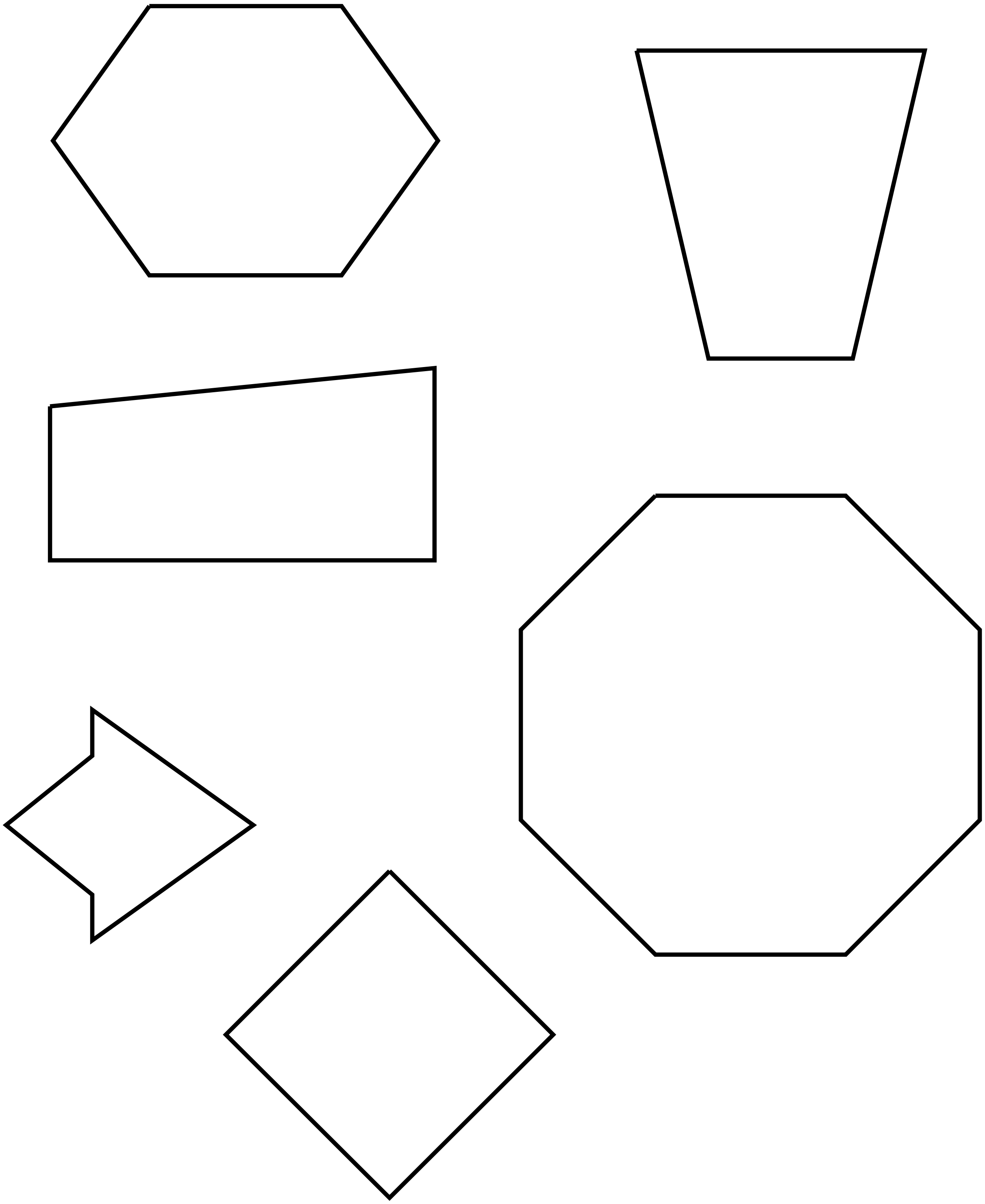

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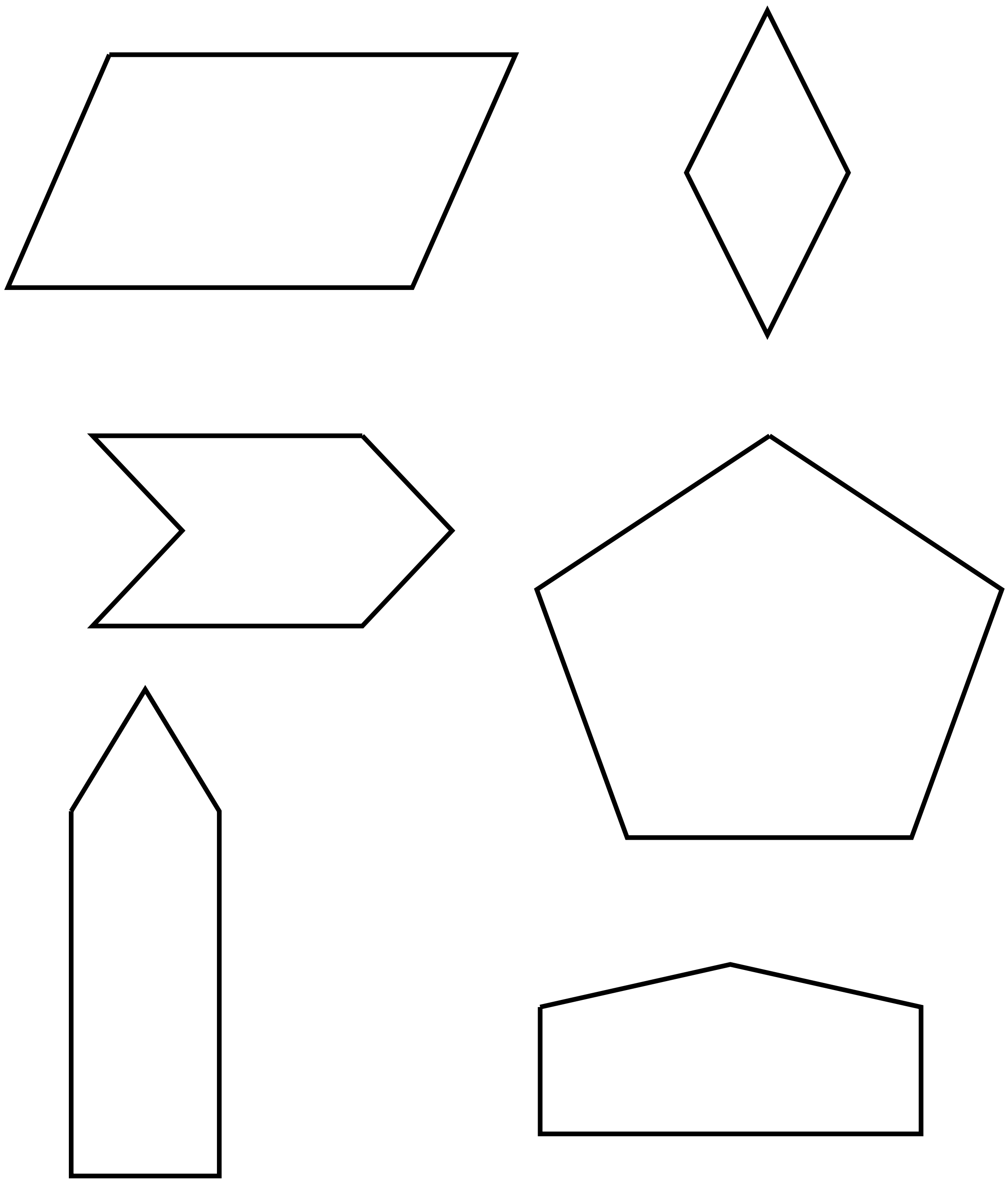

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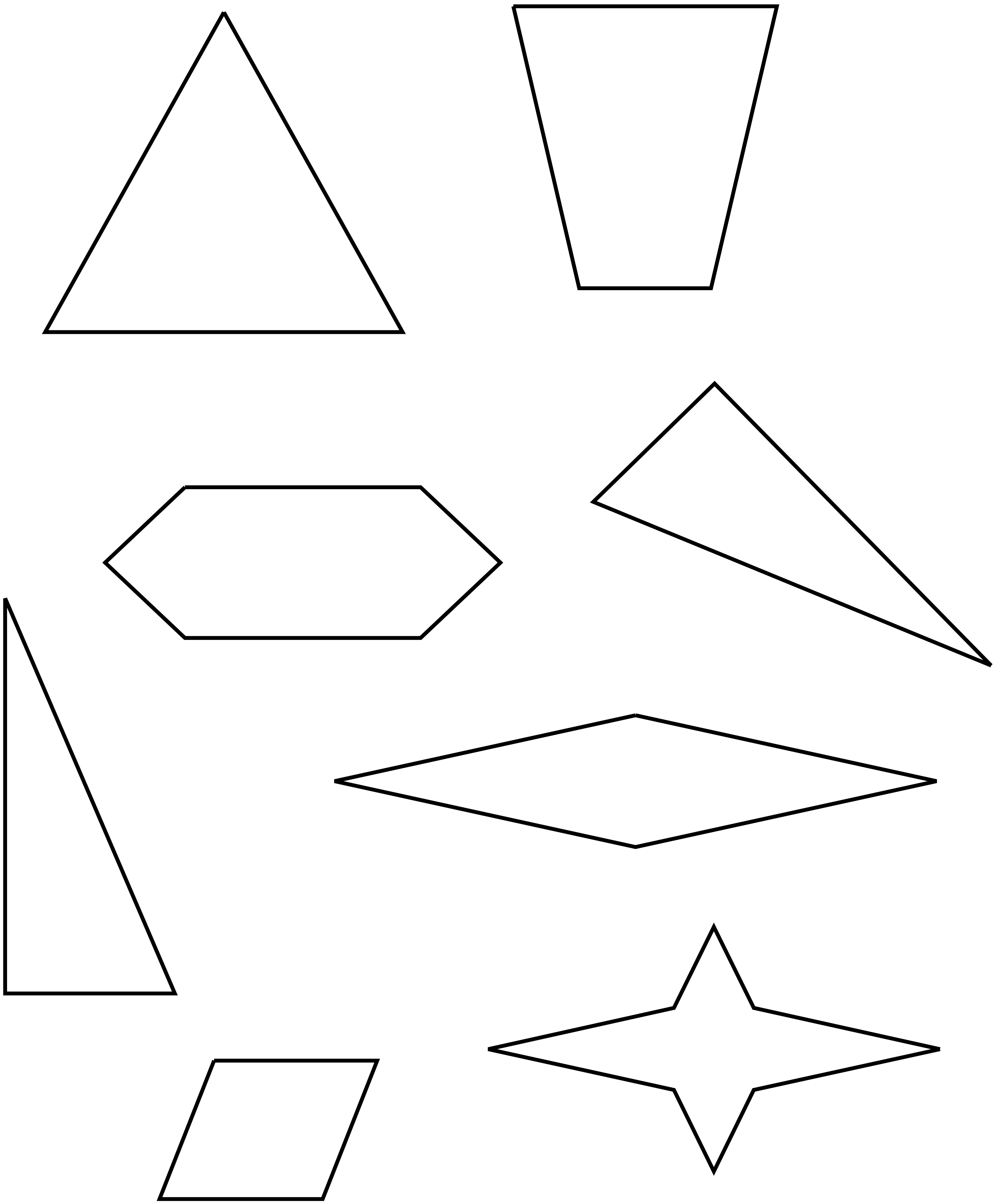

Assorted Shapes

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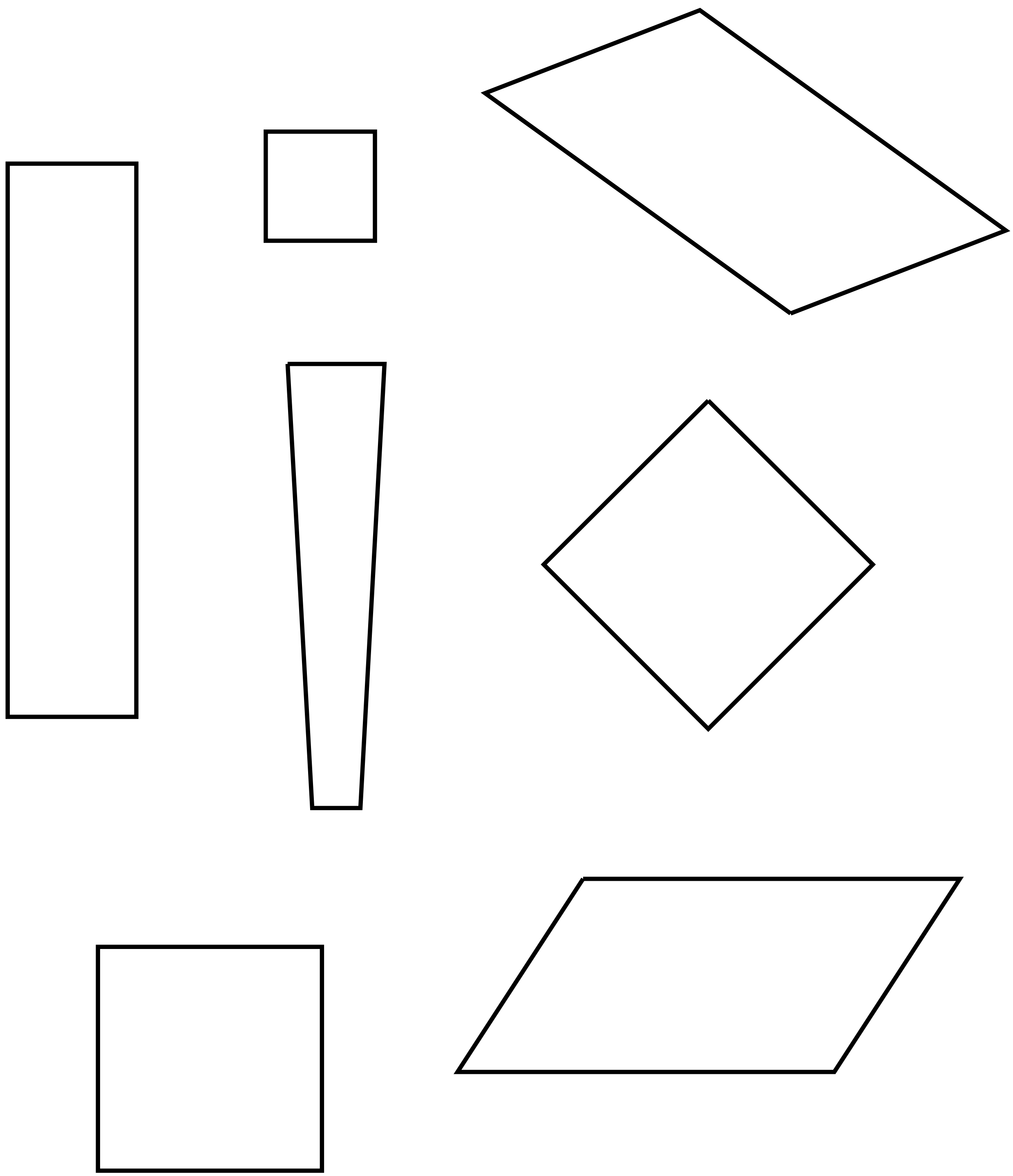
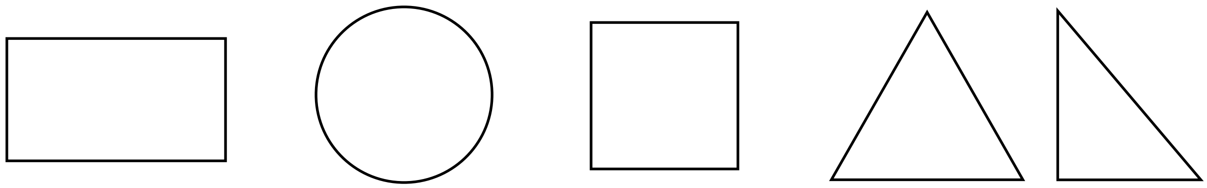


Shapes Faces at Home

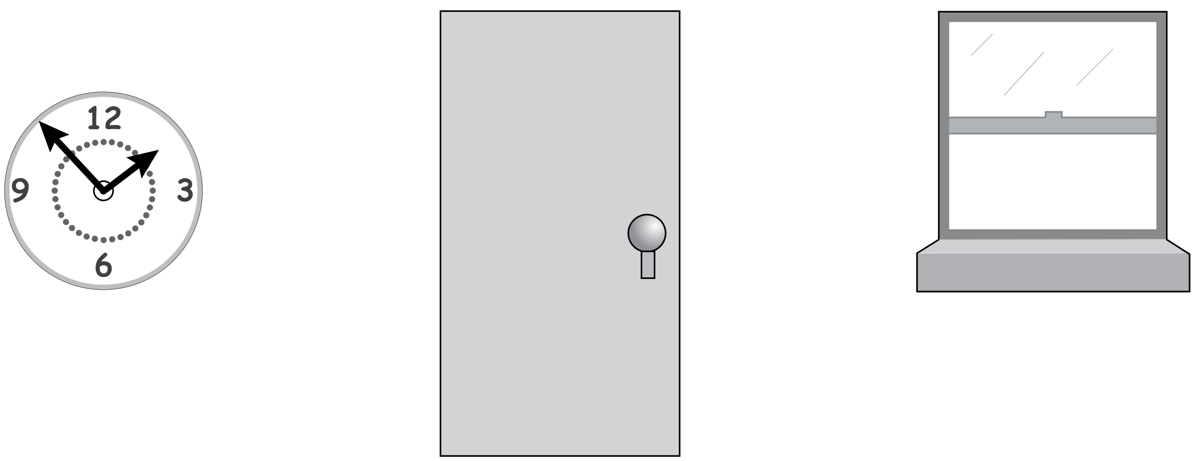
Dear Parent/Guardian:

Our class has been learning about shapes, such as rectangles, circles, squares, and triangles.



Rectangle **Circle** **Square** **Triangles**

Walk through your home with your child. Together, see if you can find differently shaped "faces" on objects. Here are some examples of shape faces you might find.



Circle **Rectangle** **Square**

When you find a shape face in your home, have your child do the following things:

1. Trace around the outside of the shape with a finger.
2. Describe the shape.
3. Draw a picture of the shape.

Encourage your child to bring his or her shape pictures to school to share with the class.

Have fun exploring shapes together.

What Shape Could It Be?

I thought . . .	Then I thought . . .	Now I know . . .
I thought . . .	Then I thought . . .	Now I know . . .
I thought . . .	Then I thought . . .	Now I know . . .
I thought . . .	Then I thought . . .	Now I know . . .

Famous Figures

BIG IDEA **Geometric Properties of Three-Dimensional Figures**

CURRICULUM EXPECTATIONS

Students will:

- trace and identify the two-dimensional faces of three-dimensional figures, using concrete models (e.g., "I can see squares on the cube.");
- identify and describe common three-dimensional figures (e.g., cubes, cones, cylinders, spheres, rectangular prisms) and sort and classify them by their attributes* (e.g., colour; size; texture; number and shape of faces), using concrete materials and pictorial representations (e.g., "I put the cones and the cylinders in the same group because they all have circles on them.");
- describe similarities and differences between an everyday object and a three-dimensional figure (e.g., "A water bottle looks like a cylinder, except the bottle gets thinner at the top").

*For the purposes of student learning in Grade 1, "attributes" refers to the various characteristics of two-dimensional shapes and three-dimensional figures, including geometric properties

MATERIALS

- Prop3D1.BLM1a-e: Figure Cards (1 complete set)
- Prop3D1.BLM2: Figure Finders (1 per student)
- a variety of three-dimensional figures (cubes, cones, cylinders, spheres; rectangular prisms are optional) (1 figure for each student)
- Prop3D1.BLM3: 3-D Is All Around Me (1 per student)

ABOUT THE MATH

In Grade 1, students learn to identify three-dimensional figures (cubes, cones, cylinders, and spheres) and to describe the figures using their own informal language (e.g., a sphere is round all over; a cone has a pointy part). Opportunities to locate examples of three-dimensional figures in their classroom, school, and community deepen students' understanding of the properties of the figures. Students learn, for example, that the surfaces of three-dimensional figures can be flat or curved. As well, they begin to recognize the two-dimensional faces of the three-dimensional figures. As teachers model geometric vocabulary, students begin to acquire the language that allows them to describe the figures by referring to their properties.

In the Famous Figures task, students identify similarities and differences between three-dimensional figures. This task allows students to recognize and describe properties of three-dimensional figures at students' individual level of understanding. Some students will describe similarities and differences in simple terms ("The cube and the cylinder have flat parts"), while other students will recognize and explain similarities and differences with greater sophistication ("Both the cylinder and the cone have faces that are circles").

The focus of the task and the learning connections that follow is on investigating and describing the attributes of three-dimensional figures, not on recording and memorizing the number and kinds of faces of different figures. These kinds of tasks help students recognize that three-dimensional figures have specific properties and that three-dimensional figures can be compared using these properties.

GETTING STARTED

Have a cube, cone, cylinder, sphere, and rectangular prism on hand. Hold each up, in turn, and ask student to identify the three-dimensional figures and to find examples of them in the classroom (e.g., a marker is a cylinder, a tennis ball is a sphere). Hold the found objects next to the matching pictures (Prop3D1.BLM 1a–e: Figure Cards), and have students discuss the similarities between the three-dimensional object and its two-dimensional representation (e.g., a tennis ball has a curved surface, and the picture of the sphere has rounded lines).

As you discuss examples of three-dimensional figures, explain to students that the surface of a figure can be flat or curved. Explain that a flat surface is called a "face". Ask students to locate faces on their found objects that are examples of three-dimensional figures.

Discuss with students that three-dimensional figures can have edges and corners. Ask students to locate edges and corners on the found classroom objects.

Take students on a walk through the school, playground, or community, and instruct them to look for examples of three-dimensional figures. As Figure Finders, they need to find examples of cubes, cones, cylinders, spheres, and rectangular prisms, and then draw and label them on Prop3D1.BLM2: Figure Finders.

On the walk, ask questions, such as the following:

- "Why is this object an example of a cone (cube, cylinder, sphere, rectangular prism)?"
- "Which figure does this object look like? Why?"
- "What do we need to look for when we want to find an example of a cone?"
- "In what ways are a cylinder and a cone the same? How are they different?"

WORKING ON IT

Have students sit in a circle. Discuss the meaning of the word "famous". Explain to students that they will meet some Famous Figures. Provide each student with a three-dimensional figure. Choose a figure to be the Famous Figure. Pass the Famous Figure around the circle. Instruct students that when they receive the Famous Figure, they need to think of and explain a way in which their own figure is the same as or different from the Famous Figure.

For example, if the Famous Figure is a cube, students could make the following statements:
- "My figure is the same because it has straight edges on it too." (rectangular prism)
- "My figure is different because it has a circle face." (cone, cylinder)
- "My figure is the same because they both can slide." (cone, cylinder, rectangular prism)
- "My figure is the same because they're both cubes." (cube)

REFLECTING AND CONNECTING

Pose riddles about Famous Figures, such as the following:
- "This Famous Figure has six faces. All its faces are squares. What is the Famous Figure?"
- "This Famous Figure has a face that is a circle and a curved surface. What is the Famous Figure?"

Ask students to justify their answers.

Provide opportunities for students to create and pose their own riddles about Famous Figures.

ADAPTATIONS/EXTENSIONS

Some students may have difficulty comparing their own figure with the Famous Figure. Asking questions such as "Does your figure have any corners?" or "What kind of faces does your figure have?" can help students to focus on the attributes of their shape. Then examine the Famous Figure together, looking at its attributes.

Challenge students by asking them to find all the ways two figures are alike or different. For example, if students select a cylinder and a cone, they might explain that a cylinder and a cone are alike because both figures have a face that is a circle, and that a cylinder and a cone are different because a cylinder has two circular faces, but the cone has only one.

Challenge students to name all the three-dimensional figures that share a common attribute. Ask such questions as:
- "Which figures have a face that is a circle?"
- "Which figures have a face that is a rectangle?"
- "Which figures have a curved surface?"

MATH LANGUAGE

- three-dimensional figure
- two-dimensional shape
- face
- edge
- surface
- curved
- flat
- straight
- cone
- cube
- cylinder
- sphere

SAMPLE SUCCESS CRITERIA

- identifies three-dimensional figures using appropriate mathematical vocabulary (e.g., "It's a cube.")
- describes three-dimensional figures using appropriate mathematical vocabulary (e.g., "A cube has square faces.")
- describes similarities and differences between everyday objects and three-dimensional figures, using appropriate mathematical vocabulary (e.g., "This tissue box is an example of a rectangular prism" or "A water bottle looks like a cylinder, except the bottle gets thinner at the top.")
- classifies three-dimensional figures by attributes (e.g., "Cones and cylinders have curved surfaces.")
- sorts three-dimensional figures by attributes (e.g., "Spheres roll, cubes stack, and cylinders do both.")
- identifies the two-dimensional faces of three-dimensional figures (e.g., "A cube has six square faces.")

HOME CONNECTION

Send home Prop3D1.BLM3: 3-D Is All Around Me. In this Home Connection task, students locate and draw three-dimensional figures found in their home.

LEARNING CONNECTION 1

Just Like Me in 3-D

Materials

- a variety of three-dimensional figures (cubes, cones, cylinders, spheres)

Provide each student with a three-dimensional figure. Play Just Like Me in 3-D:

- Have students sit in a circle.
- As the leader, make a statement to the group, such as, "I am a cube", or "My figure has a circle on it".
- Tell students to stand if they have a figure that matches the leader's statement and exclaim, "Just like me!"
- After a few rounds, let students take the role of the leader.

LEARNING CONNECTION 2

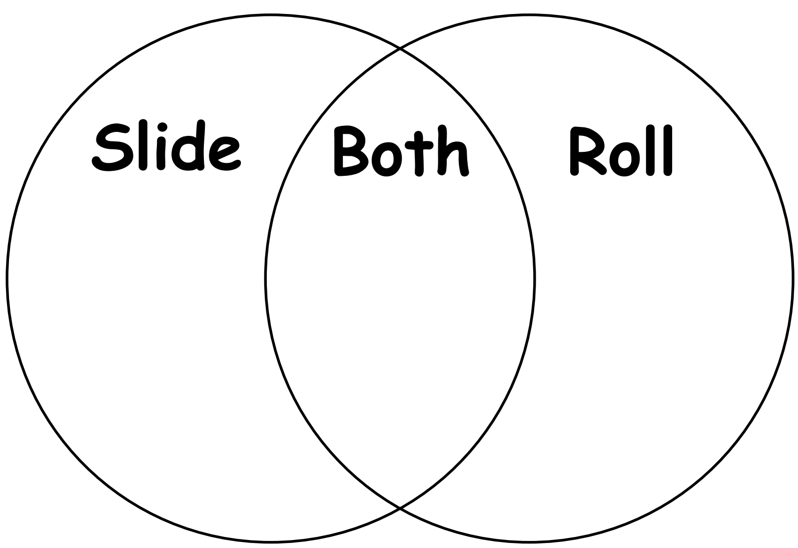
To Roll or Not to Roll

Materials

- a variety of three-dimensional figures (cubes, cones, cylinders, spheres, rectangular prisms)
- a ramp made from a wooden board propped up at one end on a few books
- 2 large sorting circles or hoops
- cards labelled Slide, Roll, Stack, Both

Tell students that they will need to work with a partner to investigate which figures roll, slide, and stack and to be prepared to discuss their findings.

After students have carried out their investigations, gather them for a sorting task. Use two overlapping sorting circles (or hoops) to represent a Venn diagram (as shown below), and label the sections Slide, Roll, and Both.



Hold up the figures, one at a time, and ask students to explain in which section of the Venn diagram each should be placed. For example, a cone should be placed in the section labelled Both, because it slides and rolls.

Sort the figures in different ways by changing the labels on the Venn diagram: Slide and Stack or Roll and Stack. The section created by the overlapping circles is always labelled Both.

LEARNING CONNECTION 3

Play Dough Figures

Materials

- a variety of three-dimensional figures (cubes, cones, cylinders, spheres, rectangular prism)
- play dough (see recipe below)

Have students create three-dimensional figures by using play dough. Provide models of three-dimensional figures.

Play Dough Recipe

Mix 2 cups flour
1 cup salt
2 tablespoons cooking oil
water
food colouring

Combine ingredients, using just enough water to allow the mixture to be kneaded. Knead until smooth. Store in an airtight container.

LEARNING CONNECTION 4

Tinytown

Materials

- Prop3D1.BLM4: Request for Packaging Materials (1 per student)
- scissors
- glue
- tape
- construction paper
- paint
- markers

Before this task, send home Prop3D1.BLM4: Request for Packaging Materials. Explain to students that they will use the materials to create structures for Tinytown – a miniature town with buildings, playgrounds, and vehicles.

Brainstorm a list of structures that students could construct for Tinytown. Encourage students to describe how they could use packaging materials to build these structures (e.g., "I could use a shoebox to build a fire station"). Ask each student to choose a structure to build for Tinytown.

Provide the necessary time for students to build their structures and to add details using construction paper, paint, and markers.

Gather students to share their finished structures. Encourage students to identify their structures (e.g., house, car, apartment, slide, bridge) and to explain how they used three-dimensional figures to build them. Prepare an area in the room where Tinytown can be assembled and displayed. Suggest that students paint roads and grassy areas on a large sheet of mural paper.

Visit Tinytown with students and have them find, identify, and compare different three-dimensional figures in the structures. Ask questions, such as the following:

- "What object is shaped like a cube? a cone? a sphere? a cylinder?"
- "What three-dimensional figures were used to make this structure?"
- "How are these two structures alike? How are they different?"
- "What is the most common figure found in Tinytown?"

Figure Cards – Cube

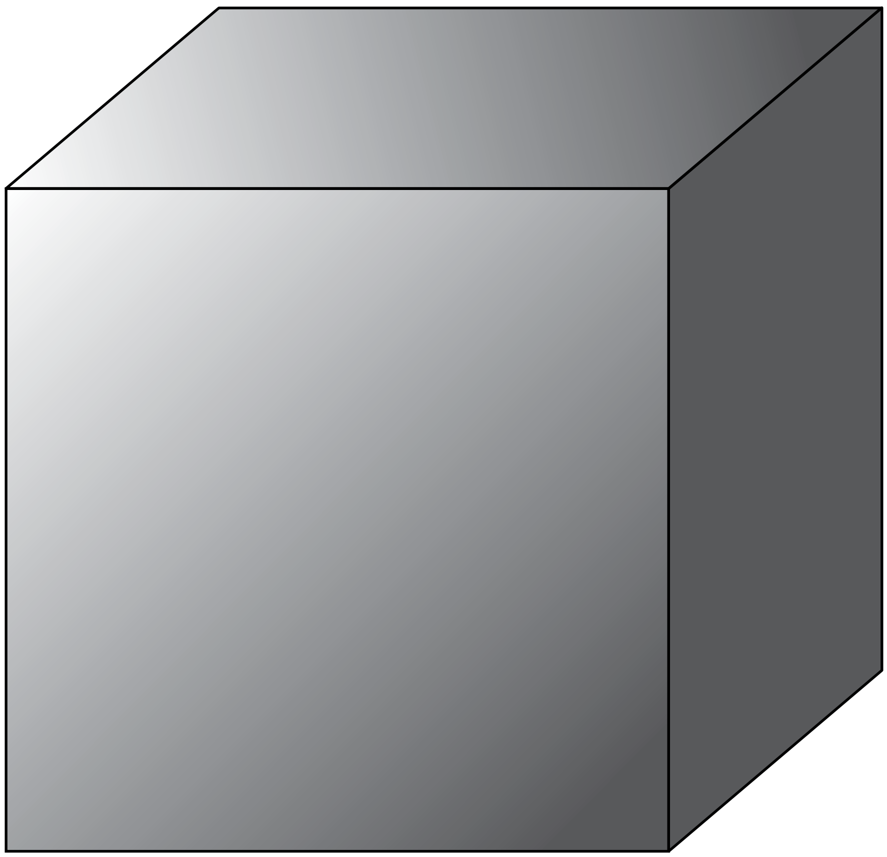


Figure Cards – Cone

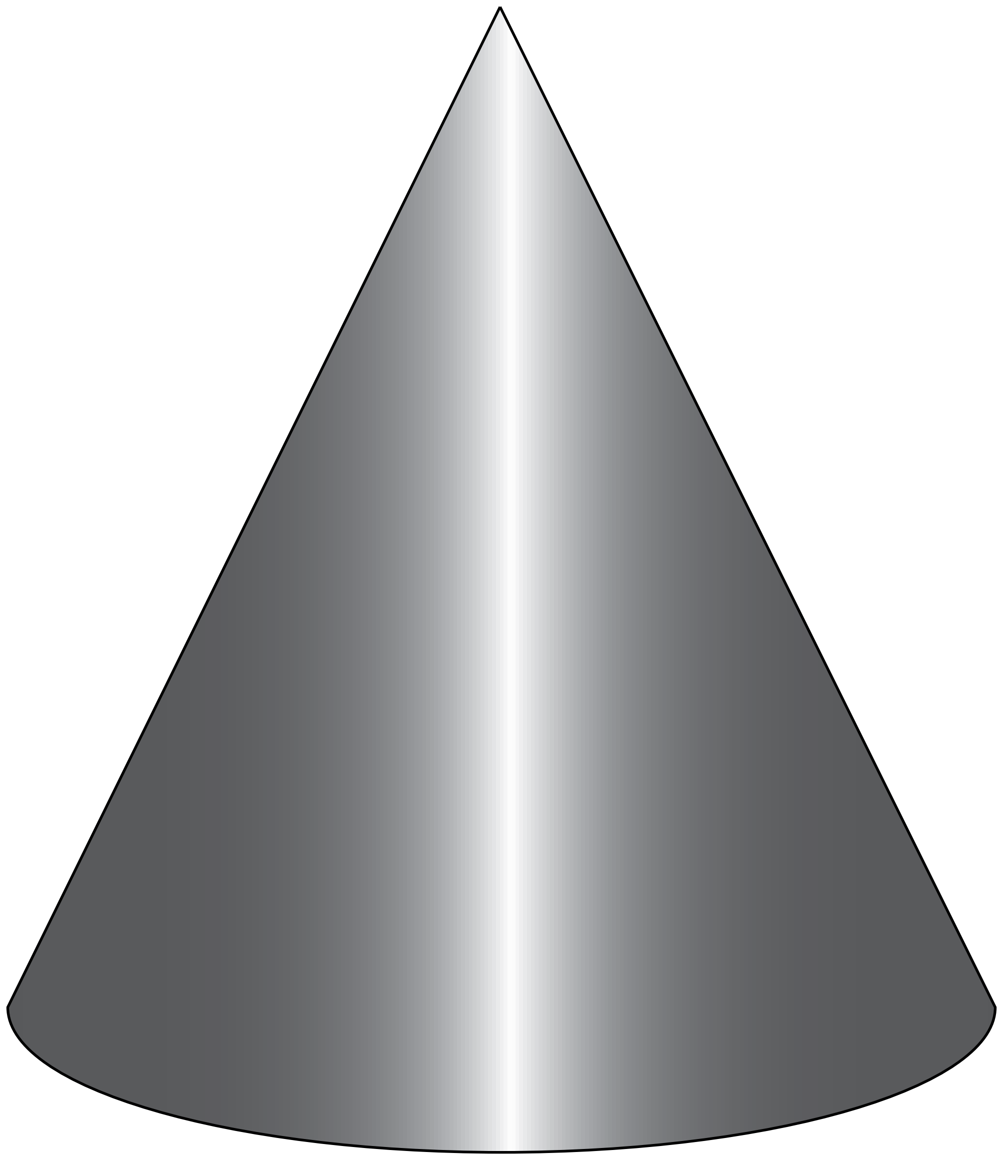


Figure Cards – Cylinder

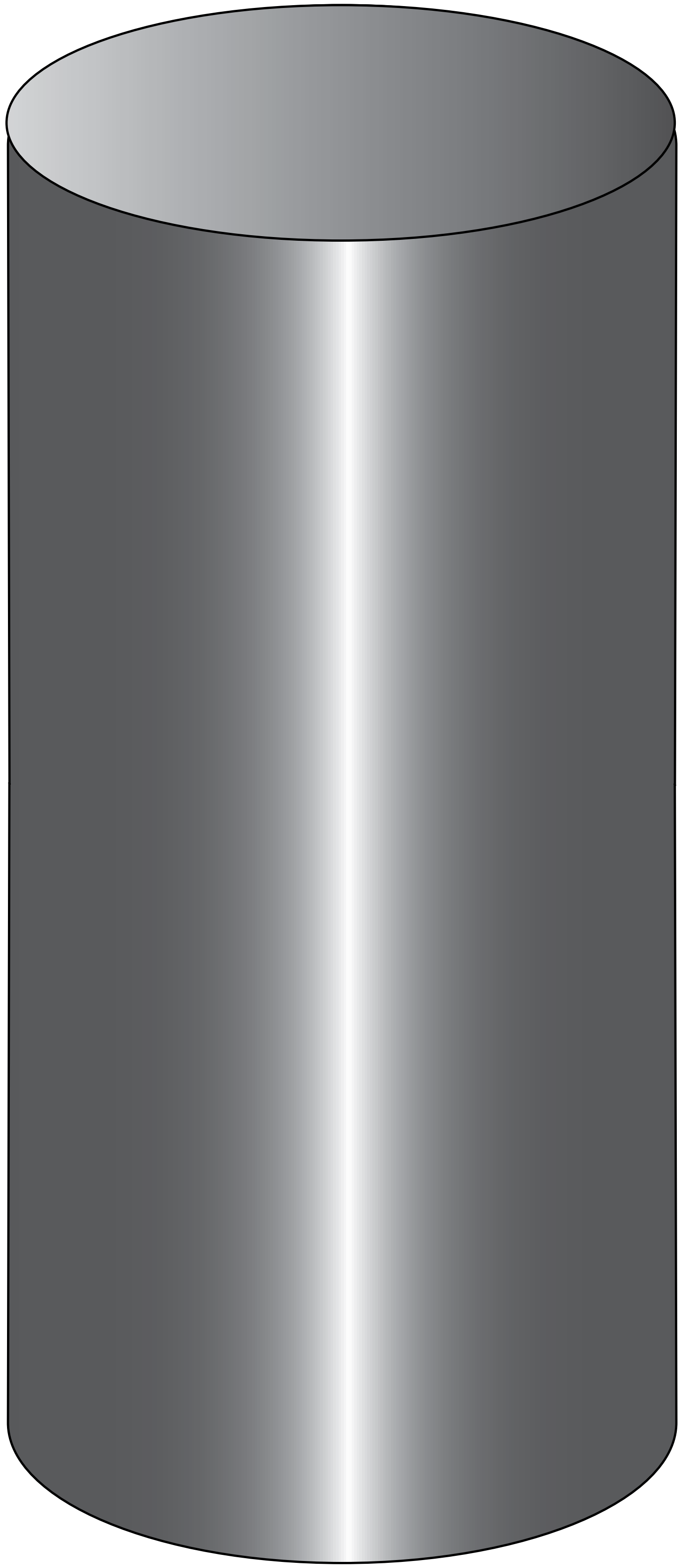


Figure Cards – Sphere

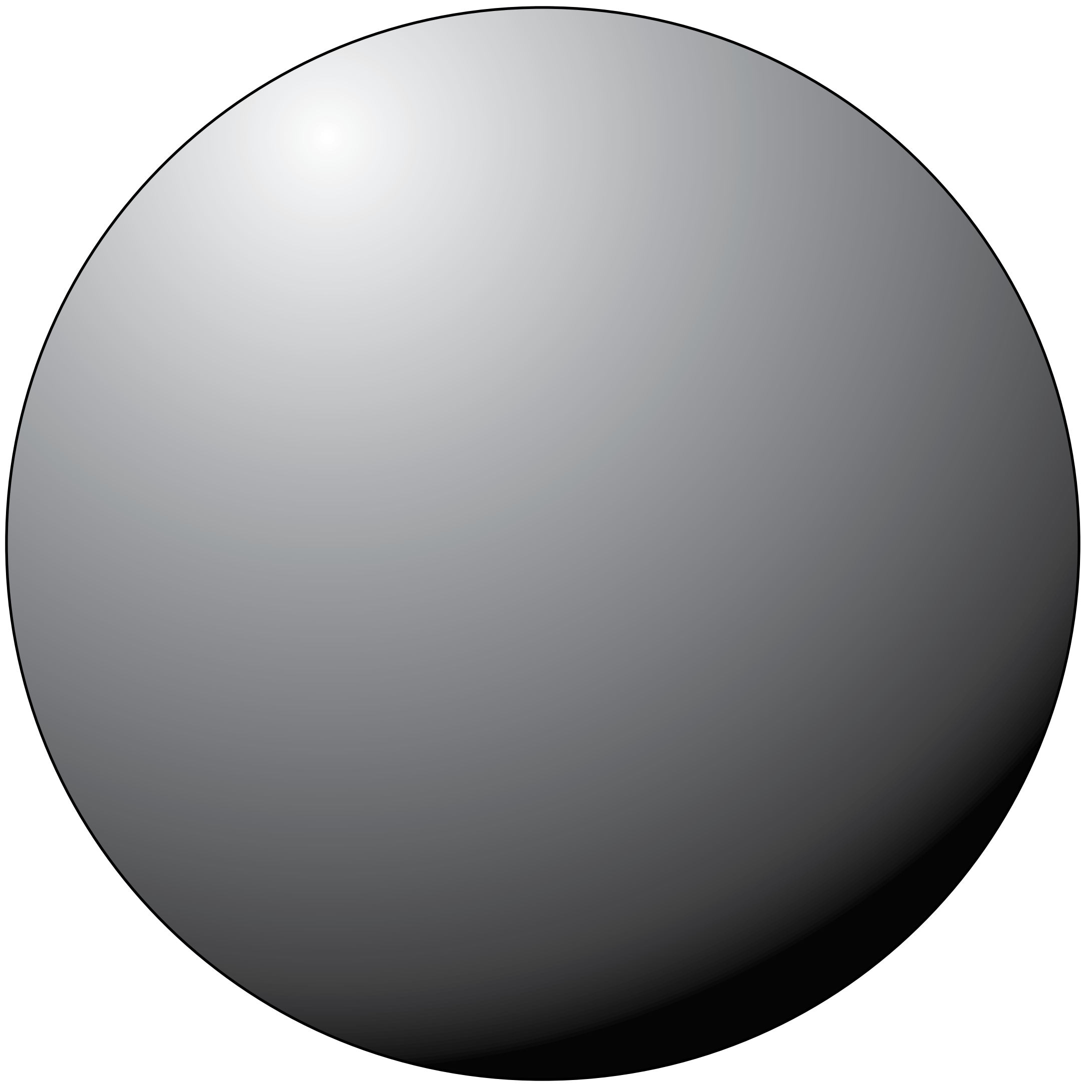


Figure Cards - Rectangular Prism

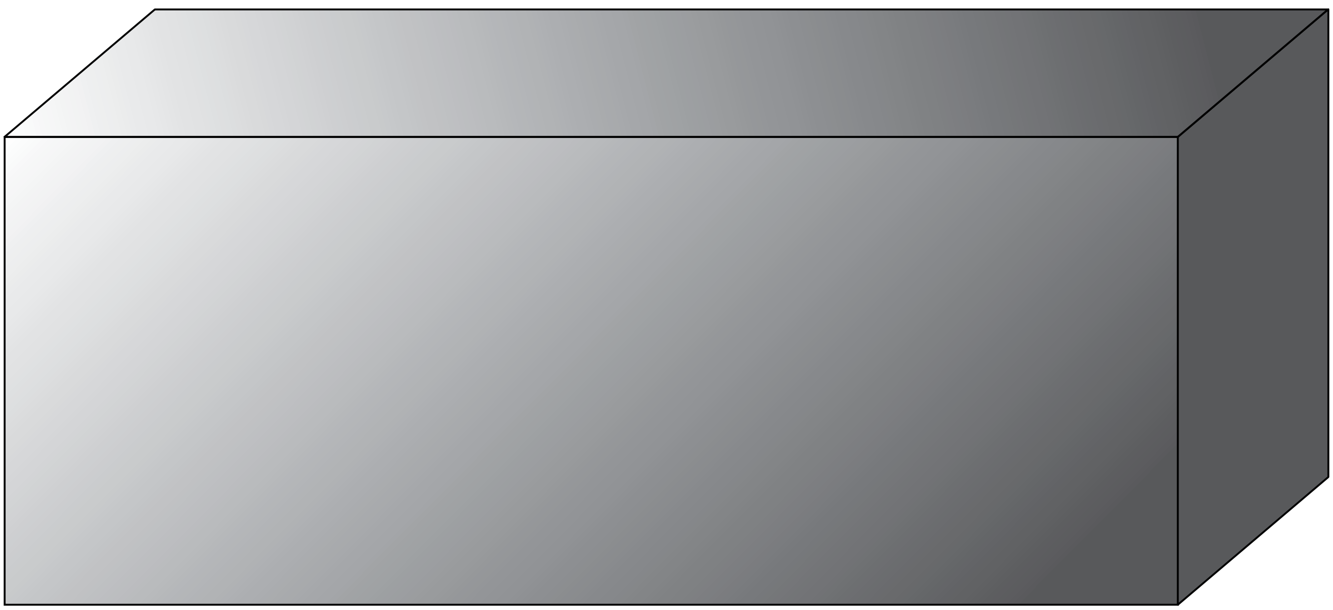
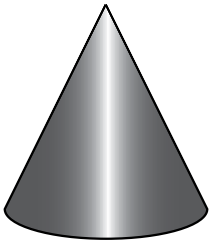
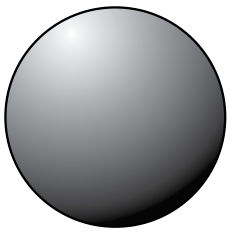


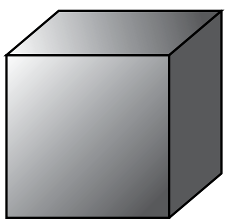
Figure Finders



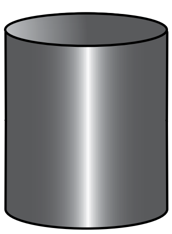
Cones



Spheres



Cubes



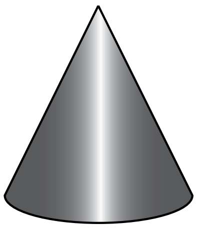
Cylinders

Rectangular Prisms

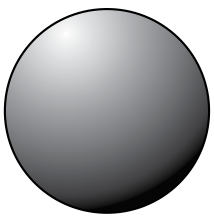
3-D Is All Around Me

Dear Parent/Guardian:
Our class has been learning about three-dimensional figures.

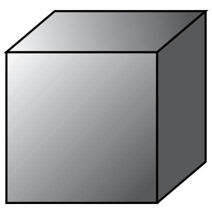
Help your child find examples at home of the three-dimensional figures shown below. Have your child draw the objects that look like these figures.



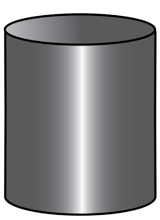
Cones



Spheres



Cubes



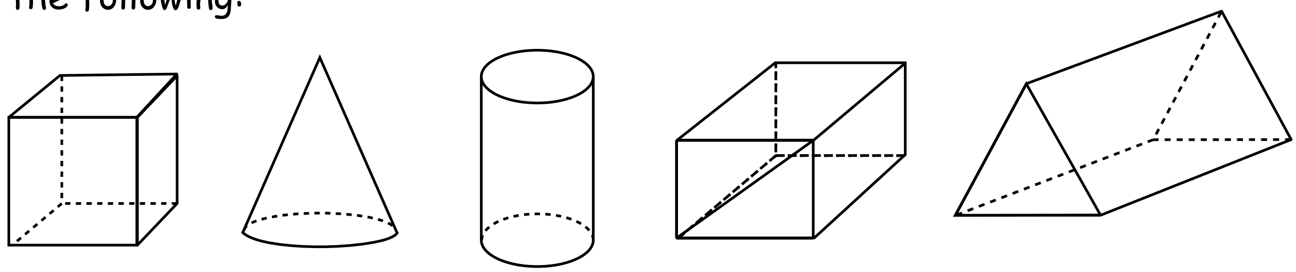
Cylinders

Rectangular Prisms

Request for Packaging Materials

Dear Parent/Guardian:

Our class has been learning about three-dimensional figures, such as the following:

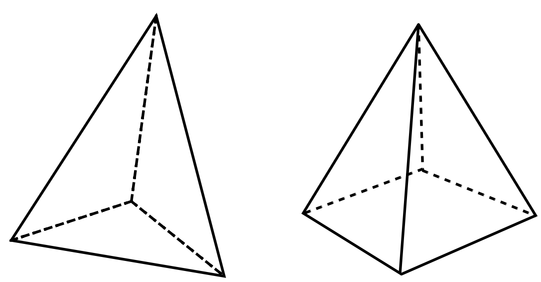


Cube **Cone** **Cylinder** **Rectangular Prism** **Triangular Prism**

We will be doing an activity in which students will be building a town using three-dimensional figures.

You can help! We would appreciate it if you could collect empty packaging materials that are three-dimensional figures and send them to class with your child. For example, you could send such materials as cardboard boxes, cartons, cereal boxes, and paper rolls.

Other three-dimensional figures, such as the following, will also be used to create the structures. If you find one of these figures, share the name with your child:



Triangle-Based Pyramid **Square-Based Pyramid**

Thank you in advance for the materials you are able to provide for our math activity.

Pattern Block Pets

BIG IDEA ***Geometric Relationships***

CURRICULUM EXPECTATIONS

Students will:

- identify and describe common two-dimensional shapes (e.g., circles, triangles, rectangles, squares) and sort and classify them by their attributes* (e.g., colour; size; texture; number of sides), using concrete materials and pictorial representations (e.g., "I put all the triangles in one group. Some are long and skinny, and some are short and fat, but they all have three sides.");
- compose patterns, pictures, and designs, using common two-dimensional shapes (**Sample problem:** Create a picture of a flower using pattern blocks.);
- identify and describe shapes within other shapes (e.g., shapes within a geometric design);
- describe the relative locations of objects or people using positional language (e.g., over, under, above, below, in front of, behind, inside, outside, beside, between, along).

*For the purposes of student learning in Grade 1, "attributes" refers to the various characteristics of two-dimensional shapes and three-dimensional figures, including geometric properties.

MATERIALS

- pattern blocks (10 per student)
- overhead pattern blocks (if available)
- pattern block stickers, pattern block stamps, or copies of GeoRel1.BLM1a-f: Pattern Block Shapes
- glue
- crayons or markers to colour shapes if using GeoRel1.BLM1a-f: Pattern Block Shapes
- 8.5 in. x 11 in. (letter-sized) paper (1 sheet per student)
- GeoRel1.BLM2: First You, Then Me. How Many Triangles? Let's See! (1 per student)

ABOUT THE MATH

Opportunities to compose and decompose shapes help students to develop their geometric thinking and spatial sense. Through picture-making tasks using two-dimensional shapes, students explore how shapes can be combined or taken apart to form new shapes.

The Pattern Block Pets learning activity allows students to use pattern blocks to create a picture. After students create their pictures using pattern blocks, they are asked to re-create the pictures using stickers, stamps, or paper cut-outs. Students may be at different levels in their abilities to compose a picture (see pp. 26–28). For example, some students may be at a piece-assembler stage: They create simple pictures in which each pattern block represents part of the animal (e.g., a hexagon used for the animal's head). Other students may be at the picture-maker stage or the shape-composer stage and may assemble more complex pictures (e.g., different pattern blocks used to create the face, ears, eyes, and mouth).

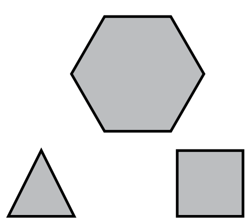
An important aspect of this learning activity is students' sharing of their pictures with their classmates. This opportunity allows students to verbalize how they composed their pictures. It gives other students a chance to view and consider examples of varying complexity and to think about how they might increase the complexity of their own pictures.

These kinds of tasks help students to reflect on how they combined the shapes and to develop positional language (e.g., beside, above, next to) as they describe their arrangement of pattern blocks to the other students.

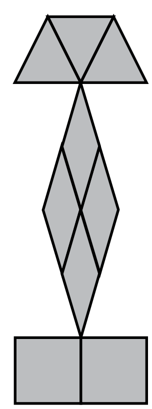
GETTING STARTED

Have students sit in a circle. Place a large number of pattern blocks in the middle of the circle. Ask each student to choose 10 pattern blocks and to place them on the floor in front of them. Give students some time to explore their blocks, and then ask them to show what they can do with the blocks (e.g., stack, sort, order by height, make a design, create a picture).

Show students a simple picture in which each pattern block represents a different object (e.g., Picture A below) and another picture in which pattern blocks are combined to create an object (e.g., Picture B below). Discuss the differences between the two pictures.



Picture A:
Sun, House, and Tree



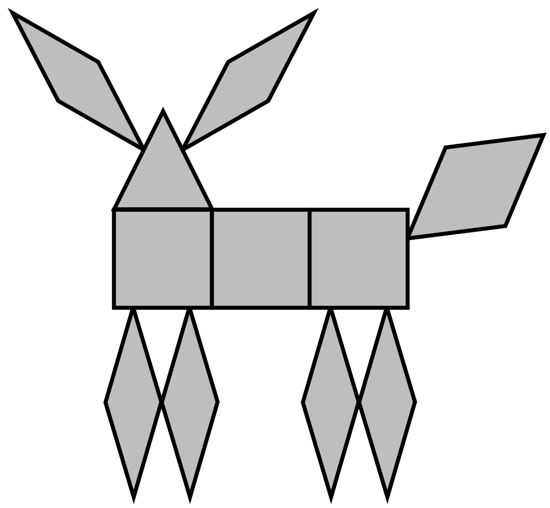
Picture B:
A Lamp

Ask students to use their pattern blocks to create a picture of an object. Encourage them to fit the pattern blocks together to form their picture.

After students have finished making their pattern block pictures, choose one student's picture and re-create the pattern block arrangement on the overhead projector. (Use overhead pattern blocks, if available.) Discuss how the pattern blocks have been combined to form the different parts of the picture.

Next, ask students to share their creations with a partner and to explain how they used pattern blocks to make their picture.

WORKING ON IT
Create a picture of an animal by using pattern blocks on the overhead projector.



As you assemble the picture, identify the pattern blocks you are using. Explain how the different shapes represent parts of the animal (e.g., a rhombus for the tail).

When you have finished the picture, ask students:

- "What shape is the body?"
- "Which pattern blocks did I use for the body?"
- "How did I use rhombuses in my picture?"
- "How did I make the head?"
- "Why do you think I chose rhombuses for the ears?"

Ask students to create Pattern Block Pets by arranging pattern blocks on sheets of paper. When students have completed their pictures, have them re-create their pets on paper using pattern block stickers, pattern block stamps, or paper cut-outs from GeoRel1.BLM1a-f: Pattern Block Shapes. If students use the paper cut-outs, they can colour the shapes to match the pattern blocks.

After the task, save students' Pattern Block Pets for use in Learning Connection 1.

REFLECTING AND CONNECTING

Ask students to show the paper copies of their Pattern Block Pets to their classmates and to explain how they created their pictures.

Encourage students to reflect on their work by asking:

- "What was easy about creating your Pattern Block Pet? What was difficult?"
- "What pattern blocks did you use for the head? the body? the legs? Why did you choose these shapes?"
- "How did you use triangles in your picture?"
- "What pattern block shapes fit well together? Why?"
- "What shapes, other than pattern blocks, could you use to create a picture of a pet?"
- "If you made another pet, what would you do differently? Why?"

ADAPTATIONS/EXTENSIONS

Some students may have difficulty knowing how to combine shapes in their pictures. For these students, demonstrate ways to combine pattern blocks to make larger shapes. These students might benefit from working with a partner.

Some students may need to follow your oral directions as you guide them in making a simple picture.

Challenge students to create complex pictures in which different objects in the picture are made from pattern blocks.

Challenge students to find the value of their Pattern Block Pet. Assign a monetary value to each type of pattern block (e.g., a triangle is worth two cents, a square is worth one cent, a hexagon is worth six cents, a rhombus is worth four cents, and a trapezoid is worth three cents). Have students calculate the cost of their pet. Allow students to use play coin sets to help them.

MATH LANGUAGE

- triangle
- square
- rhombus
- hexagon
- trapezoid

positional language, such as:

- to the right of
- under
- above
- beside

SAMPLE SUCCESS CRITERIA

- uses correct vocabulary, including shapes and positional language, to describe the Pattern Block Pet (e.g., "I used a triangle for the head of my cat and put it on top of a rectangle that I used for the body.")
- composes a picture using common two-dimensional shapes
- explains how different shapes were used in the design of the pet, using appropriate mathematical language (e.g., "I used a rhombus for the tail.")

HOME CONNECTION

Send home GeoRel1.BLM2: First You, Then Me. How Many Triangles? Let's See! This Home Connection task provides an opportunity for students to observe how a large triangle can be composed of smaller triangles.

LEARNING CONNECTION 1

More Pattern Block Pets

Materials

- paper copies of students' Pattern Block Pets (completed in Working on It)
- pattern blocks
- barrier (e.g., file folder, book) (1 per pair of students)

Have students work in pairs. Explain that they will try to re-create their partner's Pattern Block Pet in one of two ways:

1. Students follow the visual example of their partner's picture (i.e., they observe their partner's picture and place pattern blocks in the same arrangement).
2. Students follow oral instructions given by their partner. Students could place a barrier (e.g., file folder, book) between them so that the student following the oral instructions is unable to see the completed picture.

LEARNING CONNECTION 2

Flower Power

Materials

- spinner made with GeoRel1.BLM3: Flower Power Spinner, a paper clip, and a pencil (1 spinner per group of students)
- GeoRel1.BLM4: Flower Power Game Board (1 per student)
- pattern blocks

Have students play Flower Power in groups of three or four. Tell students to take turns spinning the spinner on GeoRel1.BLM3: Flower Power Spinner to determine which pattern block to place on their Flower Power game board on GeoRel1.BLM4: Flower Power Game Board. Explain that if the spinner indicates a pattern block shape that cannot be placed anywhere on a player's game board, the turn passes to the next player. The game is finished when a player fills his or her game board with pattern blocks.

Variations of this game are possible:

1. Players may not move pattern blocks after they have been placed on their game board.
2. Players may move pattern blocks on their game board in order to accommodate new blocks as they are added.
3. One player spins and all players have to use that block.

LEARNING CONNECTION 3

Circus Shapes

Materials

- *Circus Shapes* by Stuart J. Murphy or a similar book about shapes
- "Pattern Block" or "Notepad" learning tools at Mathies.ca
- computer(s)

Read *Circus Shapes* by Stuart J. Murphy (New York: HarperTrophy, 1998), if available, or another book about shapes. After reading the book, discuss shapes found in the book and the ways that the illustrator used the shapes to support the story.

Have students use the "Pattern Block" or "Notepad" learning tools at Mathies.ca to create their own pictures using a variety of shapes. Print these pictures and compile them to make a class book. Have students record sentences about the pictures they create.

LEARNING CONNECTION 4

Tangram Puzzles

Materials

- GeoRel1.BLM5a-e: Tangram Puzzles (1 set per student)
- sets of tangram pieces (1 set per student)

Have students use a set of tangram pieces to fill in the outlines on GeoRel1.BLM5a–e: Tangram Puzzles.

LEARNING CONNECTION 5

Millie's Math House Shape Game

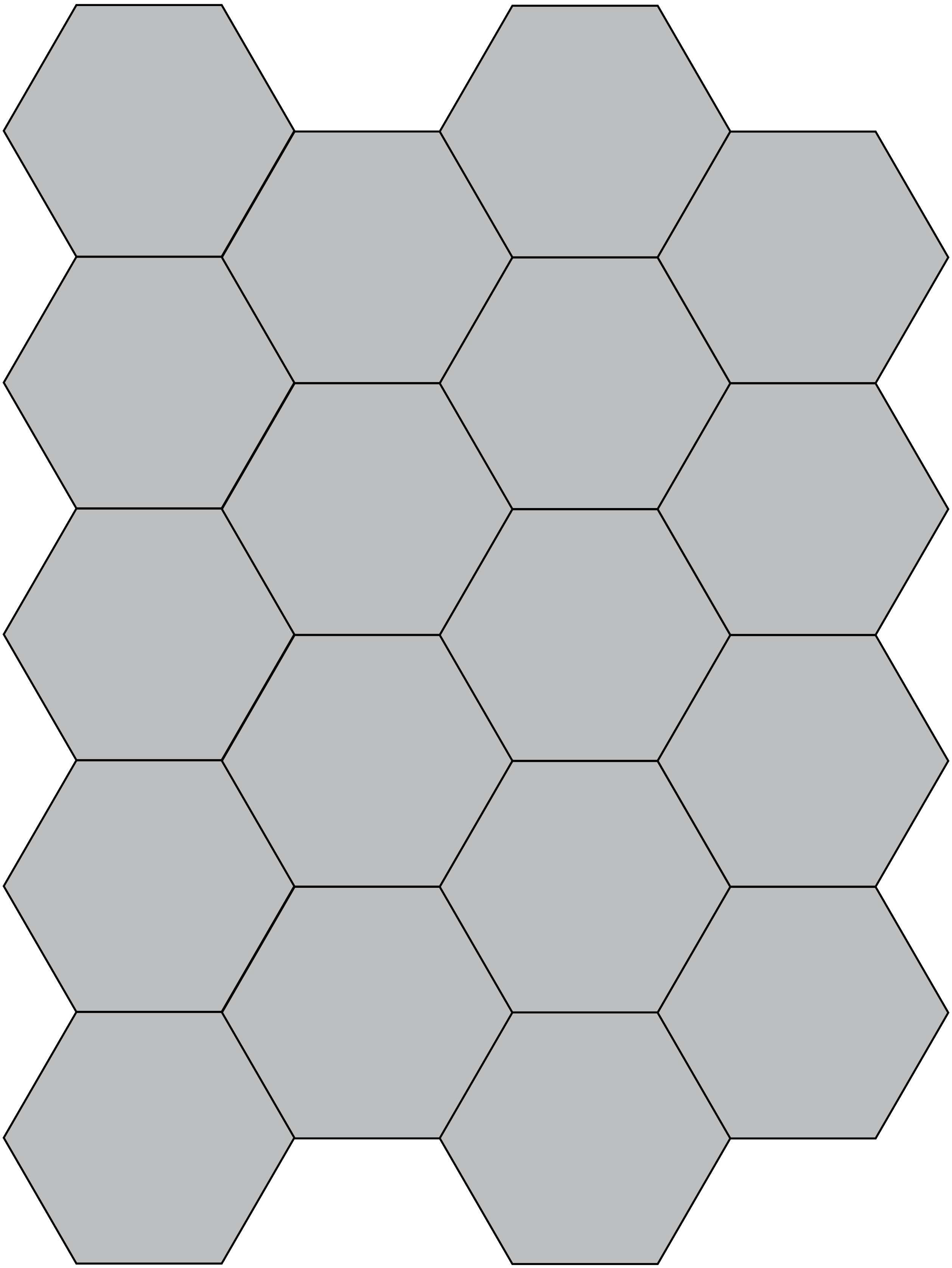
Materials

- Millie's Math House (Ministry-licensed software)
- computer(s)

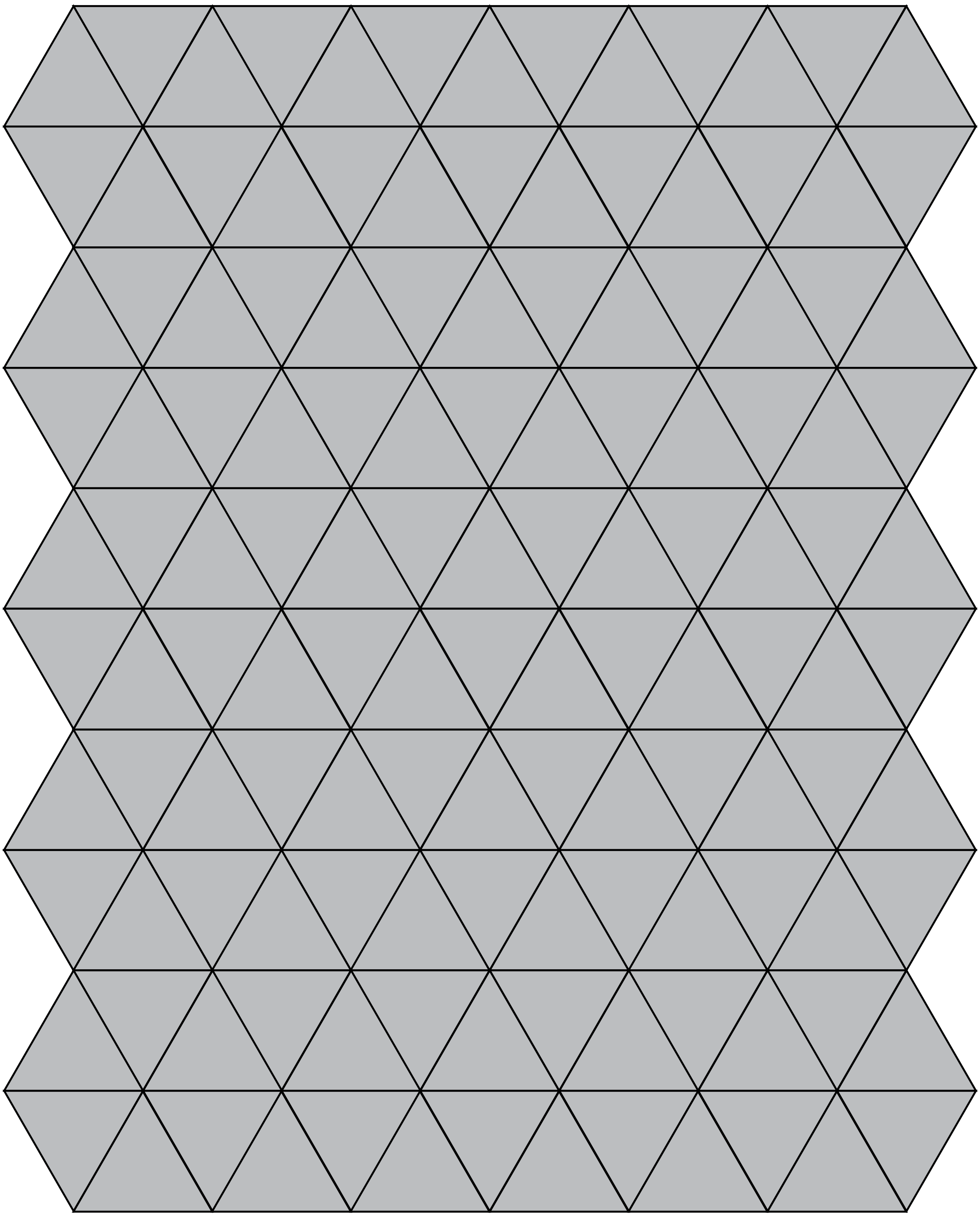
On the opening screen, have students click the house made of shapes. This option takes students to a section of the program that allows them to create pictures using two-dimensional shapes. There are three kinds of tasks:

1. Students can drag two-dimensional shapes from the menu on the left onto complex pictures consisting of outlines.
2. Students can use a greater number of shapes to cover outlines that are more complex, that is, outlines that require more shapes and shapes that have different attributes (e.g., different sizes) from those in the first task.
3. Students can create their own pictures using available shapes.

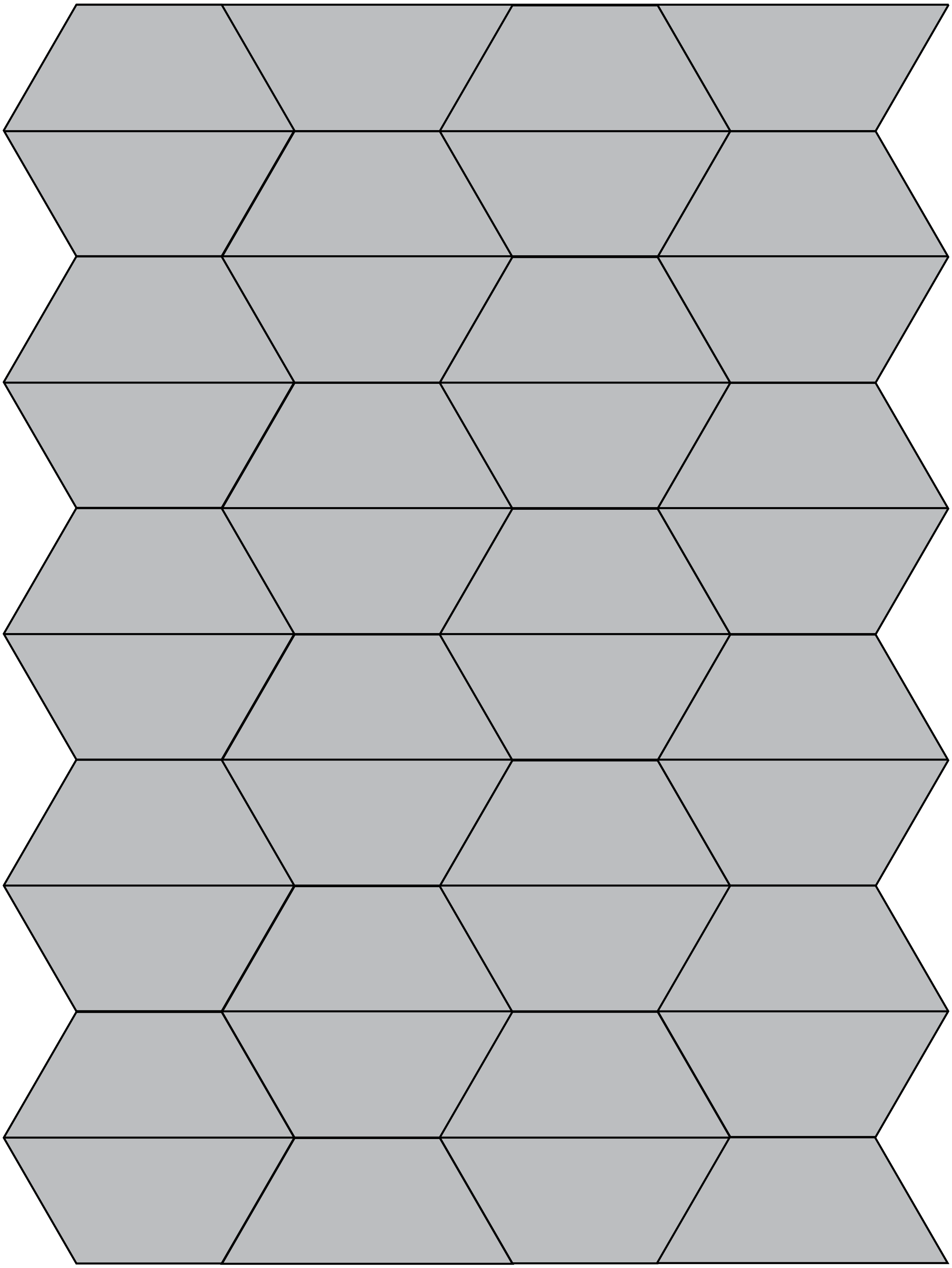
Pattern Block Shapes – Hexagons



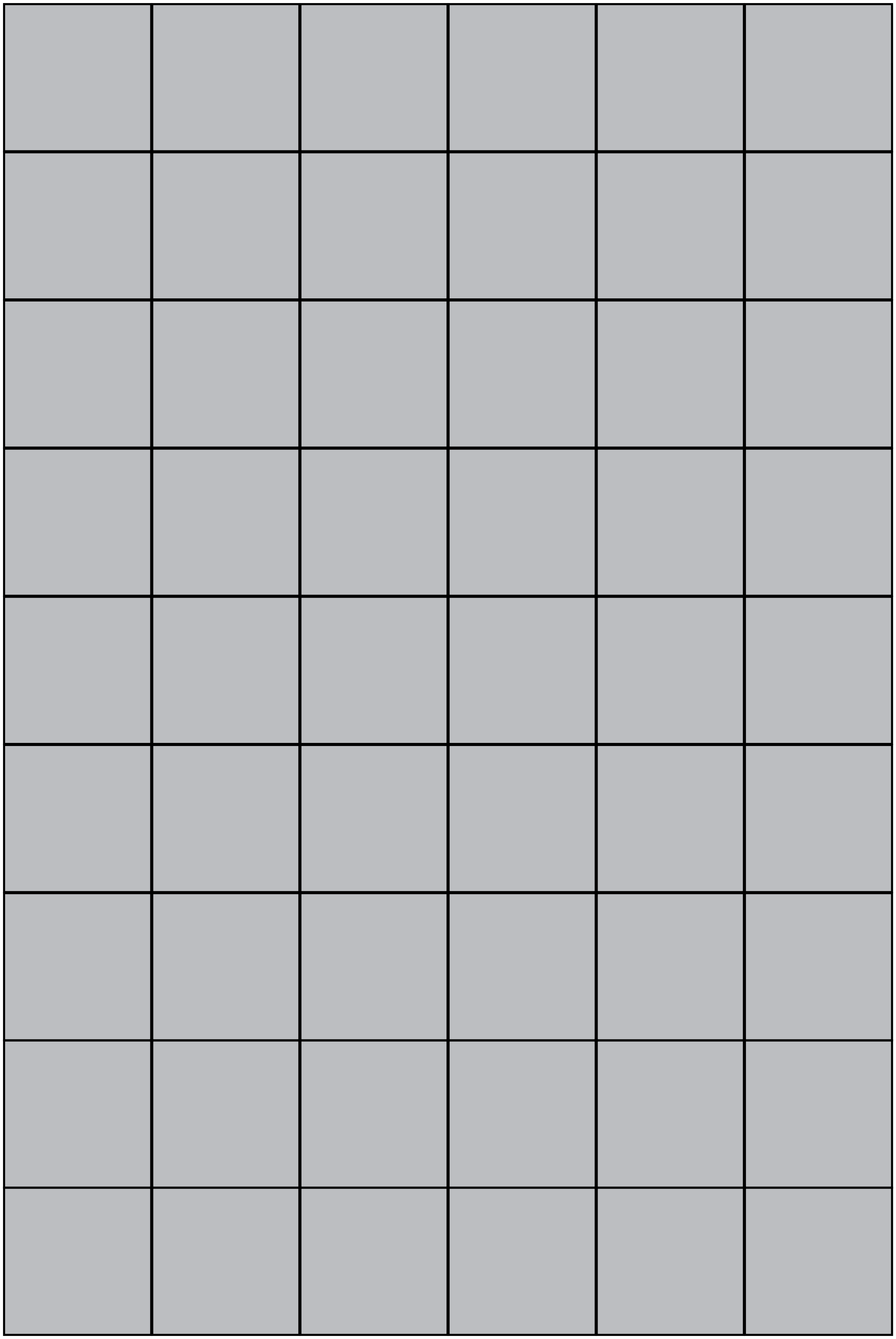
Pattern Block Shapes – Triangles



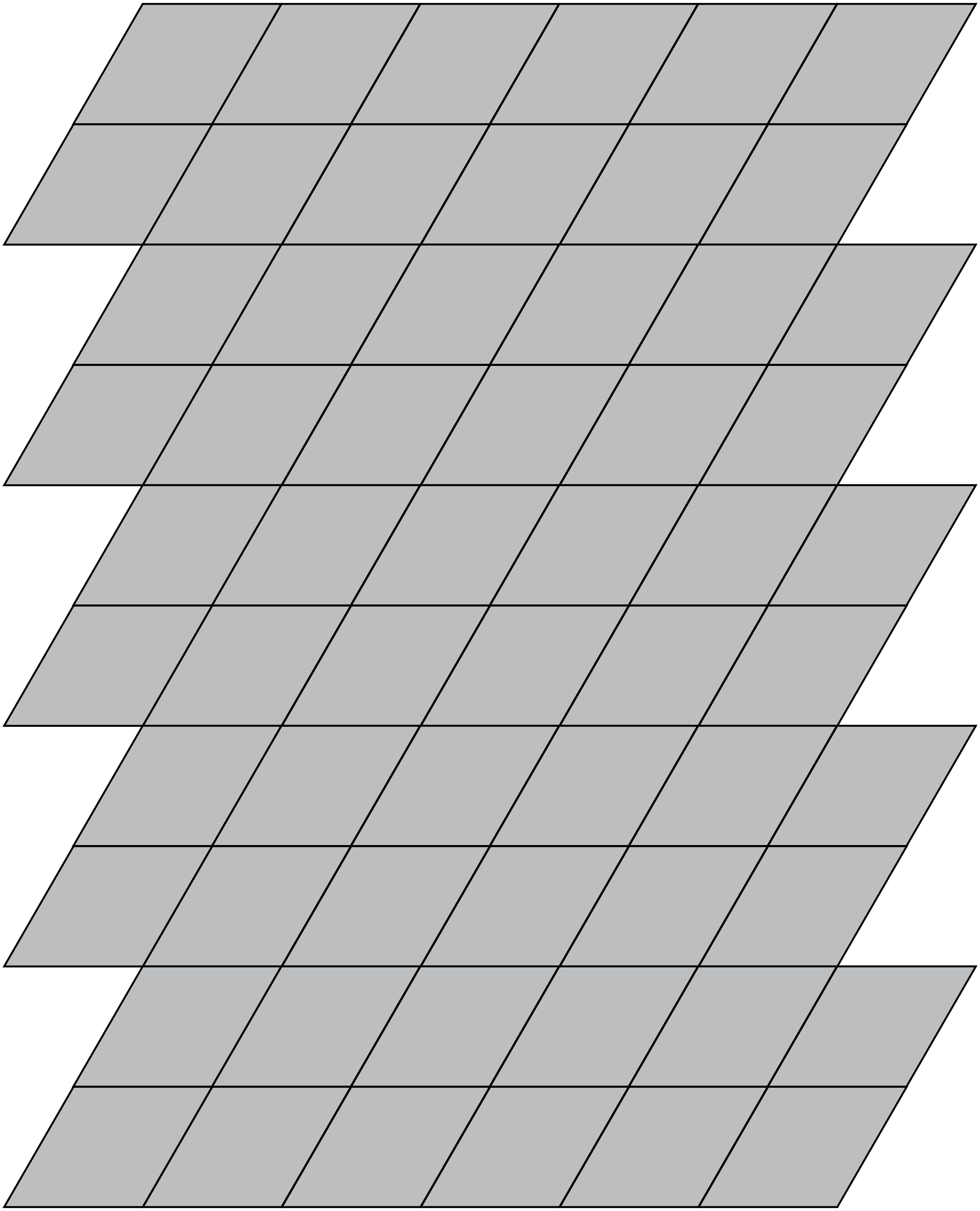
Pattern Block Shapes – Trapezoids



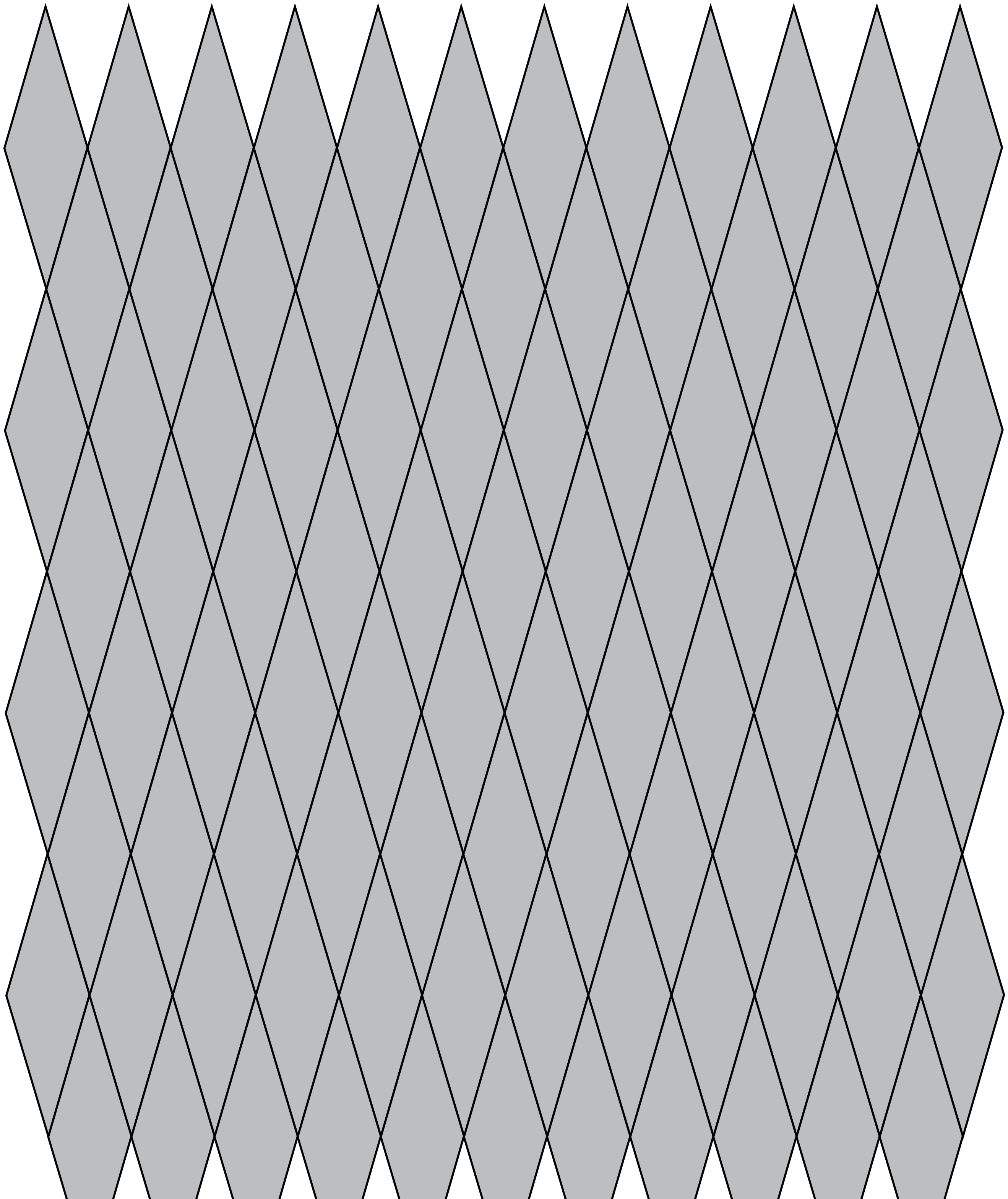
Pattern Block Shapes – Squares



Pattern Block Shapes – Large Rhombuses



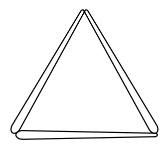
Pattern Block Shapes – Small Rhombuses



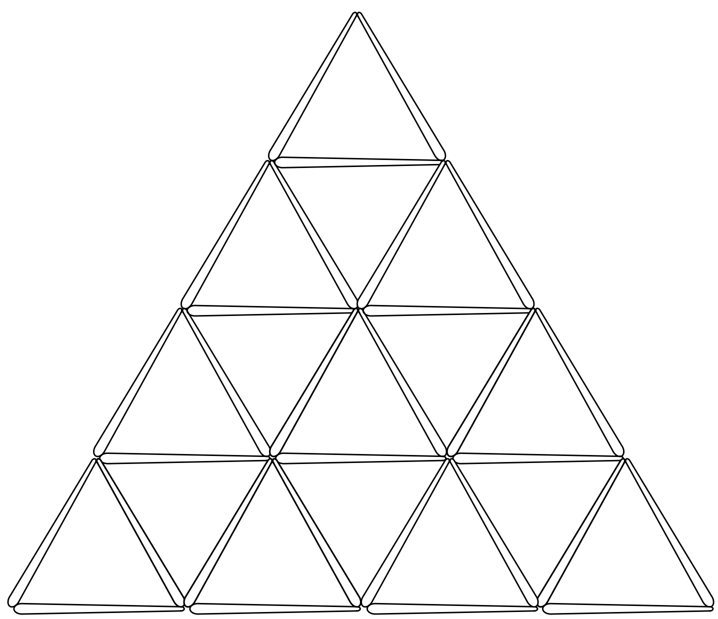
First You, Then Me.
How Many Triangles? Let's See!

Dear Parent/Guardian:

Try this activity with your child. Together, use toothpicks (or drinking straws) to build a triangular arrangement. Start by making a small triangle with three toothpicks.



Next, you and your child take turns adding toothpicks to the triangular arrangement. Continue to add toothpicks until you have created a triangular arrangement like the one pictured below.



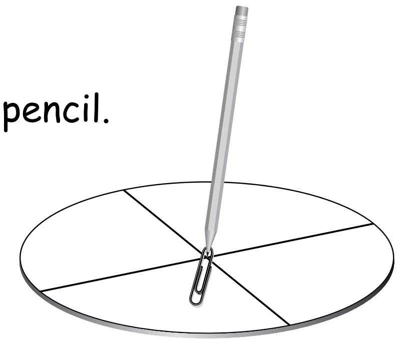
Ask your child to estimate the number of small triangles in the triangular arrangement. Then have your child count the small triangles to check his or her estimate.

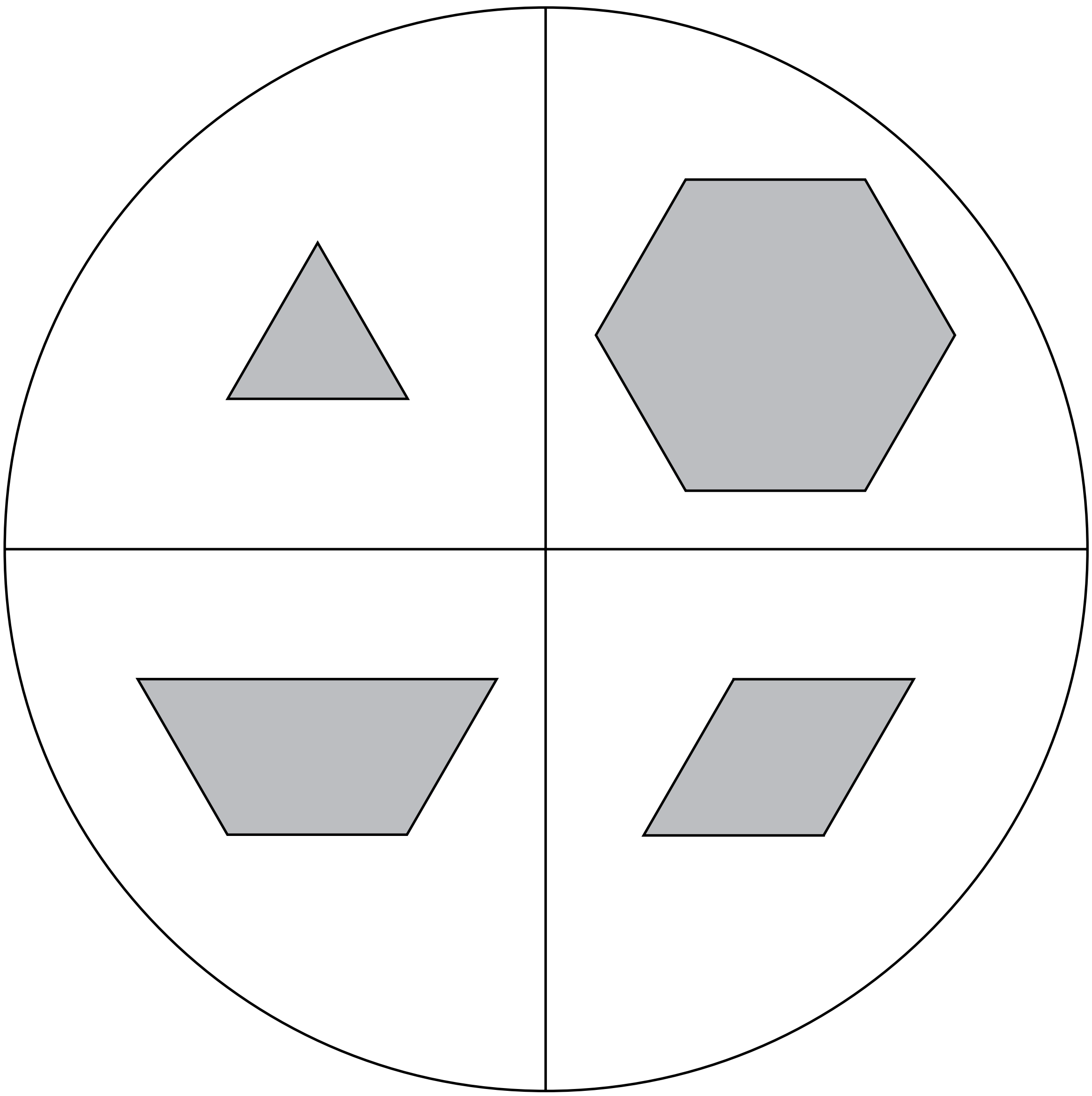
Now take turns removing the toothpicks, one at a time. As each toothpick is removed, keep track of the number of small triangles that are still in the arrangement.

GeoRel1.BLM3

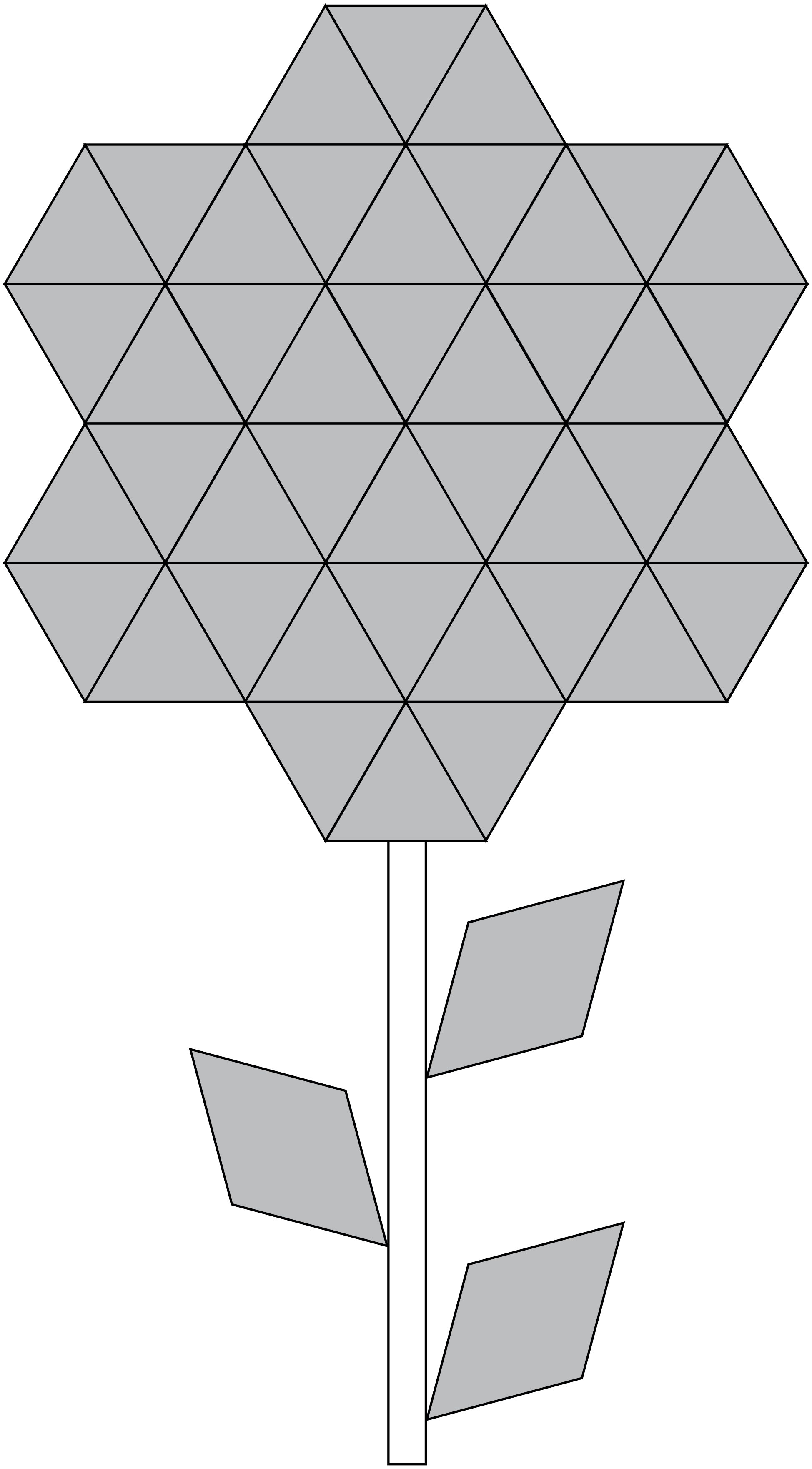
Flower Power Spinner

Make a spinner using this page, a paper clip, and a pencil.



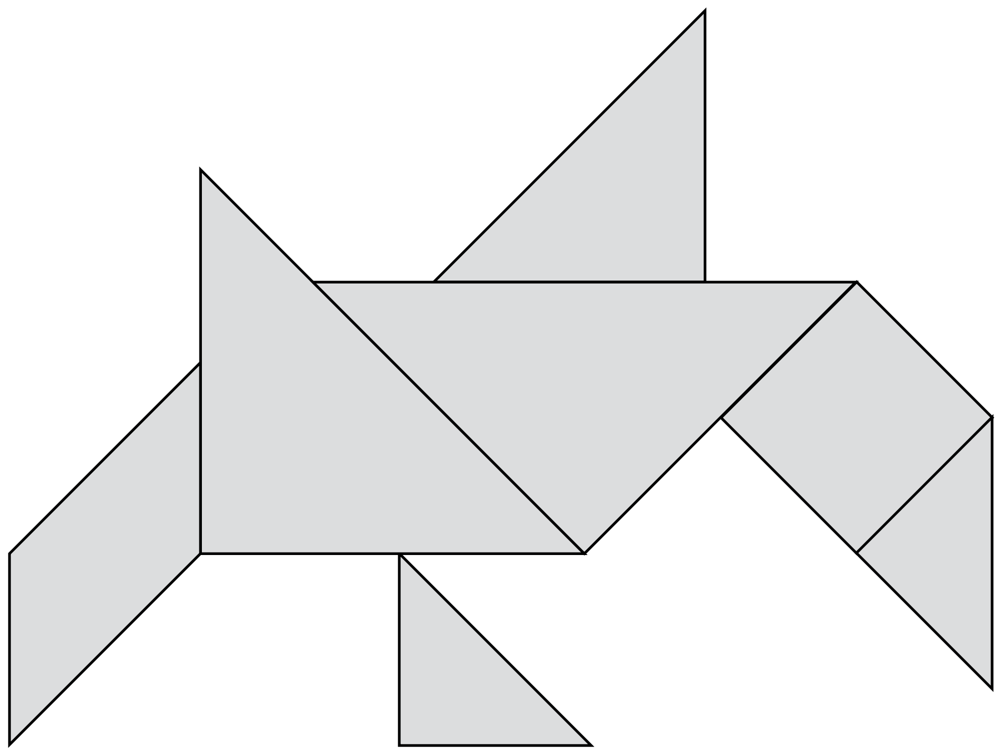


Flower Power Game Board



Tangram Puzzles

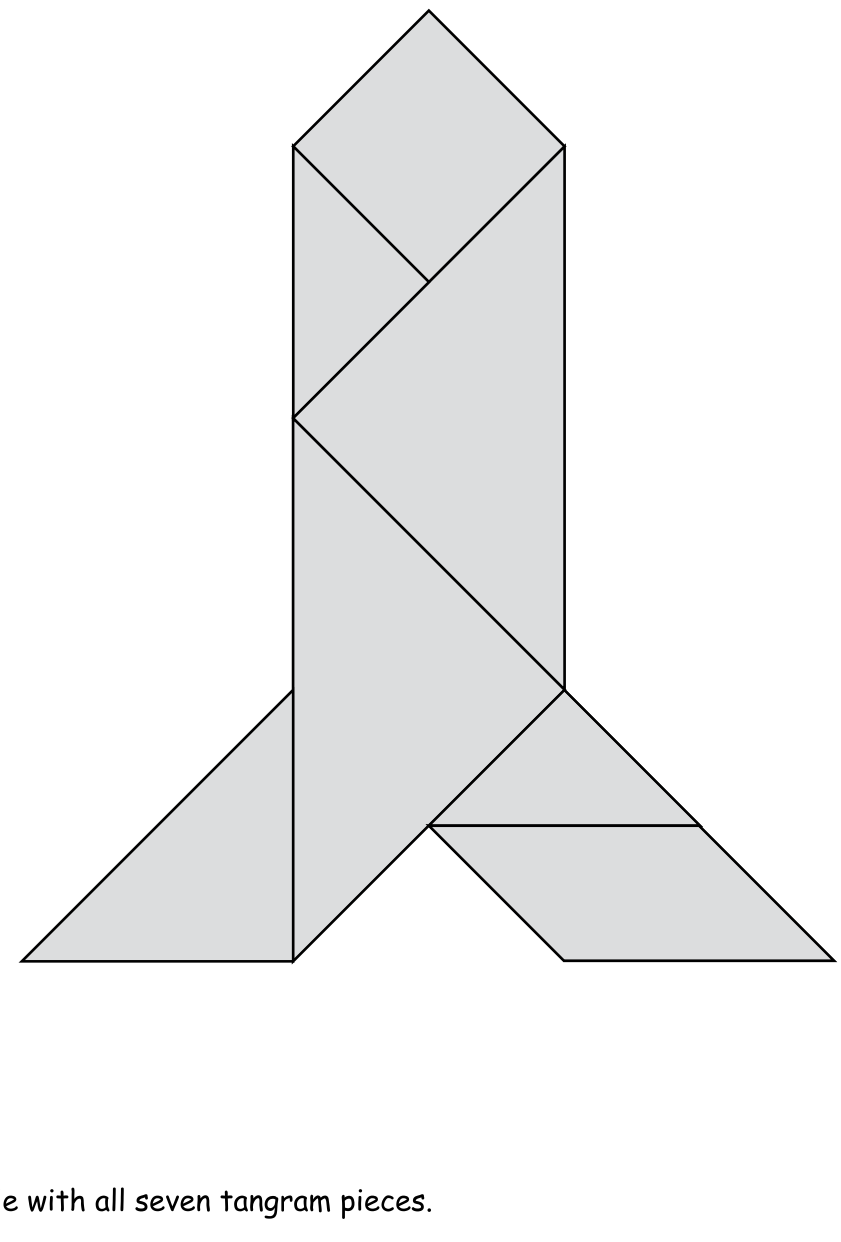
What am I?



Cover this puzzle with all seven tangram pieces.

Tangram Puzzles

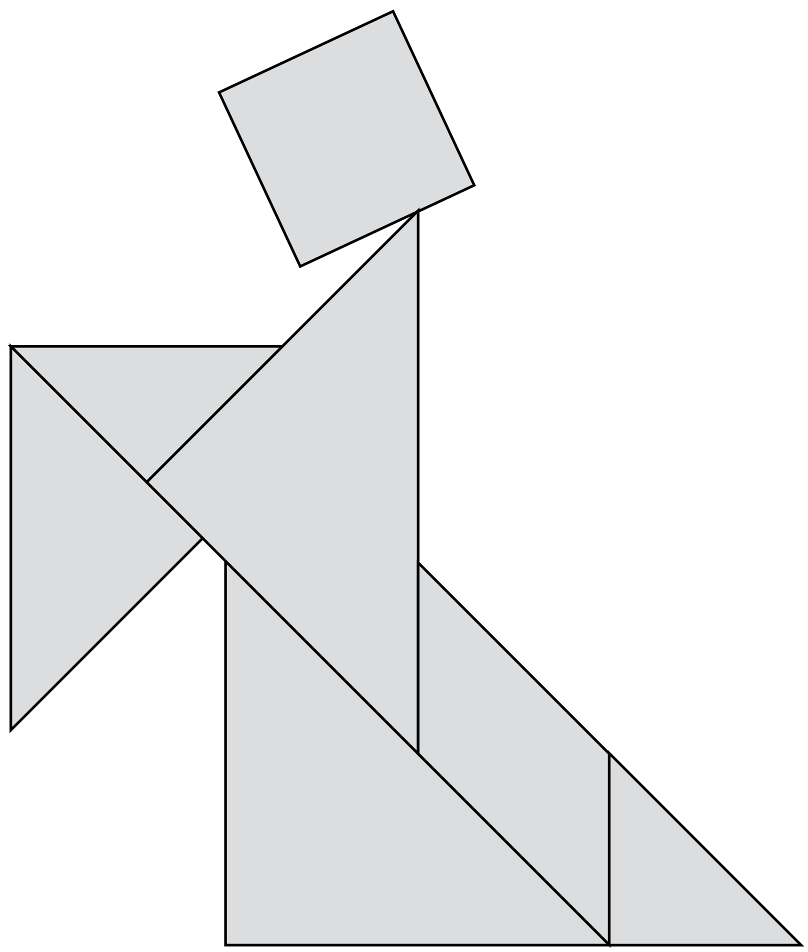
What am I?



Cover this puzzle with all seven tangram pieces.

Tangram Puzzles

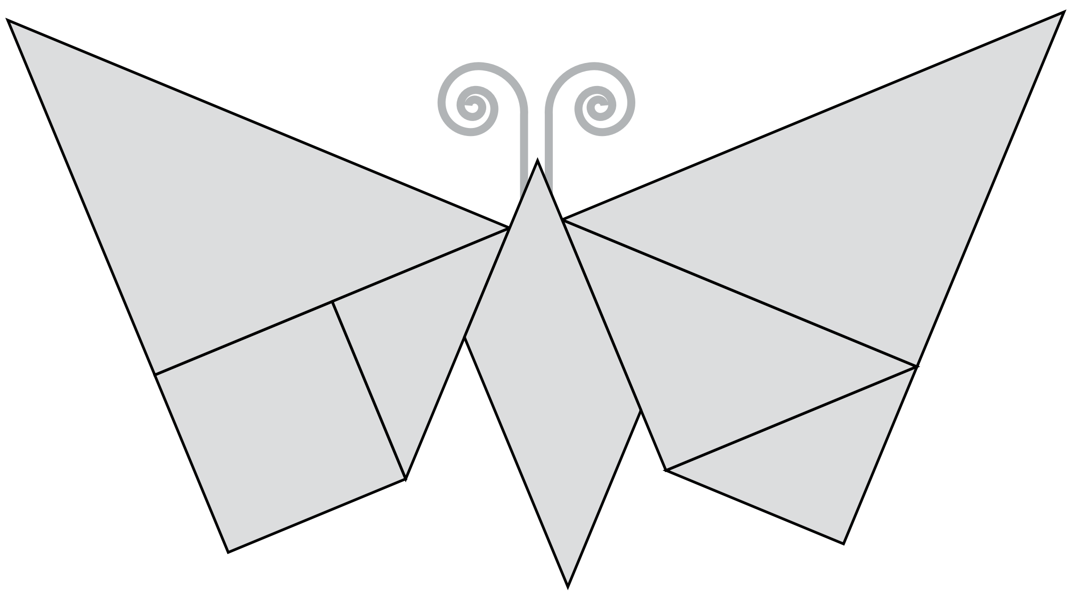
What am I?



Cover this puzzle with all seven tangram pieces.

Tangram Puzzles

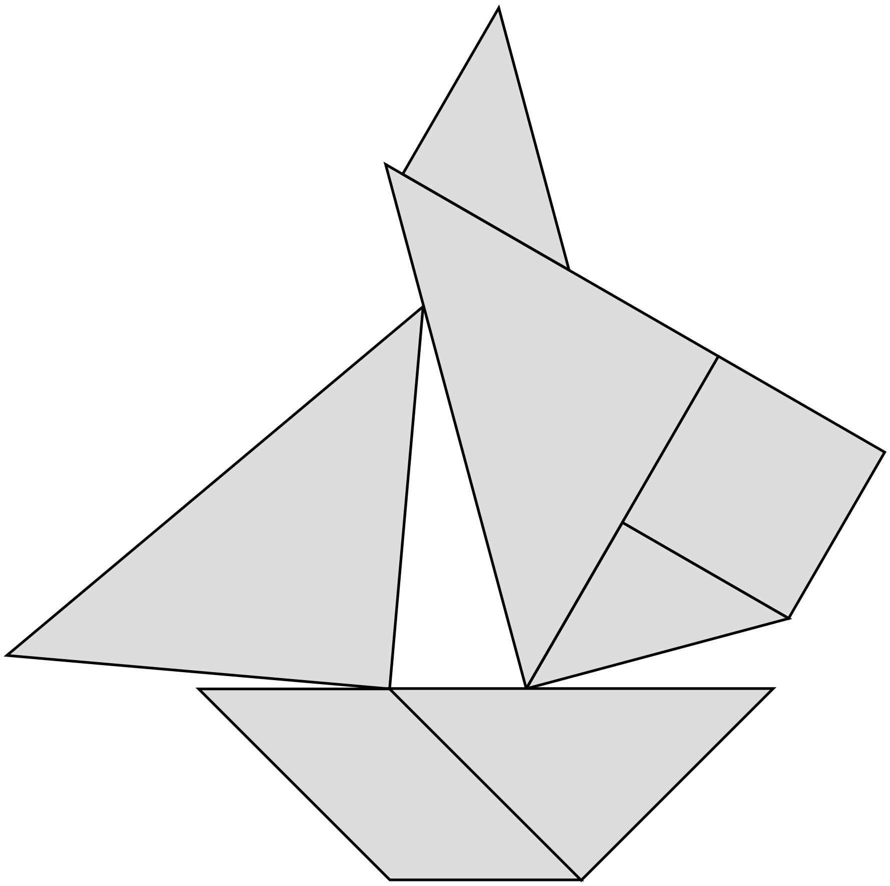
What am I?



Cover this puzzle with all seven tangram pieces.

Tangram Puzzles

What am I?



Cover this puzzle with all seven tangram pieces.

Simply Symmetrical

BIG IDEA **Location and Movement**

CURRICULUM EXPECTATIONS

Students will:

- describe the relative locations of objects or people using positional language (e.g., over, under, above, below, in front of, behind, inside, outside, beside, between, along);
- create symmetrical designs and pictures, using concrete materials (e.g., pattern blocks, connecting cubes, paper for folding), and describe the relative locations of the parts.

MATERIALS

- symmetrical pictures, designs, and logos (on clothing, wallpaper, fabric, etc.)
- non-symmetrical pictures, designs, and logos
- ruler
- Loc1.BLM1: Line of Symmetry (1 per student)
- 1 transparency of Loc1.BLM1: Line of Symmetry
- pattern blocks (each student must have same set as teacher)
- overhead projector
- 8.5 in. x 11 in. (letter-sized) paper (1 sheet per student)
- pattern block stickers, pattern block stamps, or copies of Loc1.BLM2a–f: Pattern Block Shapes
- glue
- Loc1.BLM3a-c: Symmetry Memory (1 per student)

ABOUT THE MATH

Young students are intrigued by the symmetrical designs and pictures they observe in their environment. In Grade 1, students can describe symmetry in simple terms. They might explain, for example, that symmetry is like "looking in a mirror" because one half of a picture or design is the same as the other.

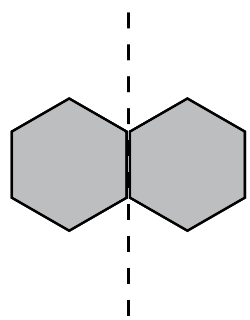
The following tasks provide students with experiences that allow them to develop an understanding of a line of symmetry. As students find, create, and discuss symmetrical designs, they learn to recognize that a line of symmetry separates the design into two parts, and they begin to understand that one part is the reflection, or mirror image, of the other. As students create and discuss symmetrical designs, they recognize the symmetry in their creations and use positional language (e.g., beside, above, next to) to communicate the arrangement of symmetrical parts in their designs.

GETTING STARTED

Show students some symmetrical pictures, designs, and logos. Fold, draw a line, or use a ruler to show the line of symmetry on each picture, design, or logo. Ask students to describe what you are doing and what they notice. Discuss with students the idea of symmetry (i.e., how one half of the picture, design, or logo matches the other half).

Next, show some pictures, designs, and logos that are not symmetrical. Repeat the process of trying to fold, draw, or use a ruler to determine symmetry. Ask students to describe what they notice. Have them explain how they know that the pictures, designs, and logos are non-symmetrical.

Provide students with pattern blocks, and give each student a copy of Loc1.BLM1: Line of Symmetry. Place a transparency of the same page on the overhead projector, or create a similar workspace on an interactive whiteboard. Set a pattern block on one side of the line of symmetry on the transparency. Instruct students to place the same type of pattern block on their papers to match the position of the pattern block on the overhead. Next, ask a student to place another pattern block on the overhead projector to demonstrate symmetry. Instruct students to do the same on their paper.



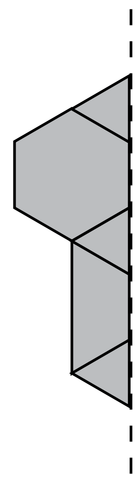
Remove the first two blocks. Place a different pattern block on one side of the line of symmetry on the overhead projector, and direct students to place the same block on their page to match the position on the overhead. Then ask students to set another block on their page to demonstrate symmetry.

Repeat the task using different pattern blocks. Gradually increase the number of pattern blocks, placing two, three, and four blocks on one side of the line of symmetry. Challenge students to complete the symmetrical design on their sheet of paper.

Have students check their work by comparing their designs with ones you complete on the overhead. Occasionally, place a shape in an incorrect position so that your design is not symmetrical. Ask students to explain how they know whether the block designs are symmetrical.

WORKING ON IT

Arrange students in pairs. Instruct each student to select up to five pattern blocks and to place them along one side of the line of symmetry on Loc1.BLM1: Line of Symmetry. Encourage students to arrange the blocks so that sides are touching.



Next, have students change places and complete the design their partner started so that the completed design is symmetrical. Ask students to examine each other's completed designs to check that they are symmetrical.

Allow students to repeat the task using different arrangements of pattern blocks.

Before concluding the task, have students re-create one of their symmetrical designs on a sheet of paper using pattern block stamps, pattern block stickers, or shapes cut from Loc2.BLM2a–f: Pattern Block Shapes.

REFLECTING AND CONNECTING

Have students show their designs to classmates, and ask them to describe the symmetry in their work. Ask students the following questions:

- "What shapes do you see in this design?"
- "Why is this design symmetrical? How can you show that it is symmetrical?"
- "What was difficult about making your design symmetrical?"

ADAPTATIONS/EXTENSIONS

Some students may have difficulty creating and describing designs as the number of pattern blocks increases. For these students, suggest that they use only a few pattern blocks to make simple symmetrical designs.

Challenge students to use a small plastic container to scoop pattern blocks from a large bin. Instruct students to create a symmetrical design using as many of the scooped pattern blocks as possible.

MATH LANGUAGE

- symmetrical
- non-symmetrical
- line of symmetry
- triangle
- square
- rhombus
- trapezoid
- hexagon

positional language, such as:

- above
- beside
- to the right of
- between

SAMPLE SUCCESS CRITERIA

- completes a symmetrical design using concrete materials, and explains why it is symmetrical using appropriate mathematical language
- identifies the line of symmetry in a symmetrical design
- uses a line of symmetry to create a symmetrical design (i.e., places pattern blocks on both sides of a line to demonstrate symmetry)
- describes a symmetrical design using appropriate positional language (e.g., beside, above, between)

HOME CONNECTION

Send home Loc.1BLM3a-c: Symmetry Memory. This Home Connection game helps students to recognize symmetrical shapes.

LEARNING CONNECTION 1

Symmetrical Mosaic Designs

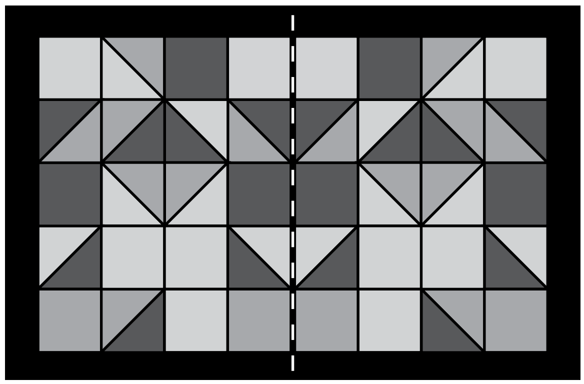
Materials

- neon-coloured paper (or construction paper) squares of different sizes and different colours
- glue
- scissors
- black construction paper (1 sheet per pair of students)

Have pairs of students work together to create a symmetrical mosaic design using shapes cut from neon-coloured paper (or construction paper) and glued onto black construction paper.

Instruct students to fold the black construction paper in half to create a line of symmetry before gluing on the shapes. Allow students to use square shapes or to cut the squares into triangles.

To begin, explain that one student glues a shape (e.g., a pink triangle) on one side of the line of symmetry, and the partner glues the same shape (a pink triangle) on the other side of the line to create a symmetrical design. Have partners take turns until they finish their symmetrical mosaic design.



LEARNING CONNECTION 2

Monster Mash

Materials
- 8.5 in. x 11 in. (letter-sized) paper (1 per student)
- paint
- paintbrushes
- markers
- scissors

Have students fold a sheet of paper in half to create a line of symmetry. Tell students to unfold the paper and use a paintbrush to dab different colours of paint on only one side of the line of symmetry. Next, have students fold the paper again along the line of symmetry and mash the paint to create their picture. Tell students to open the paper carefully to see the monster they have created. Ask students to describe the symmetry in their monsters.

Allow students to outline and decorate their monsters using markers, and then cut out the monsters.

LEARNING CONNECTION 3

Hoops Here, There, and Everywhere

Materials
- hoops (1 per student)

Do this task in the gymnasium. Provide each student with a hoop. Instruct students to find a place in which they have room to move and use their hoop without touching anyone else.

Provide oral instructions that promote students' understanding of positional language:
- "Place your hoop above your head."
- "Stand inside your hoop."
- "Stand beside your hoop."
- "Twirl your hoop beside you on the right."
- "Jump in and out of your hoop."
- "Hop, skip, or jump around the outside of your hoop."
- "Find a partner and put your hoops beside each other's."
- "Put your hoops on top of each other's."

Provide opportunities for students to give directions to their classmates.

LEARNING CONNECTION 4

Follow Me and Then We'll See

Materials
- pattern blocks
- barrier (e.g., file folder, book)

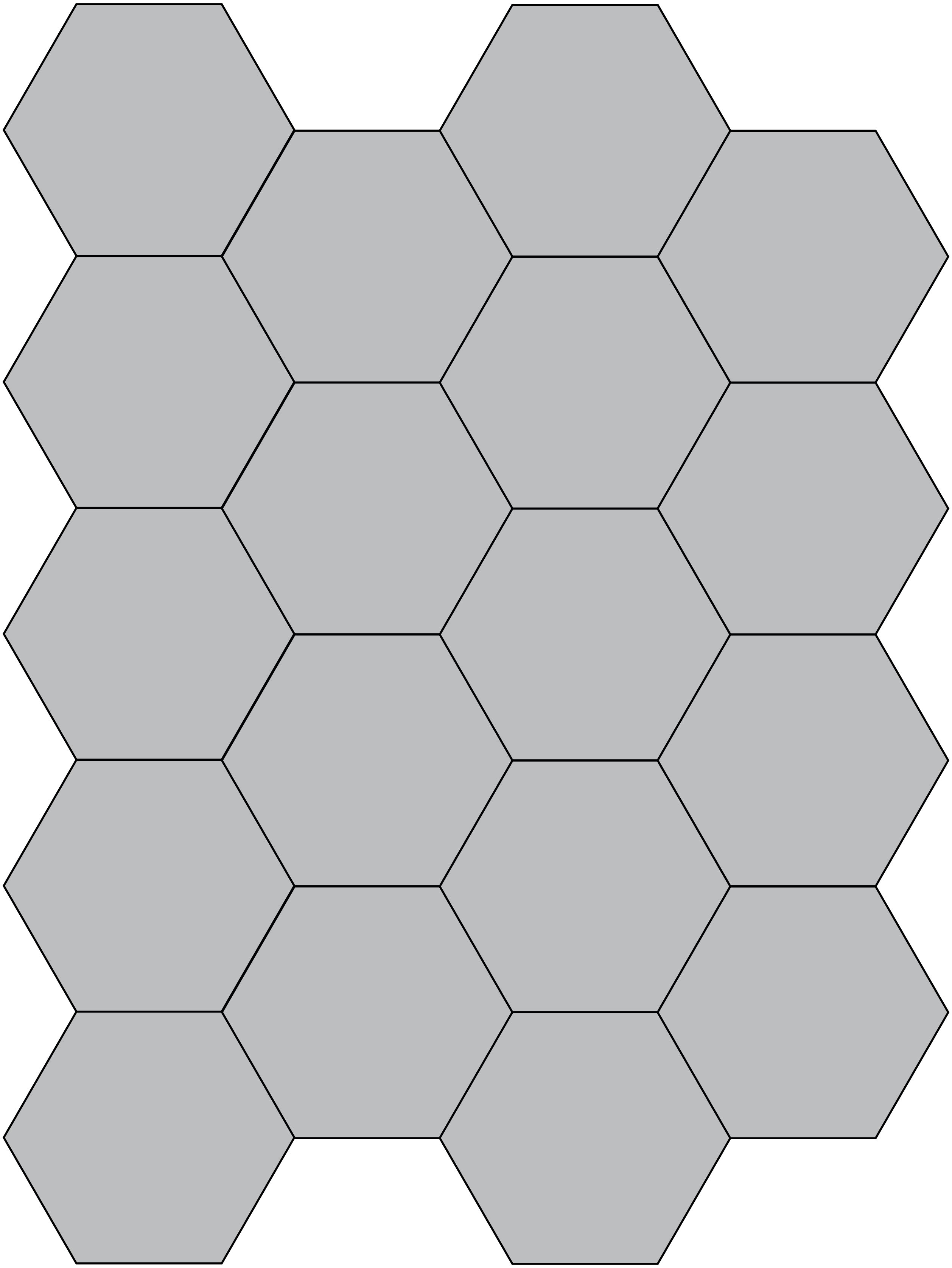
Create a simple design with pattern blocks behind a barrier (e.g., file folder, book) so that students do not see what you are doing. Give students oral directions to re-create the design. For example, you might say, "Place a hexagon in the middle of your paper. Place a triangle on the right side of the hexagon. Place a triangle on the left side of the hexagon."

When all the directions have been given, have students examine their classmates' work for similarities and differences. Encourage students to discuss possible reasons for any differences. Show students the design you created and described.

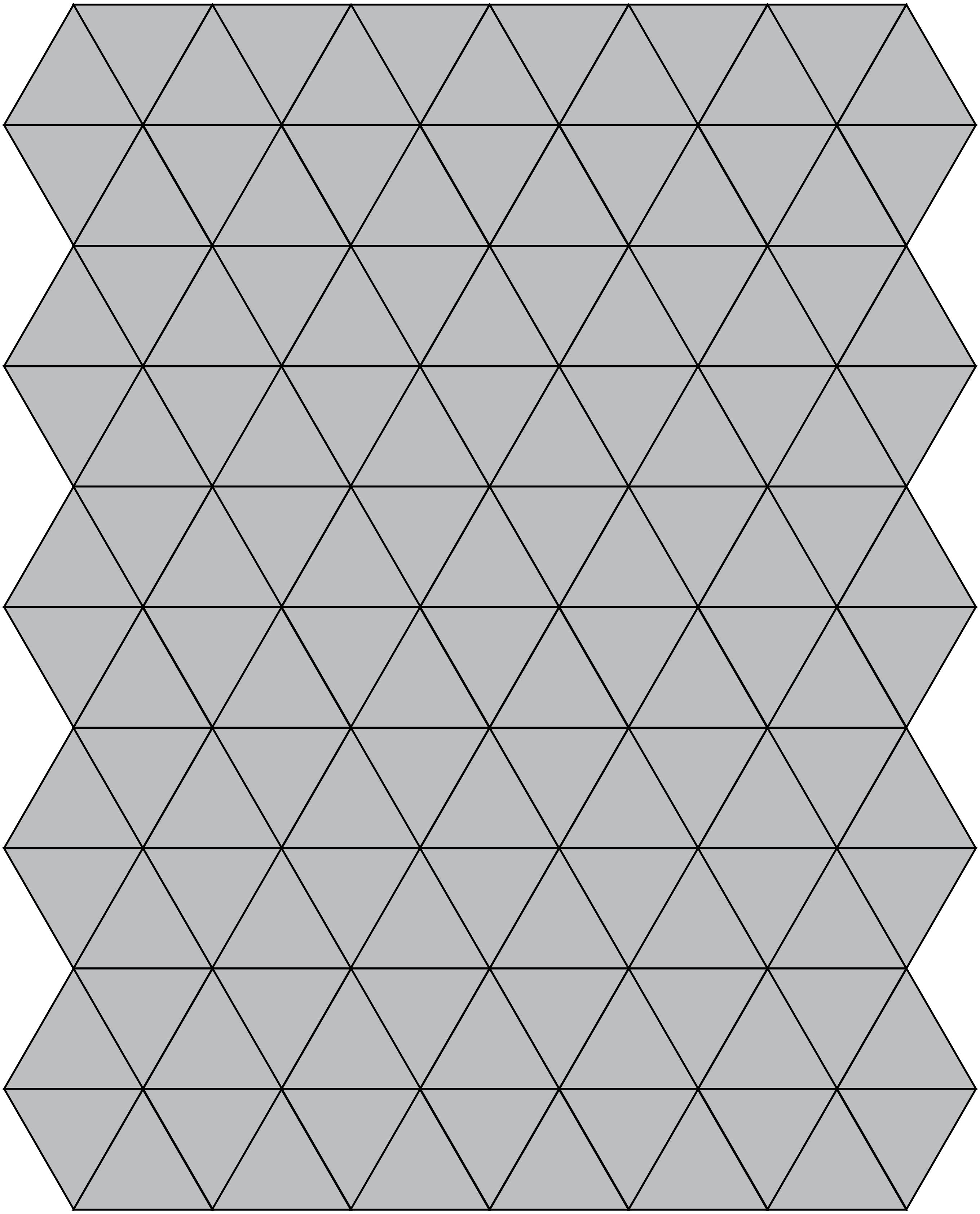
Provide opportunities for individual students to create a pattern block design and to give oral instructions to classmates on how to re-create it.

Line of Symmetry

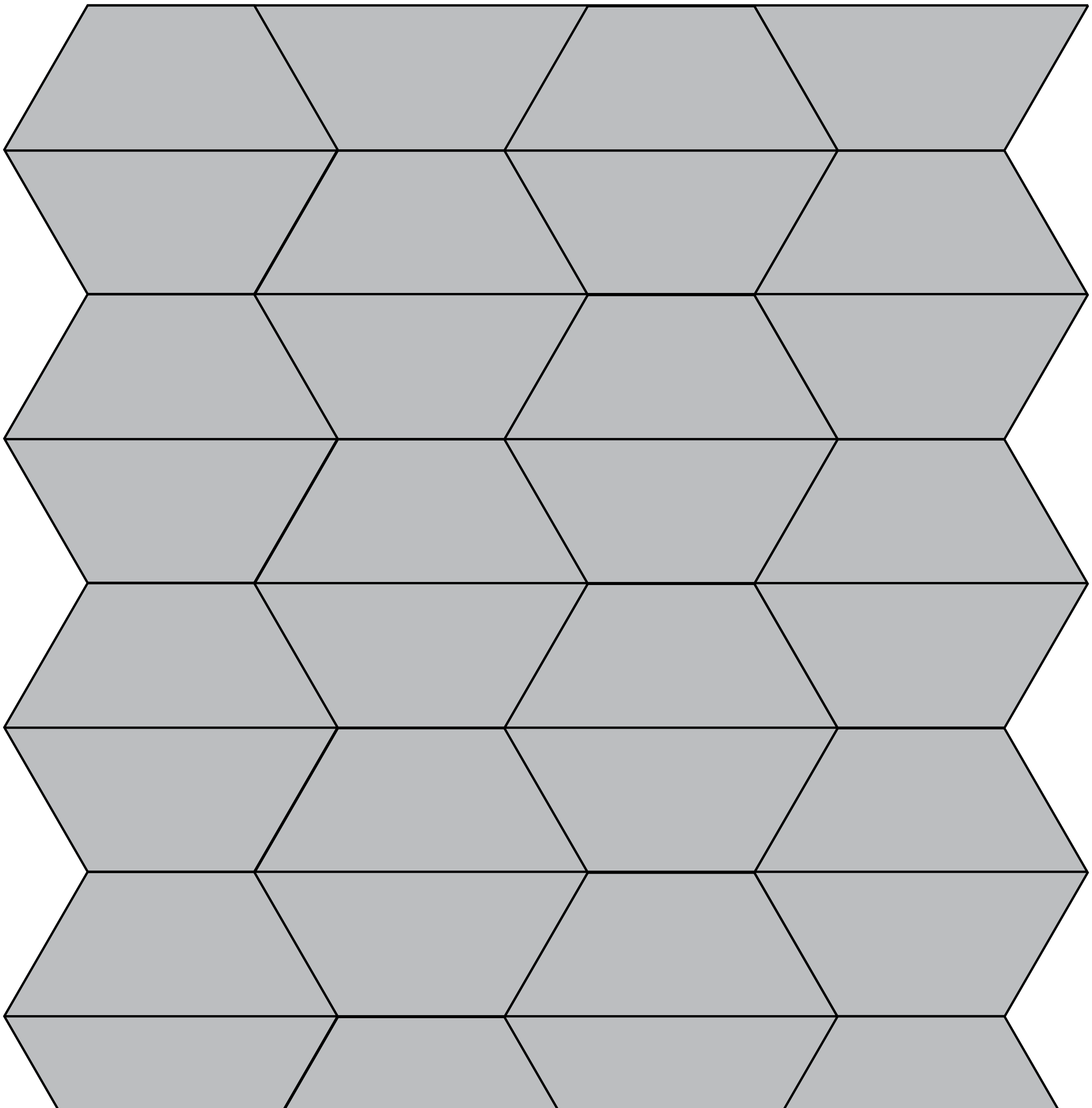
Pattern Block Shapes – Hexagons



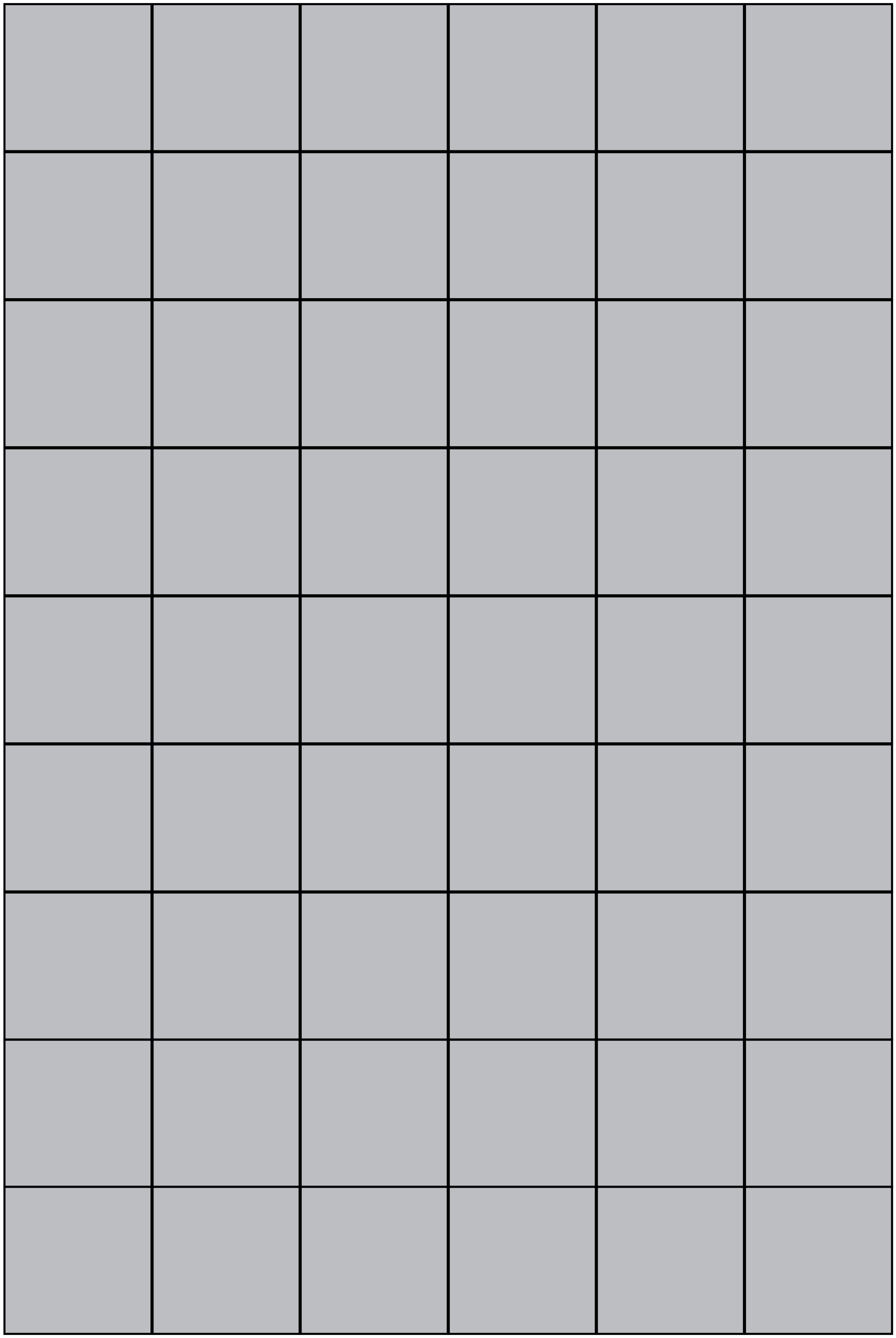
Pattern Block Shapes – Triangles



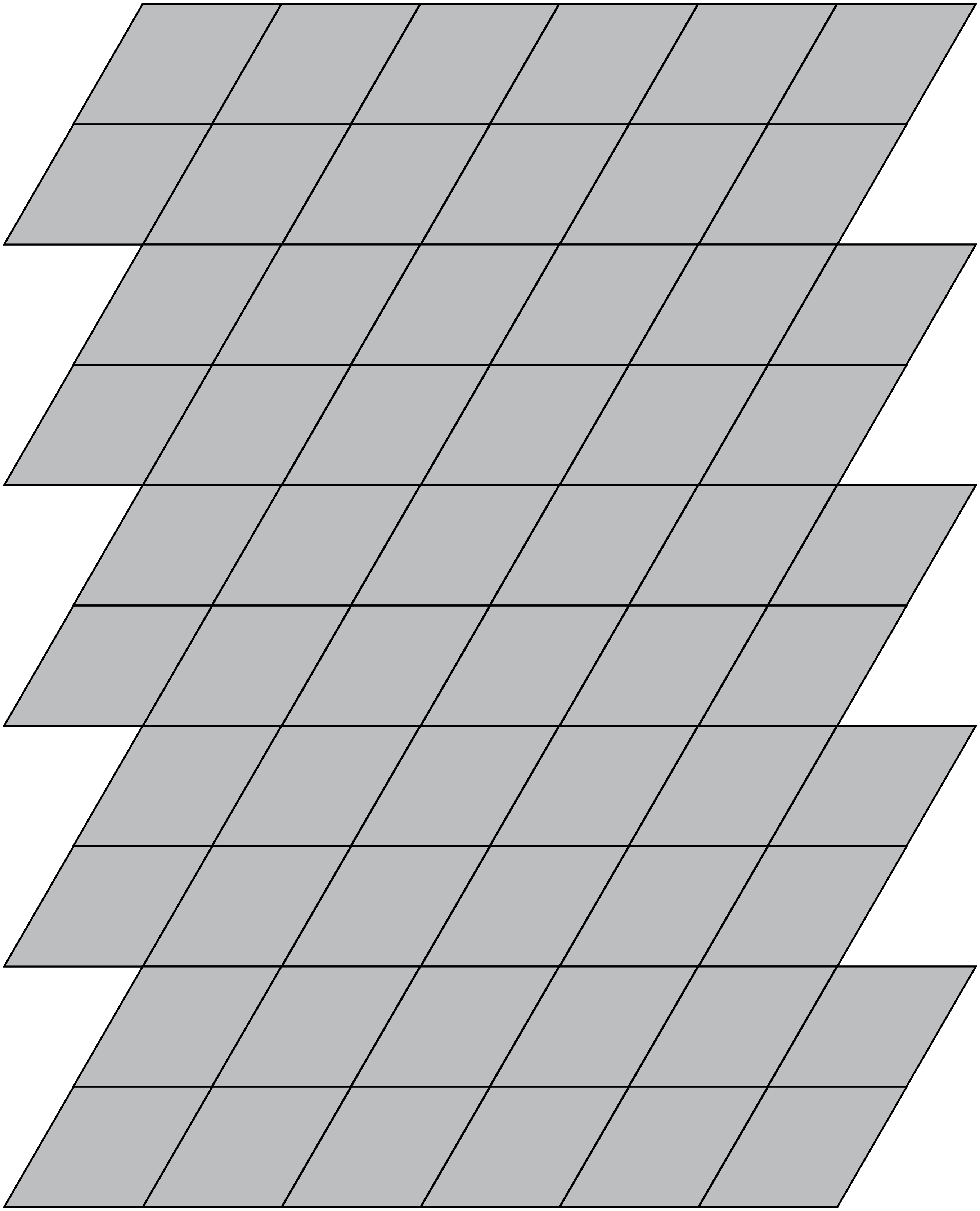
Pattern Block Shapes – Trapezoids



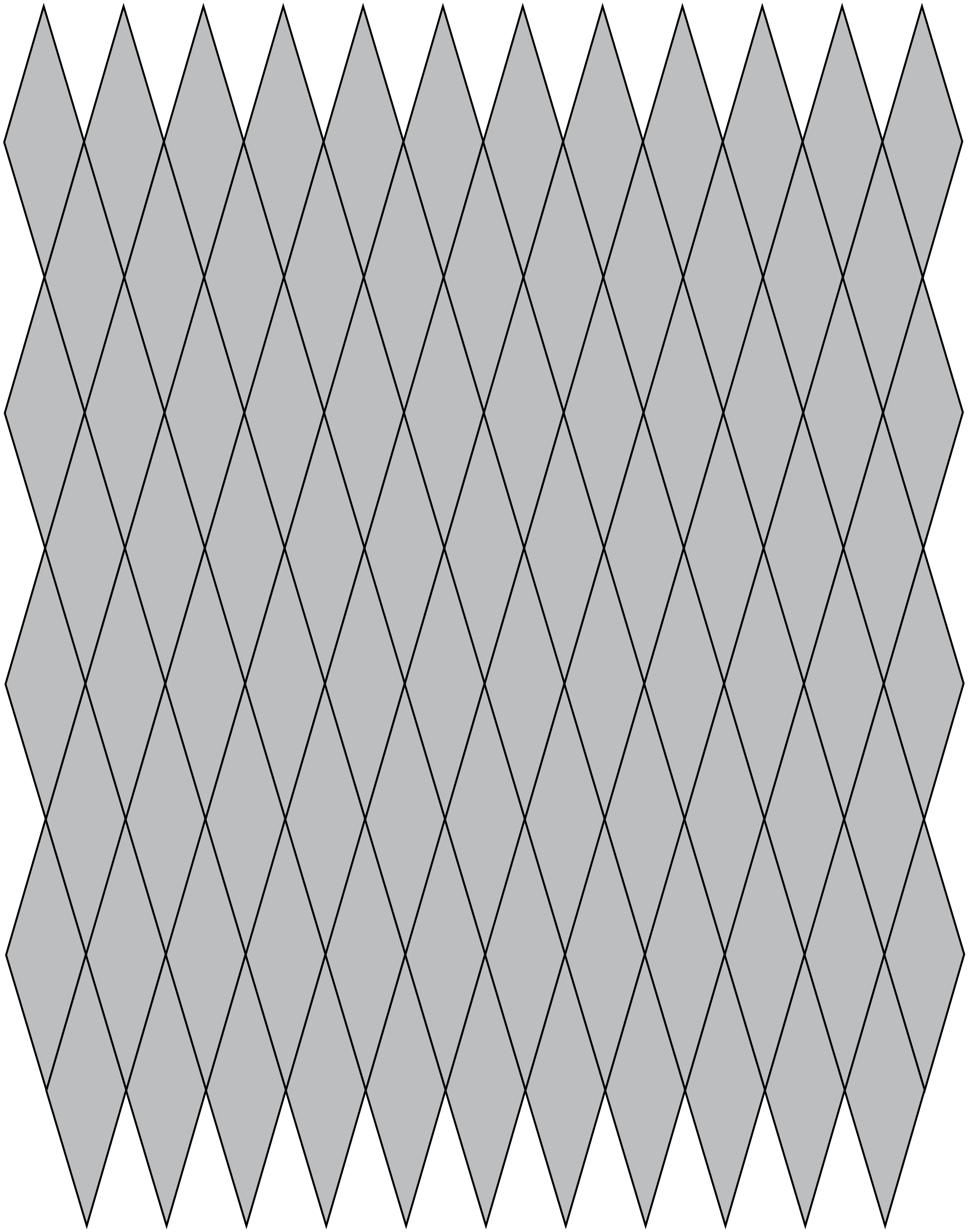
Pattern Block Shapes – Squares



Pattern Block Shapes – Large Rhombuses



Pattern Block Shapes – Small Rhombuses

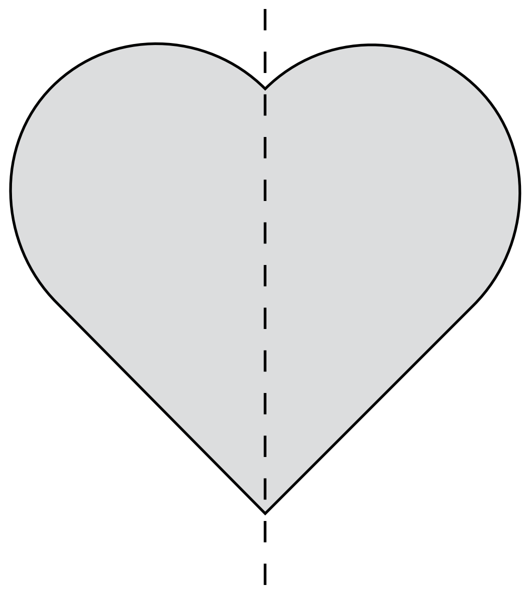


Symmetry Memory

Dear Parent/Guardian:

Our class has been learning about symmetry.

A shape is symmetrical if one half of the shape is a mirror image of the other half.



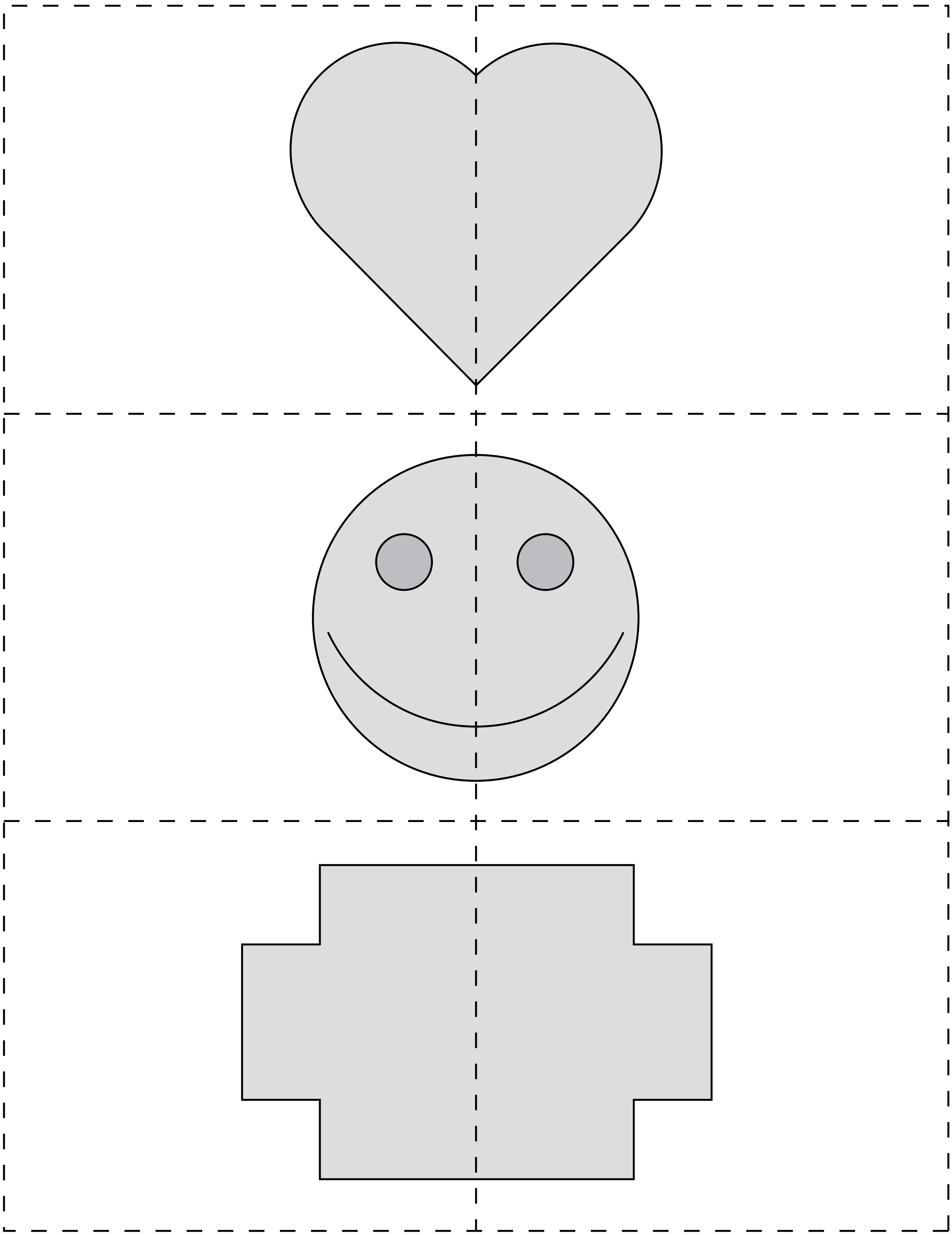
Play the Symmetry Memory game with your child. Cut out the cards on the attached sheets of paper. Each card contains half a picture.

Shuffle the cards and place them face down in a row in front of your child and you.

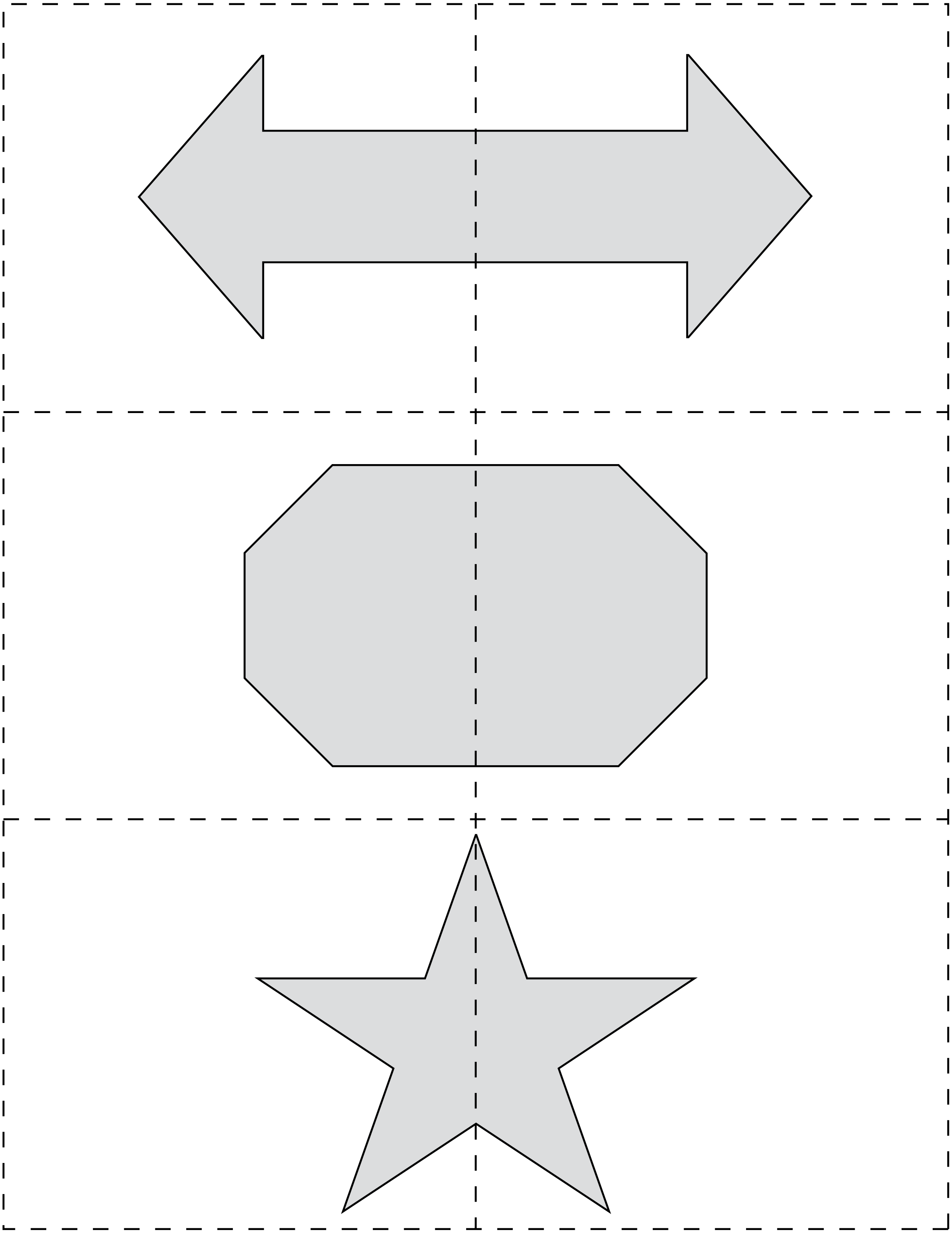
Take turns flipping over two cards. If a player turns over two cards that can be put together to make a symmetrical shape, the player keeps both cards. If the cards do not make a symmetrical shape, the player turns them over again so that each card is in its original position.

The game is finished when all cards have been matched.

Symmetry Memory Cards



Symmetry Memory Cards



B. Grade 2 Learning Activities

Appendix Contents

Polygons on Parade

BIG IDEA ***Geometric Properties of Two-Dimensional Shapes***

CURRICULUM EXPECTATIONS

Students will:

- identify and describe various polygons (i.e., triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons) and sort and classify them by their geometric properties (i.e., number of sides or number of vertices), using concrete materials and pictorial representations (e.g., "I put all the figures with five or more vertices in one group, and all the figures with fewer than five vertices in another group.").

MATERIALS

- 5 x 5 geoboards (1 per student)
- geobands (elastic bands) (1 per student)
- Prop2D2.BLM1: Polygons on Parade (1 per student)
- pencils
- rulers (1 per student)
- Prop2D2.BLM2: Plenty of Polygons (1 per student)
- 8.5 in. x 11 in. (letter-sized) paper (optional) (1 sheet per student)

ABOUT THE MATH

In the primary grades, many students operate at the visualization level of geometric thought. (See van Hiele's levels of geometric thought, p. 14.) Students at the visualization level identify shapes solely by their appearance (i.e., they identify a triangle as a triangle because it looks like one). With varied experiences identifying and sorting two-dimensional shapes, and examining shapes and their properties (e.g., number of sides, number of vertices, number and type of angles), students will progress towards the analysis level. Students learn that if a shape belongs to a particular class, then the shape has the properties of that class (e.g., all squares have four congruent sides and four right angles).

At the analysis level, students begin to understand that two-dimensional shapes can be grouped together based on their common properties. To achieve this level of thinking, young students must have many opportunities to explore two-dimensional shapes and identify and discuss their properties.

In the Getting Started section, students learn that a polygon is a closed two-dimensional (plane) shape with only straight sides. Students construct polygons on geoboards and then observe how the teacher sorts the geoboard shapes according to number of sides. Discussions about the number of sides on polygons provide opportunities for students to use such terms as “triangle”, “quadrilateral”, “pentagon”, and “hexagon” and to make the terms more meaningful by learning the properties of these two-dimensional shapes (e.g., all pentagons have five sides).

In Working on It, students construct polygons using geoboards and copy the shapes onto dot paper. After classifying the polygons according to the number of sides, students observe that all polygons within a category (e.g., all triangles) share a common property (the same number of sides) but that the polygons in a class can vary in form (i.e., some triangles have two equal sides, and others do not).

GETTING STARTED

Have students sit in a circle. Provide each student with a geoboard and a geoband. Have students create a shape on their geoboards following these rules:

- The shape can have only straight sides.
- The geoband cannot cross over itself.

After completing their shapes, students place their geoboards in the middle of the circle. Inform students that all the shapes they have created are polygons. Ask students to explain what they think “polygon” means. Clarify that a polygon is a closed shape that has only straight sides.

Select all the geoboard shapes that have three sides, and set them in the middle of the circle. Ask students to examine these polygons and to determine what they have in common. Discuss how all the triangles have three sides even though the triangles may have different forms.

Next, select the geoboards that show quadrilaterals (e.g., squares, rectangles, parallelograms, trapezoids, rhombuses). Set these geoboards together in the circle and ask students to determine why these shapes were grouped together. Clarify that all these polygons are quadrilaterals because they have four sides.

Repeat the sorting task for pentagons and hexagons. If there is time, repeat the sorting task for heptagons and octagons.

WORKING ON IT

Provide each student with a copy of Prop2D2.BLM1: Polygons on Parade, a geoboard, and a geoband. Ask students to create a polygon on their geoboards for the first section of Prop2D2.BLM1: Polygons on Parade (i.e., a triangle). Demonstrate how to copy a geoboard shape onto dot paper by matching geoboard pins to the dots on the dot paper and using a pencil and ruler to draw the sides of the polygon. Have students create geoboard polygons for the other sections of Prop2D2.BLM1: Polygons on Parade.

When students have created and recorded all the polygons, have them cut Prop2D2.BLM1: Polygons on Parade into its six sections. Organize a Polygon Parade by asking students to place the section with each kind of polygon in a designated area in the classroom (e.g., triangles posted on a bulletin board, quadrilaterals taped to the door).

Ask students to examine the groups in the Polygon Parade and to look for shapes that were not placed in the correct part of the parade. Discuss why these shapes should be placed in a different group.

After students have corrected any sorting errors, have students describe similarities and differences among the polygons in each group. Emphasize that all polygons within a group have the same number of sides but that the forms of the polygons can vary (e.g., all pentagons have five sides, but the sides can be different lengths).

REFLECTING AND CONNECTING

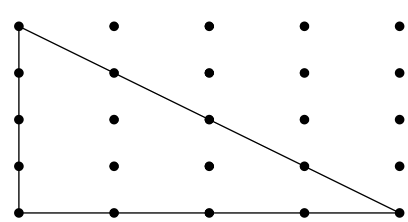
Discuss the task, and encourage students to reflect on what they have learned by asking questions, such as:

- "What was challenging for you in this task? Why?"
- "What strategies did you use to copy your geoboard polygons onto the dot paper?"
- "How did you know which group to place each polygon into?"
- "How are all the polygons in this group alike?"
- "Are there congruent polygons? How do you know that the polygons are congruent?" (They have the same size and the same shape.)
- "How are the polygons in this group different from the polygons in other groups?"

ADAPTATIONS/EXTENSIONS

Some students may have difficulty recording geoboard shapes on dot paper. Allow these students to draw the shapes on blank sheets of paper.

Challenge students to create a triangle (quadrilateral, pentagon, hexagon) on their geoboard with a specified number of pins inside of it (e.g., create a triangle that has three pins inside it).



MATH LANGUAGE

- polygon
- triangle
- quadrilateral
- square
- rectangle
- trapezoid
- parallelogram
- rhombus
- pentagon
- hexagon
- heptagon
- octagon
- congruent
- vertex/vertices (corner/corners)
- quadrilaterals
- angle

SAMPLE SUCCESS CRITERIA

- understands what makes a polygon a polygon (two-dimensional, closed figure with only straight sides)
- identifies various polygons (i.e., triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons) using the appropriate labels
- describes various polygons (i.e., triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons), using appropriate mathematical language (e.g., "A triangle is a polygon with three sides.")
- sorts polygons using geometric properties (i.e., number of sides or number of vertices)
- classifies polygons by geometric properties (i.e., number of sides or number of vertices)

HOME CONNECTION

Send home Prop2D2.BLM2: Plenty of Polygons. In this Home Connection task, students work with parents/guardians to create specific polygons by using a pencil and ruler.

LEARNING CONNECTION 1

What's My Sort?

Materials

- resealable plastic bag containing all the shapes from Prop2D2.BLM3a-d: Polygons (1 bag per pair of students)
- glue
- large sheets of paper (1 per pair of students)

Have students work with a partner, and provide each pair with a bag containing the shapes from Prop2D2.BLM3a-d: Polygons. Have students empty their bags and place the shapes in front of them. Ask students to work with their partner to sort the polygons according to a rule of their choice.

Have students explain their sorting rule. Ask:
- "What is your sorting rule?"
- "Why did you place this polygon in this group?"
- "How are these two polygons alike?"
- "How are these two polygons different?"

Ask students to sort the polygons a few more times, using a different sorting rule each time. Encourage students to explore sorting rules other than the number of sides. For example, students could sort the polygons in these ways:
- polygons with a square corner and those with no square corner;
- polygons with equal side lengths and polygons with unequal side lengths;
- long, narrow polygons and short, wide polygons.

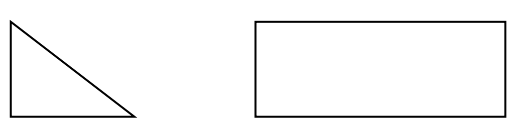
After students have sorted the polygons a few times, ask them to choose one sorting rule and to sort the polygons according to this rule. Have them glue the polygons onto paper to show their final sort. Allow pairs of students to show their paper to their classmates, who try to determine what sorting rule was used.

LEARNING CONNECTION 2

What's the Same?

Materials
- a variety of paper shapes (triangles, quadrilaterals, pentagons, hexagons; shapes should be large enough for students to see in this group task)

Gather students in a circle. Have a variety of paper shapes in the middle of the circle. Ask a student to pick up a shape and name it. Then, have another student select a different shape that is like the first shape in some way. The second student should explain how the shapes are alike. For example, if the first student selects a right-angled triangle, the second could choose a rectangle, because both shapes have at least one square corner. Students may find more than one way in which the selected shapes are alike.



Continue having students choose shapes and explain how they are alike.

LEARNING CONNECTION 3

Shape Snap

Materials

- Prop2D2.BLM4a-d: Shape Cards (2 sets per pair of students; 1 set includes all cards from the four blackline masters)

Provide each pair of students with two sets of shape cards from Prop2D2.BLM4a-d: Shape Cards. Tell students to shuffle the cards and deal them face down. When the deck has been dealt, have students stack the cards and hold them face down in one hand. Explain that both players say "Go" and flip over the top card from their stack.

If the cards show different kinds of shapes, tell students to flip the next card in their stack. If both students flip over cards with the same kind of shape, instruct students to say "snap". (The two shapes do not have to be identical, only the same kind of shape, for example, two triangles.) The first player to say "snap" on a correct match takes both cards.

When students run out of cards, have them combine the cards, shuffle, and play again.

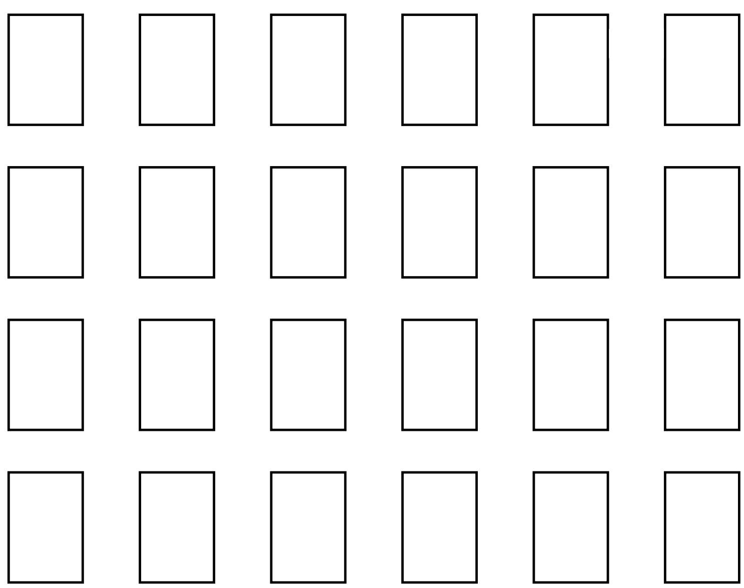
LEARNING CONNECTION 4

Shape Concentration

Materials

- Prop2D2.BLM4a-d: Shape Cards (1 set of 24 cards per pair of students)

Have students shuffle the cards from Prop2D2.BLM4a–d: Shape Cards, and place them face down in a four by six array:

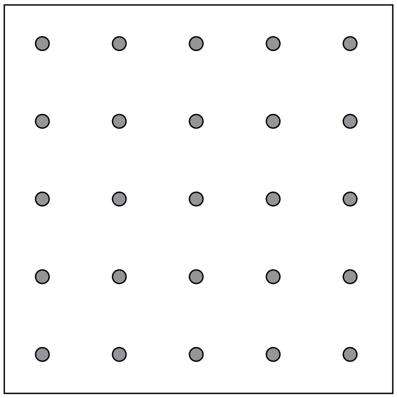
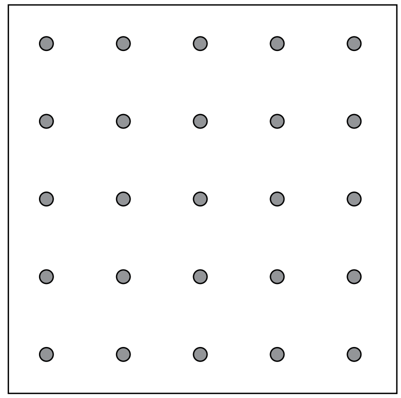
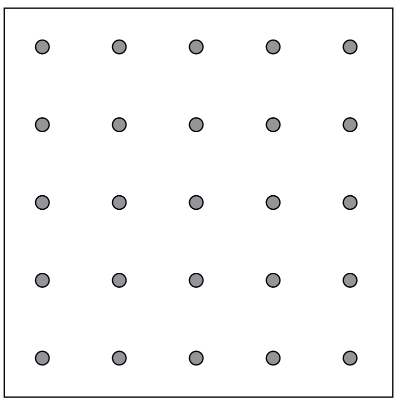
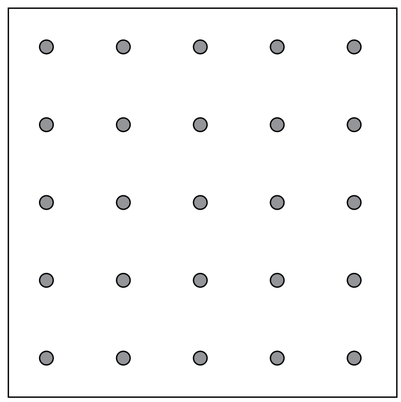
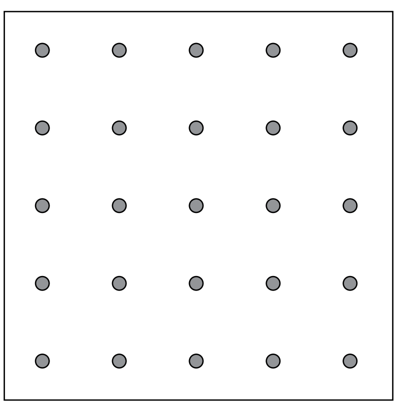
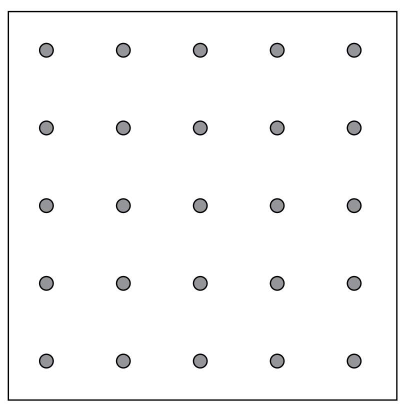


Explain that players take turns flipping over two cards. If the cards show the same kind of shape, the player keeps both cards. (The two shapes do not have to be identical, only the same kind of shape, for example, two triangles.) If the cards do not match, the player turns them over again in the same places.

Tell students that the game is finished when all cards have been matched.

Polygons on Parade

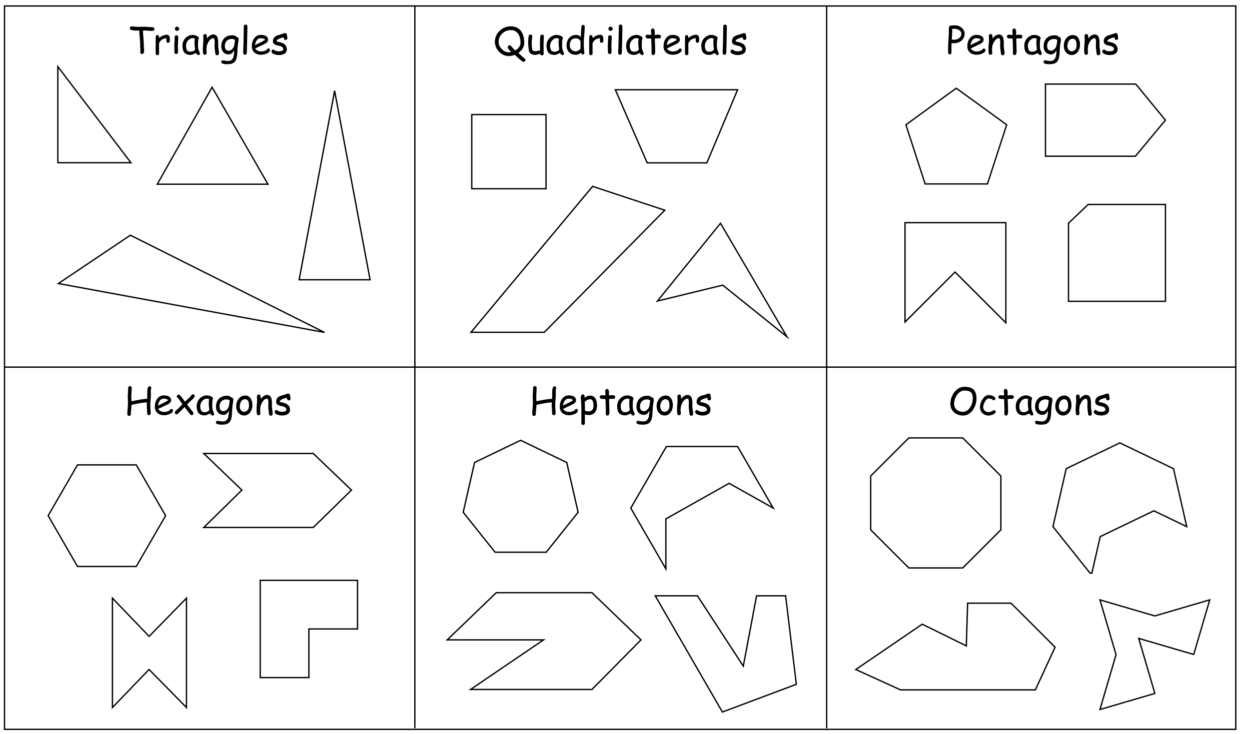
Prop2D2.BLM1

Triangle 	Quadrilateral 
Pentagon 	Hexagon 
Heptagon 	Octagon 

Plenty of Polygons

Dear Parent/Guardian:

Our class has been learning about polygons in math. Polygons are closed shapes with only straight sides. Polygons have different names depending on the number of sides they have.



Ask your child to explain what he or she knows about each kind of polygon. Encourage your child to talk about the number of sides each polygon has.

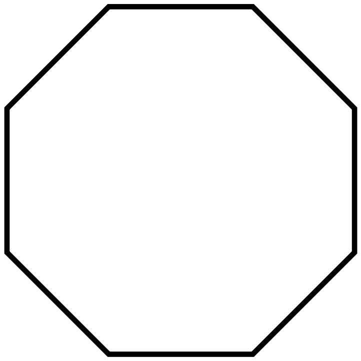
Have your child use a pencil and ruler to draw shapes with three to eight sides. Ask your child to tell you the kind of polygon he or she drew.

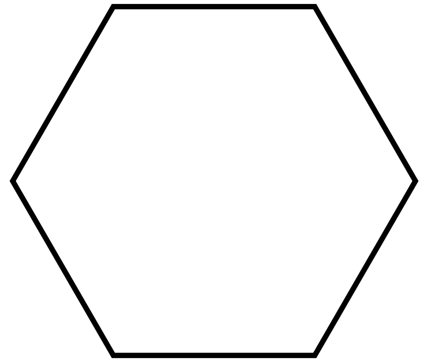
Draw some shapes with three to eight sides, and ask your child to identify them.

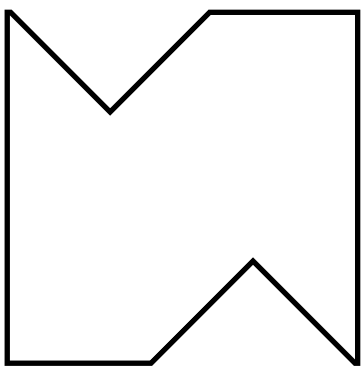
Thank you for helping your child to learn about polygons.

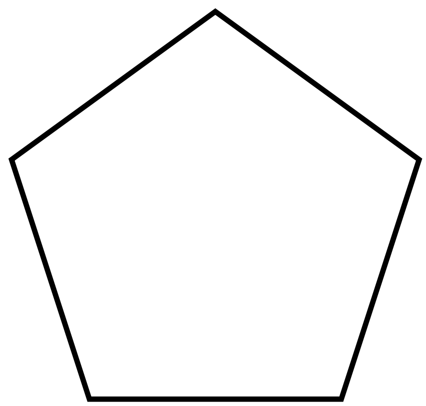
Polygons

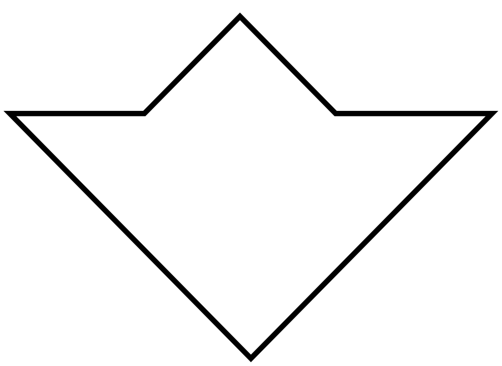
Shapes can be photocopied onto card stock or cut from foam core, plastic, or wood.

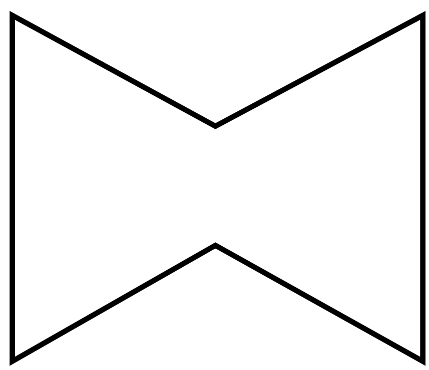






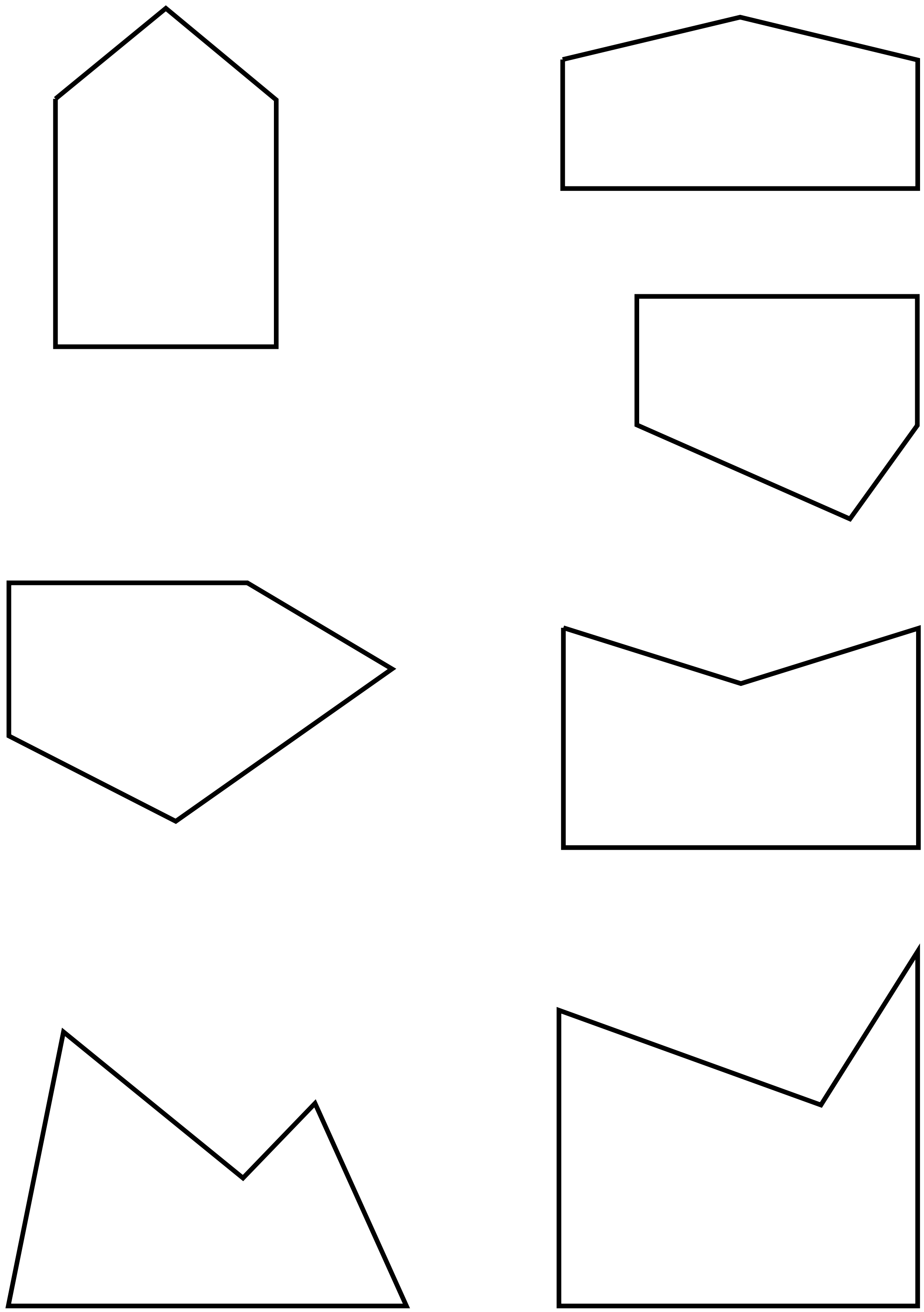






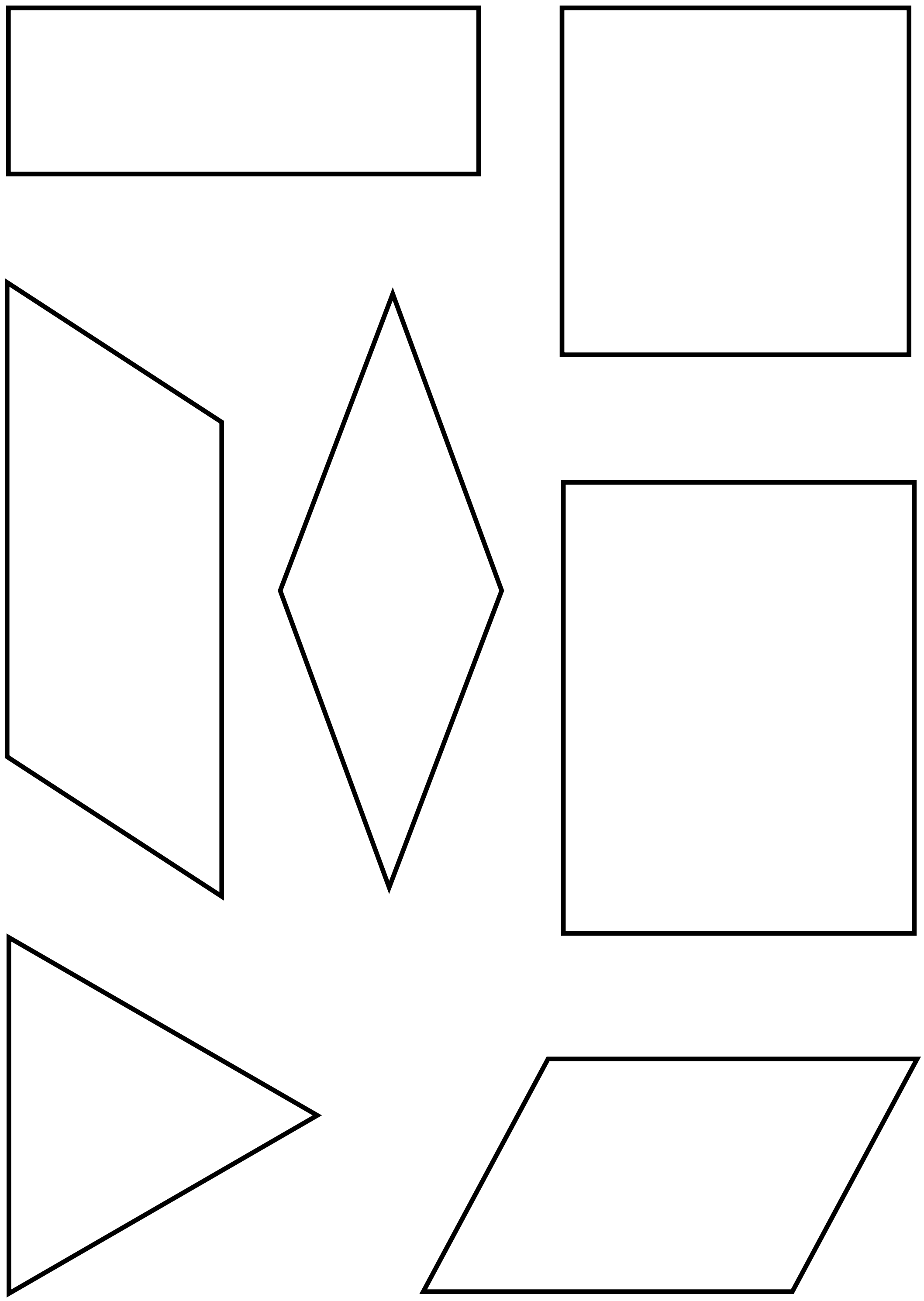
Polygons

Shapes can be photocopied onto card stock or cut from foam core, plastic, or wood.



Polygons

Shapes can be photocopied onto card stock or cut from foam core, plastic, or wood.



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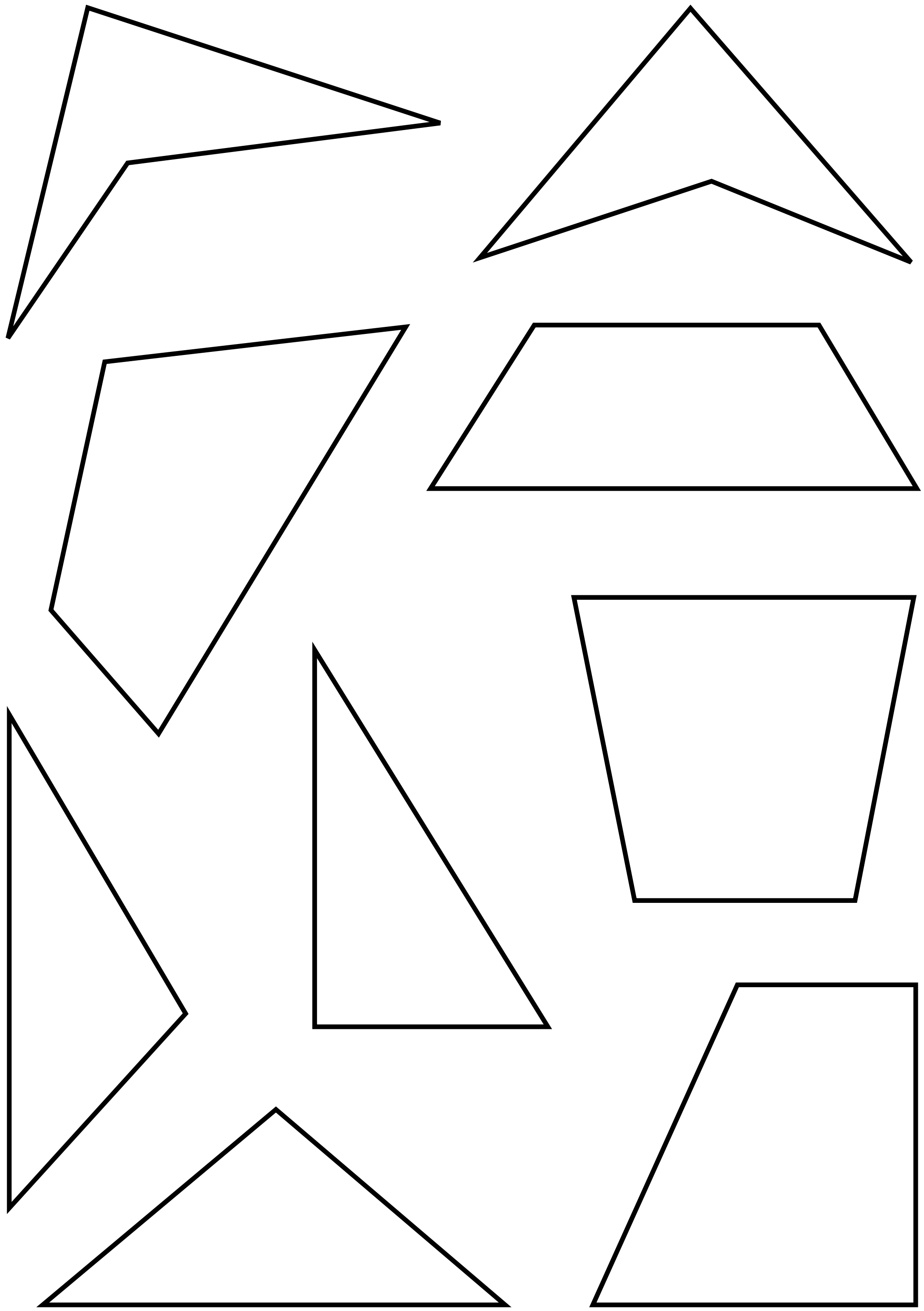
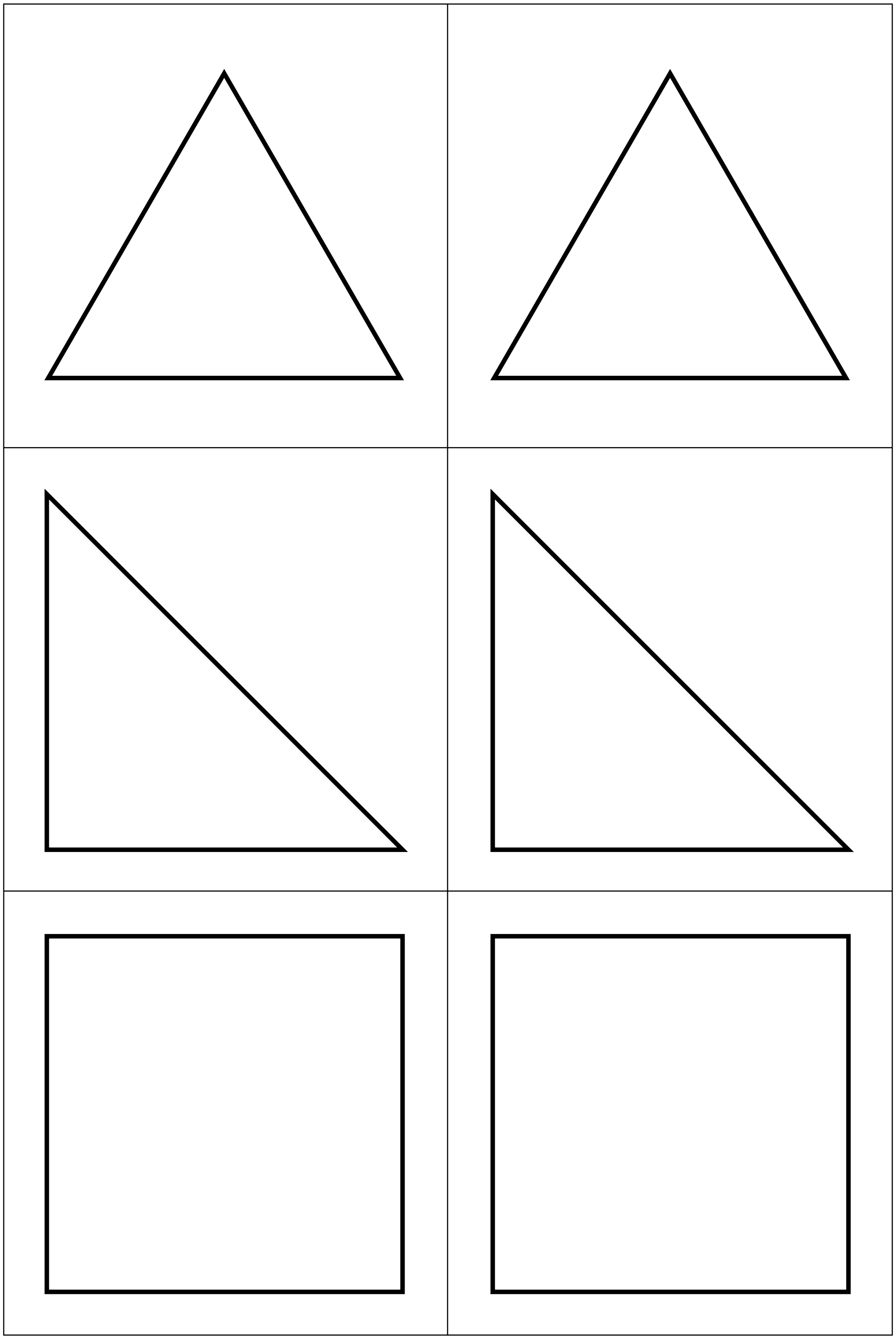
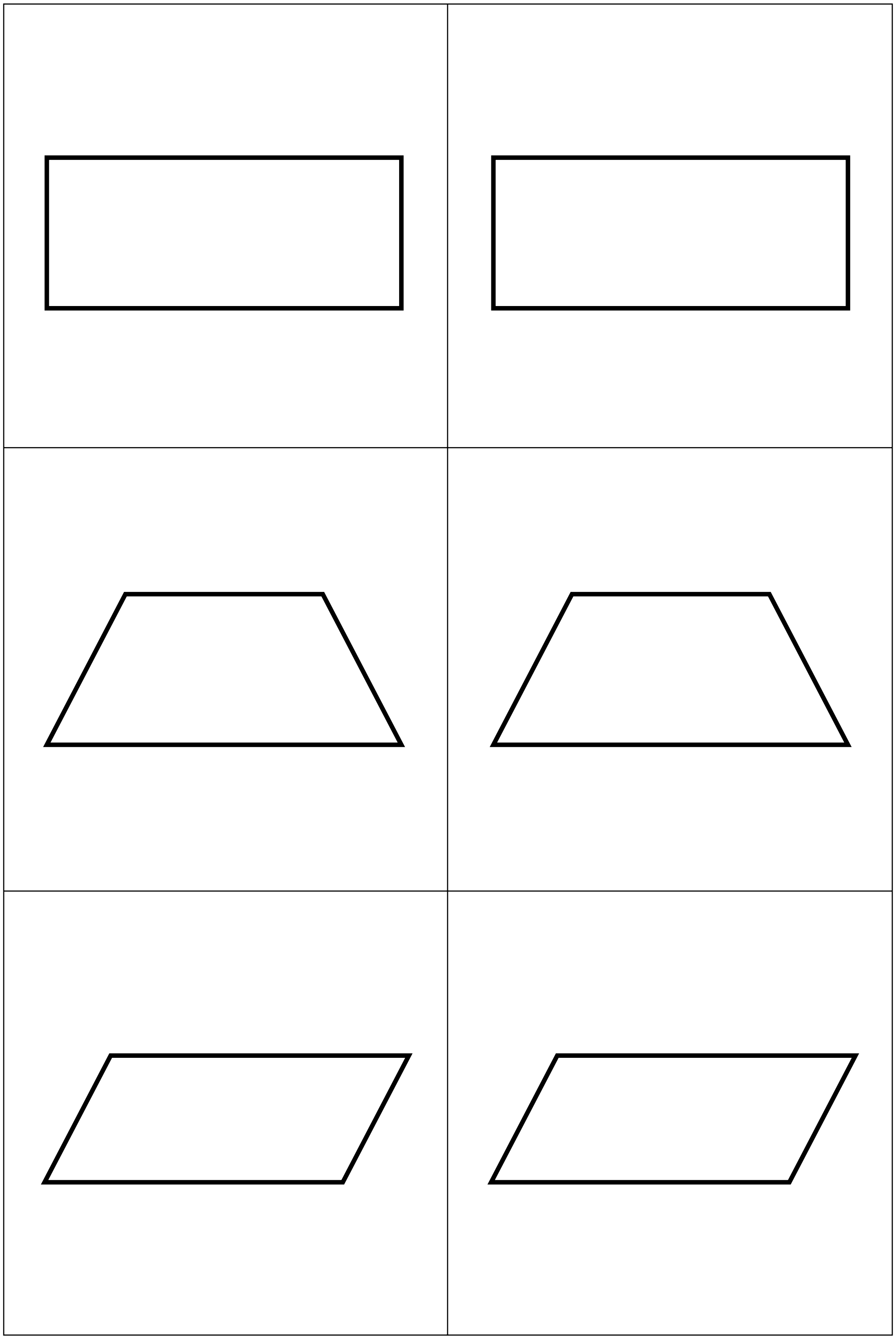


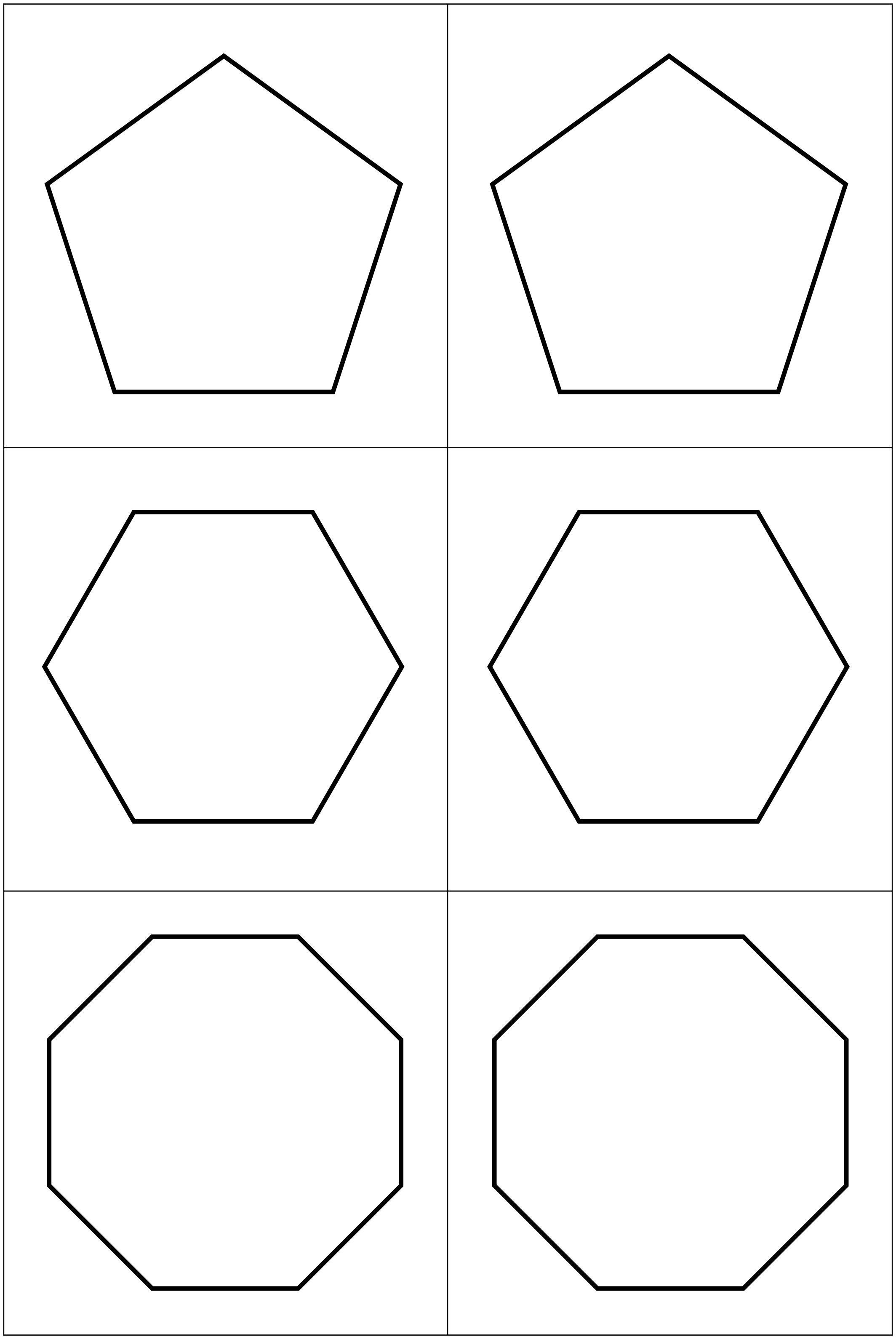
Shape Cards



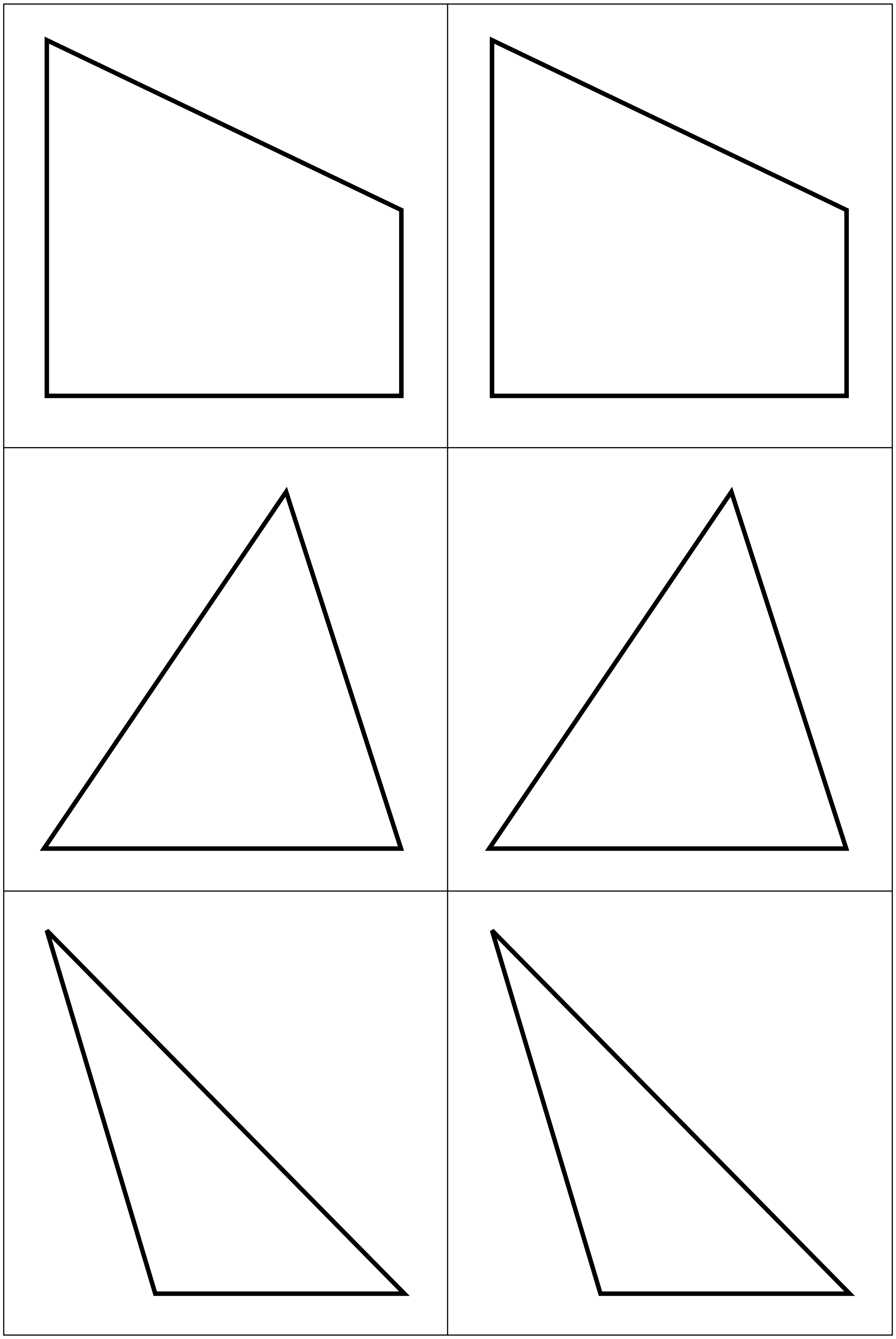
Shape Cards



Shape Cards



Shape Cards



Build It in 3-D

BIG IDEA ***Geometric Properties of Three-Dimensional Figures***

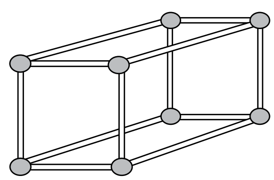
CURRICULUM EXPECTATIONS

Students will:

- identify and describe various three-dimensional figures (i.e., cubes, prisms, pyramids) and sort and classify them by their geometric properties (i.e., number and shape of faces), using concrete materials (e.g., "I separated the figures that have square faces from the ones that don't.");
- create models and skeletons of prisms and pyramids, using concrete materials (e.g., cardboard; straws and modelling clay), and describe their geometric properties (e.g., number and shape of faces, number of edges).

MATERIALS

- skeleton of rectangular prism made with drinking straws and clumps of modelling clay



- solid three-dimensional figures (cubes, rectangular prisms, triangular prisms, square-based pyramids, triangle-based pyramids) (1 figure per student or small group)
- chart paper
- marker
- drinking straws (whole and half lengths)
- modelling clay
- index cards or pieces of paper (1 per student)
- paper bags (1 per student)
- paper clips (1 per student)
- Prop3D2.BLM1: Building Skeletons (1 per student)

ABOUT THE MATH

Before Grade 2, students identify the two-dimensional faces of three-dimensional figures. Students learn, for example, that the faces of a triangular prism are two triangles and three rectangles. (These rectangles can be squares.)

The following task promotes a deeper understanding of the properties of three-dimensional figures (number of vertices, edges, faces) by focusing students' attention on the edges of the figures. Students examine and construct skeletons of three-dimensional figures in which drinking straws represent the edges and then create riddles to describe the skeletons. By constructing skeletons and creating riddles about their constructions, students have opportunities to think about the number of edges on various figures and observe the relative lengths and positions of the edges.

GETTING STARTED

Show students the skeleton of a rectangular prism made from drinking straws held together with small clumps of modelling clay. Place the skeleton next to a solid rectangular prism. Ask students:

- "How are these two figures the same?"
- "How are these two figures different?"
- "Which figure is a skeleton of a rectangular prism? Why is it called a skeleton?" (The drinking straws are like the bones of the figure.)
- "What parts of the figure does the skeleton show?" (edges and vertices)
- "What part of the figure do the drinking straws show?" (edges)

Have students estimate the number of drinking straws that were used to build the skeleton. Dismantle the skeleton and count the drinking straws. Highlight that some drinking straws are long and some are short.

Show students how to create a riddle about the skeleton of a rectangular prism by recording the following information on chart paper:

- The figure has 12 straws altogether.
- It has 4 long straws.
- It has 8 short straws.
- It has 8 joiners.
- What is it?

Next, show a solid square-based pyramid and ask students, "How could you create a skeleton of a square-based pyramid using drinking straws and small clumps of modelling clay?" Students might say that they could count the edges on the figure and decide whether they need long or short straws.

Have students select a solid three-dimensional figure. Instruct them to use drinking straws and modelling clay to build its skeleton.

After students have completed their skeletons, invite students to show their skeletons to the class and to explain how they constructed the skeletons. Ask questions, such as:

- "How are all the skeletons alike?"

- "How are the skeletons the same as the solid three-dimensional figures? How are the skeletons different from the solids?"
- "What was easy about constructing the skeletons? What was difficult?"

Next, have students dismantle their skeletons and record a riddle about the skeleton on an index card. Students can follow the example of the riddle for a rectangular prism on the chart paper.

After students have composed their riddles, have them reassemble their skeletons, place them in paper bags, and attach the riddle cards to the bags with paper clips.

WORKING ON IT
Have students exchange riddle bags with a partner. Ask them to read their partner's riddle, gather the appropriate materials, and build the same skeleton.

After students build their skeletons, have them remove their partner's skeleton from the paper bag and compare the two skeletons. If they do not match, have students make the necessary changes so that the two skeletons are congruent.

Have students select a different partner, trade riddle bags, and construct and compare new skeletons.

REFLECTING AND CONNECTING
After students have constructed several skeletons by following the riddle clues, ask questions, such as the following:
- "What was easy about constructing the skeletons? What was difficult?"
- "How are the skeletons like the solid three-dimensional figures? How are the skeletons different from the solids?"
- "Which figure has the fewest edges? How many edges does it have?"
- "Which figure has the most edges? How many edges does it have?"
- "Which figure has edges that are all the same length?"
- "Which figure has edges that are different lengths?"
- "Which figure has edges that form a square (triangle, rectangle)?"
- "What did you learn about three-dimensional figures from this task?"

ADAPTATIONS/EXTENSIONS
Some students may have difficulties understanding the riddle or constructing the skeleton. It may be easier for these students to construct the skeleton of a cube rather than of other prisms or of pyramids. Ask students to assist their partners if necessary.

Challenge students by having them create skeletons of objects (e.g., a building, a tent).

MATH LANGUAGE

- three-dimensional figure
- skeleton
- edge
- face
- cube
- rectangular prism
- triangular prism
- square-based pyramid
- triangle-based pyramid
- rectangle
- triangle
- square
- congruent

SAMPLE SUCCESS CRITERIA

- describes three-dimensional figures using geometric properties (e.g., number and shape of faces)
- creates skeletons of prisms and pyramids using riddle clues that describe number of edges and vertices
- describes skeletons using appropriate mathematical language (e.g., number and length of the edges)
- compares skeletons and solids of three-dimensional figures using geometric properties (e.g., number of vertices, edges, faces)

HOME CONNECTION

Send home Prop3D2.BLM1: Building Skeletons. In this Home Connection task, students and their parents/guardians build skeletons of three-dimensional figures using materials found at home.

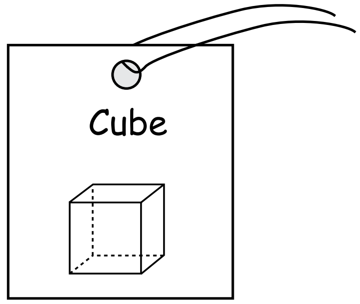
LEARNING CONNECTION 1

What Am I?

Materials

- Prop3D2.BLM2: What Am I? (1 shape card per student)
- string
- paper punch

Make "What Am I?" necklaces using string, a paper punch, and the shape cards from Prop3D2.BLM2: What Am I?



Place a "What Am I?" necklace around each student's neck, with the picture of the three-dimensional figure hanging on the student's back. Tell students that they must try to determine the figure on their own necklace by asking classmates questions that they can answer with only "yes" or "no". For example, students might ask:

- "Do I roll?"
- "Do I have any rectangular faces?"
- "Are all my faces the same shape?"
- "Do I have eight edges?"

Allow students to walk around the classroom and ask questions of their classmates until they are able to determine the three-dimensional figure on their necklace.

After the task, ask questions, such as the following:

- "What questions helped you identify your three-dimensional figure?"
- "Could you identify your figure if you could ask only one question? Why or why not?"
- "What was easy about this task?"
- "What was difficult about this task?"
- "How did you know which three-dimensional figure you had on your necklace?"

LEARNING CONNECTION 2

Where Does It Go?

Materials

– a large assortment of solid three-dimensional figures

Provide small groups of students with a large assortment of solid three-dimensional figures. Ask students to sort the figures according to a sorting rule of their choice. As students sort the figures, ask them questions, such as:

- "What is your sorting rule?"
- "How are all these figures alike? What properties do they share?"
- "In which group should you place this figure?"
- "In what other ways could you sort these figures?"

LEARNING CONNECTION 3

Chain Game

Materials

- a large assortment of solid three-dimensional figures (traditional and non-traditional) (at least 1 figure per student)

Have students sit in a circle. Place a large assortment of solid three-dimensional figures in the middle of the circle. Choose a three-dimensional figure (e.g., a cube) and place it in front of you. Ask the student sitting beside you to select another three-dimensional figure that shares a property with your figure (e.g., a square-based pyramid). Ask students to identify the property that the figures have in common (e.g., both figures have a square face). Continue to develop the chain of figures by having each student, in turn, add a three-dimensional figure that shares a property with the previous one.

LEARNING CONNECTION 4

Guess My Figure

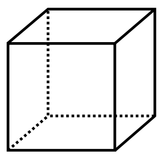
Ask students to think of a three-dimensional figure. Invite students to describe their figure to classmates using only gestures. For example, if a student chooses a square-based pyramid, he or she could draw four triangles and a square in the air using a finger.

Alternatively, have students draw the faces of a figure on paper or the board and challenge their classmates to identify the figure.

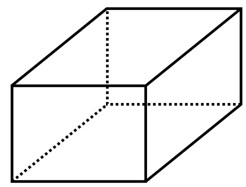
Building Skeletons

Dear Parent/Guardian:

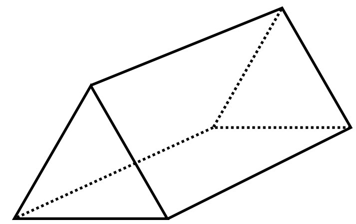
Our class has been learning about three-dimensional figures. Here are the figures we have been investigating:



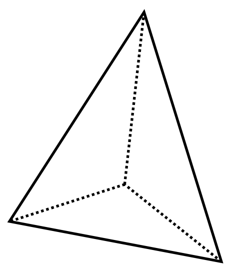
Cube



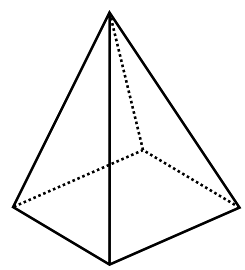
Rectangular Prism



Triangular Prism

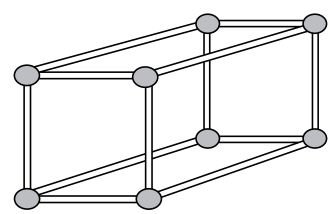


Triangle-Based Pyramid



Square-Based Pyramid

We have been building skeletons of these three-dimensional figures using drinking straws for the edges and clumps of modelling clay for the joiners.

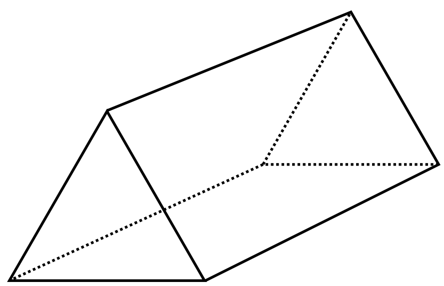


Look around your home for other materials that you and your child could use to build skeletons of three-dimensional figures. Try using toothpicks or spaghetti for the edges and miniature marshmallows for the joiners.

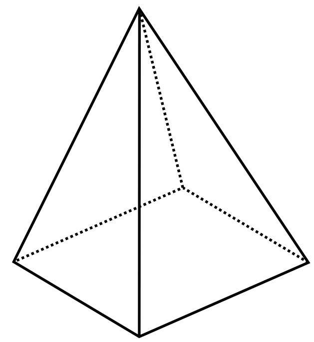
Have fun building skeletons of three-dimensional figures!

What Am I?

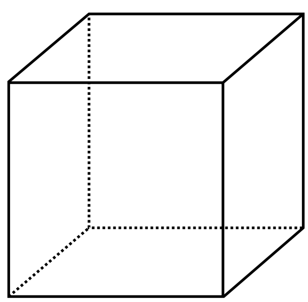
Triangular Prism



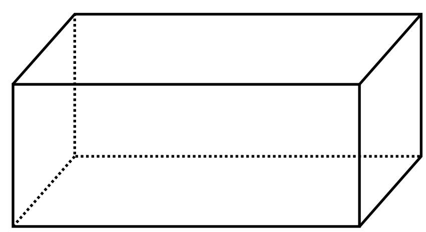
Square-Based Pyramid



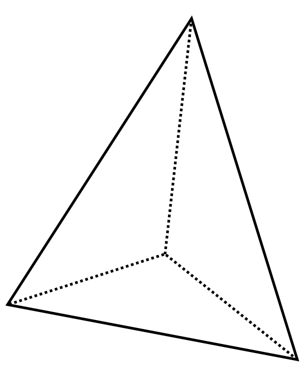
Cube



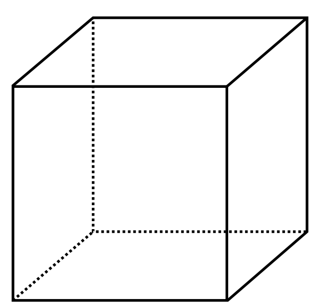
Rectangular Prism



Triangle-Based Pyramid



Cube



Geometry Exploration Centres

BIG IDEA ***Geometric Relationships***

CURRICULUM EXPECTATIONS

Students will:

- identify and describe various three-dimensional figures (i.e., cubes, prisms, pyramids) and sort and classify them by their geometric properties (i.e., number and shape of faces), using concrete materials (e.g., "I separated the figures that have square faces from the ones that don't.");
- compose and describe pictures, designs, and patterns by combining two-dimensional shapes (e.g., "I made a picture of a flower from one hexagon and six equilateral triangles.");
- compose and decompose two-dimensional shapes (**Sample problem:** Use Power Polygons to show if you can compose a rectangle from two triangles of different sizes.);
- cover an outline puzzle with two-dimensional shapes in more than one way;
- build a structure using three-dimensional figures, and describe the two-dimensional shapes and three-dimensional figures in the structure (e.g., "I used a box that looks like a triangular prism to build the roof of my house.").

MATERIALS

- GeoRel2.BLM1: Request for Packaging Materials (1 per student)
- cereal box for demonstration
- boxes (1 for each student)
- chart paper
- GeoRel2.BLM4a-b: Quick Views (1 per student)

Centre 1

- a variety of packaging materials, such as boxes, paper towel rolls, and cartons (brought in by students from home)
- sticky notes or strips of paper
- glue
- tape
- markers/pencil crayons
- card stock (optional)

Centre 2

- Polydron sets or Frameworks
- GeoRel2.BLM2a-c: Polydron Cards (1 set per group)

Centre 3

- GeoRel2.BLM3a-d: Tangram Puzzles (1 set per student)
- sets of tangram pieces (1 set per student)
- paper (optional)
- pencil (optional)
- sticky notes or scraps of paper and tape

Centre 4

- Polydron sets or Frameworks
- pencils
- blank sheets of paper
- crayons/markers
- scissors
- stick tack or tape
- envelopes (optional)

ABOUT THE MATH

For students to understand geometric relationships, they need opportunities to compose (put together) and decompose (take apart) two-dimensional shapes and three-dimensional objects. These experiences deepen students' understanding of how two-dimensional shapes are related to one another and to three-dimensional figures.

In Getting Started, students unfold boxes and identify and discuss the two-dimensional faces of three-dimensional figures.

The four tasks in Working on It provide students with other opportunities to explore geometric relationships:

Centre 1: Sculptures from Scraps
At this centre, students create sculptures by gluing and taping different three-dimensional packaging materials together and explore how structures can be made from three-dimensional figures.

Centre 2: Polydron Party
The task at this centre allows students to recognize the two-dimensional faces of three-dimensional figures by constructing figures using Polydron pieces.

Centre 3: Tangram Puzzles
At this centre, students use tangram puzzles to explore how larger two-dimensional shapes can be composed of smaller ones.

Centre 4: Party Clothes
In this task, students trace around the faces of three-dimensional figures to investigate the shapes of the faces.

GETTING STARTED

Before this task begins, send home GeoRel2.BLM1: Request for Packaging Materials.

Show students a cereal box and ask them to explain how they think the box is put together (e.g., where tabs are glued). Demonstrate how to unfold a box by releasing its tabs. Provide students with a box each, and instruct them to unfold it carefully. Ask students to show their unfolded box to the class and to identify the two-dimensional shapes they recognize in the unfolded box. Have students label the shapes they identify on their unfolded boxes. Record terms, such as square, rectangle, and triangle, on the board or chart paper for students' reference.

WORKING ON IT

Explain to students that they will be working on tasks involving two-dimensional shapes and three-dimensional figures at four different centres. Clarify the four tasks with the whole class. Have students visit the centres in small groups.

Centre 1: Sculptures from Scraps

Ask students to build sculptures using packaging materials (e.g., boxes, paper towel rolls, cartons). Have them label the three-dimensional figure that make up their sculpture, using sticky notes or strips of paper. Allow students to present their sculptures to the class and to explain how they constructed them.

Centre 2: Polydron Party

In this game for two to four players, students build three-dimensional figures using Polydron pieces. (Allow students to build skeletal models if Frameworks are available.)

Have students shuffle the game cards from GeoRel2.BLM2a-c: Polydron Cards and place them face down in a pile. Explain that players take turns choosing a card from the pile and selecting the corresponding Polydron piece. As students collect Polydron pieces, have them try to recognize three-dimensional figures that they could build with their pieces. For example, after accumulating a square and two triangles, a student might recognize that he or she could construct a square-based pyramid or a triangular prism once he or she has more pieces.

As the game proceeds and students gather more Polydron pieces, ask them to determine a specific figure that they want to build. The game is finished when a player constructs a three-dimensional figure. Explain that students do not have to use all their collected Polydron pieces in their figure.

Centre 3: Tangram Puzzles

Instruct students to use a set of tangram pieces to cover the outlines on GeoRel2.BLM3a-d: Tangram Puzzles. When students complete a puzzle, have them trace around the tans inside the outline on the blackline master. Ask students to print the name of the shape (e.g., triangle, square) inside each tan. If students are unfamiliar with the parallelogram, allow them to label it as a quadrilateral.

Centre 4: Party Clothes
Have students create three-dimensional figures using Frameworks or Polydron pieces. To make "clothes" for their figures, instruct students to use a pencil to trace around each face on blank sheets of paper. Have them use crayons or markers to decorate the shapes. Have students cut out the shapes and attach them to the figures using stick tack or small rings of tape.

REFLECTING AND CONNECTING

Discuss the tasks with students at the conclusion of each work session. Help students to reflect on the geometric relationships they explored at the centres by asking questions, such as:

- "What did you learn about shapes or figures today?"
- "What did you learn about the ways shapes and figures can be put together?"
- "What went well at your centre?"
- "What difficulties did you experience at your centre? What did you do to overcome these difficulties?"
- "What advice would you give to someone who will work at your centre tomorrow?"

ADAPTATIONS/EXTENSIONS

Some students may find the centre tasks difficult. These students may benefit from working closely with a partner.

Challenge students at each centre:

Centre 1: Have students use card stock to assemble boxes that they combine to create sculptures.

Centre 2: Have students select twelve pieces at random from a container of Polydron pieces or Frameworks. Instruct them to try to assemble a three-dimensional figure using any of the pieces they selected.

Centre 3: Have students create tangram puzzles by arranging the tangram pieces to represent an object or animal and then tracing around the outside of the arrangement.

Centre 4: Have students place the "clothes" (decorated cut-out shapes) in an envelope. Let students exchange envelopes with a partner, examine the shapes in their partner's envelope, and use Polydron pieces (or Frameworks) to construct a three-dimensional figure that can wear the "clothes".

MATH LANGUAGE

- two-dimensional shape
- triangle
- quadrilateral
- rectangle
- square
- side
- vertex/vertices (corner/corners)
- three-dimensional figure
- cube
- rectangular prism
- triangular prism
- square-based pyramid
- triangle-based pyramid
- cylinder
- cone
- face
- edge

SAMPLE SUCCESS CRITERIA

- identifies various two-dimensional shapes and three-dimensional figures using appropriate mathematical vocabulary
- describes various two-dimensional shapes and three-dimensional figures using geometric properties (e.g., number of sides or number of vertices)
- compares shapes and figures by their geometric properties (e.g., "This cube has six square faces and this rectangular prism has two square and four rectangle faces.")
- builds sculptures using three-dimensional materials and describes the three-dimensional figures in the structure
- composes and decomposes two-dimensional shapes (e.g., determines what tangram pieces can be put together to make a square)
- describes geometric relationships (e.g., how two or more shapes fit together to make a larger shape)
- describes shapes and figures using appropriate mathematical language

HOME CONNECTION

Send home GeoRel2.BLM4a–b: Quick Views. In this Home Connection task, students have a few seconds to look at shape arrangements made by their parents/guardians. Students then re-create the shape arrangements from memory.

LEARNING CONNECTION 1

Shapely Silhouettes

Materials
- barrier (e.g., file folder, book)
- overhead projector
- three-dimensional figures

Use a barrier to block students' view as you place a three-dimensional figure on the overhead projector. Turn on the projector. Ask students to look at the projected shape and to try to determine the three-dimensional figure. Have students give reasons for their conjectures. For example, if you place a cylinder on the projector and students see a circle, they might guess that the figure is a cylinder or a cone. After projecting one face, turn the figure onto another face, and ask students whether they want to change their conjecture.

LEARNING CONNECTION 2

Shape Flash

Materials
- blank paper (a few sheets per student)
- GeoRel2.BLM5a-f: Shape Flash Cards (1 set)

Provide students with blank paper. Flash each shape from GeoRel2.BLM5a-f: Shape Flash Cards for two to three seconds. On the blank paper, have students draw the shape they remember seeing. Show the shape again and ask students to compare their drawings with the original shape.

LEARNING CONNECTION 3

Pizza Parlour

Materials
- pattern blocks
- GeoRel2.BLM6: Pizza Parlour Game Board (1 per student)
- spinner made with GeoRel2.BLM7: Pizza Parlour Spinner, a paper clip, and a pencil (1 per group of students)

Have students play this game with a partner or in groups of three or four. The object of the game is to be the first player to fill his or her game board with pattern blocks.

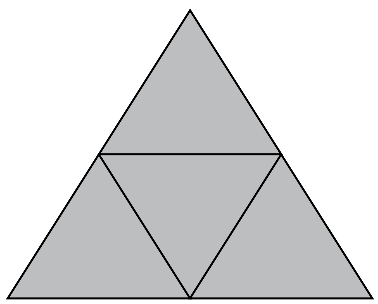
Explain that players, in turn, spin the spinner, take the pattern block indicated by the spinner, and place the pattern block on their game board. Tell students that as the game progresses, they may trade a group of pattern blocks for one pattern block that matches the shape of the group. For example, students could replace two trapezoids with a hexagon, or they could replace three triangles with a trapezoid. Explain that if a player cannot use the pattern block indicated on the spinner, then he or she cannot take a pattern block. The turn passes to the next player. The game ends when one player's pizzas are ready to serve (i.e., all the pizza shapes are covered with pattern blocks).

LEARNING CONNECTION 4

Shapes Within Shapes

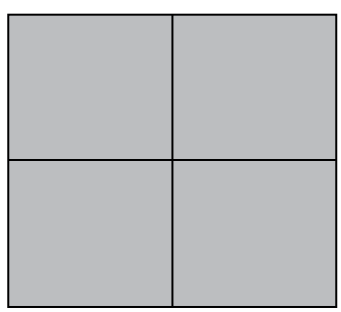
Materials
- square pattern blocks (16 per student)
- triangle pattern blocks (16 per student)
- pencils
- GeoRel2.BLM8: Triangle Paper (1 per student)
- GeoRel2.BLM9: Grid Paper (1 per student)

Have students use up to 16 triangle pattern blocks to create as many different triangles as they can. Have students record the triangles on GeoRel2.BLM8: Triangle Paper.



A triangle made with four triangle pattern blocks

Have students use up to 16 square pattern blocks to create as many different squares or rectangles as they can. Ask them to record the squares or rectangles on GeoRel2.BLM9: Grid Paper.

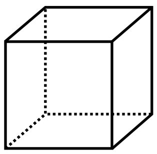


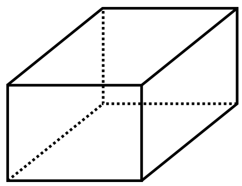
A square made with four square pattern blocks

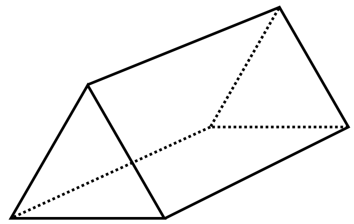
Request for Packaging Materials

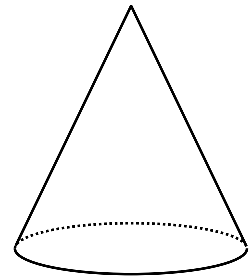
Dear Parent/Guardian:

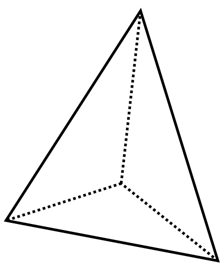
In math, we are learning about three-dimensional figures, such as the following:

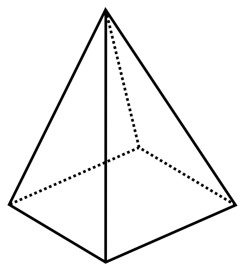

Cube

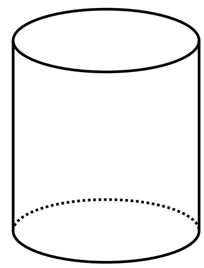

Rectangular Prism


Triangular Prism


Cone


Triangle-Based Pyramid


Square-Based Pyramid


Cylinder

We will also be learning how three-dimensional figures can be put together to build structures, and we will be doing an activity in which we build structures with packaging materials.

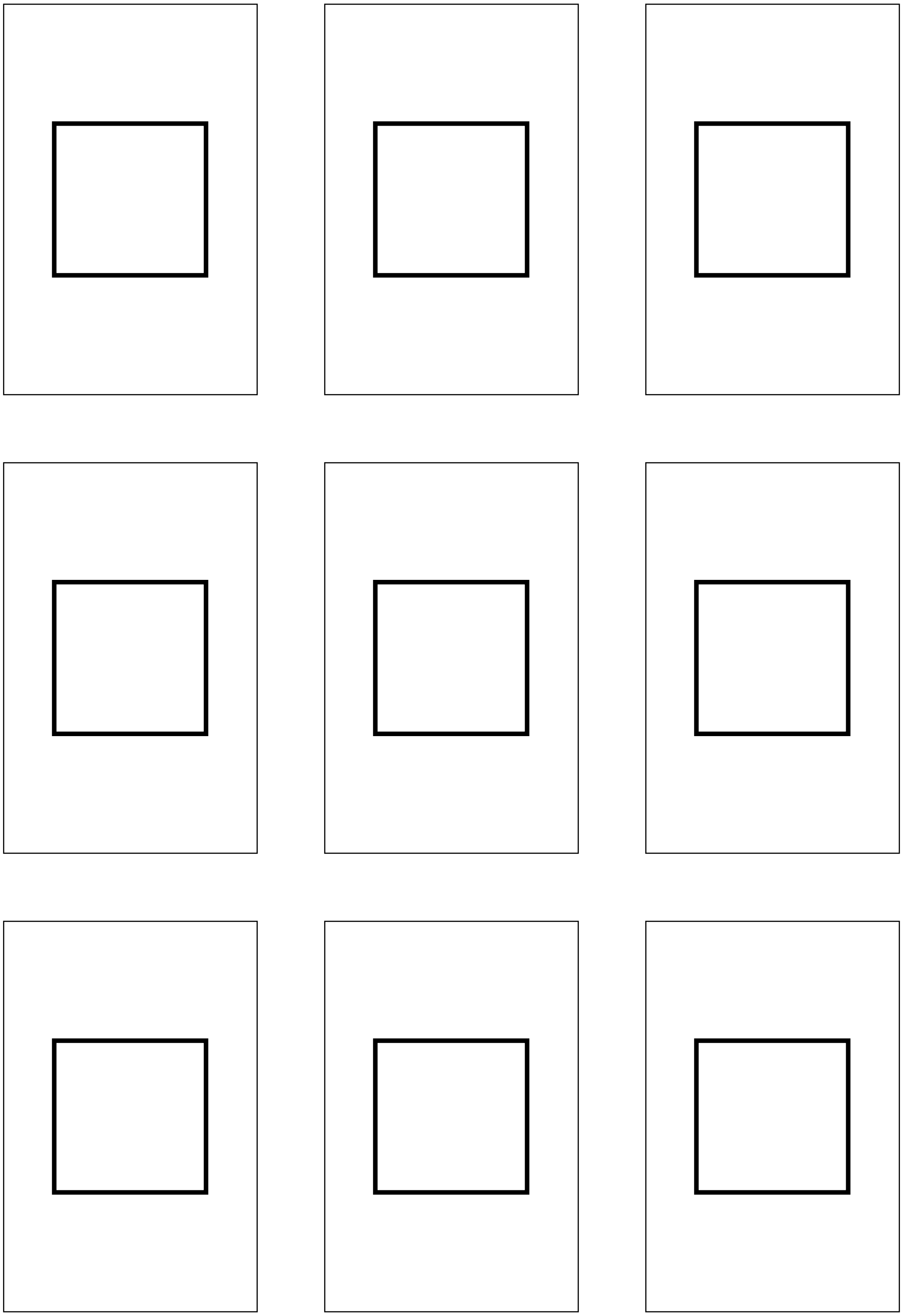
You can help us! We would appreciate if you could collect packaging materials that look like the three-dimensional figures illustrated above (for example, cardboard boxes, cartons, paper towel rolls, toilet tissue rolls) and send them to class with your child.

Thank you in advance for the materials you are able to provide for our math activity.

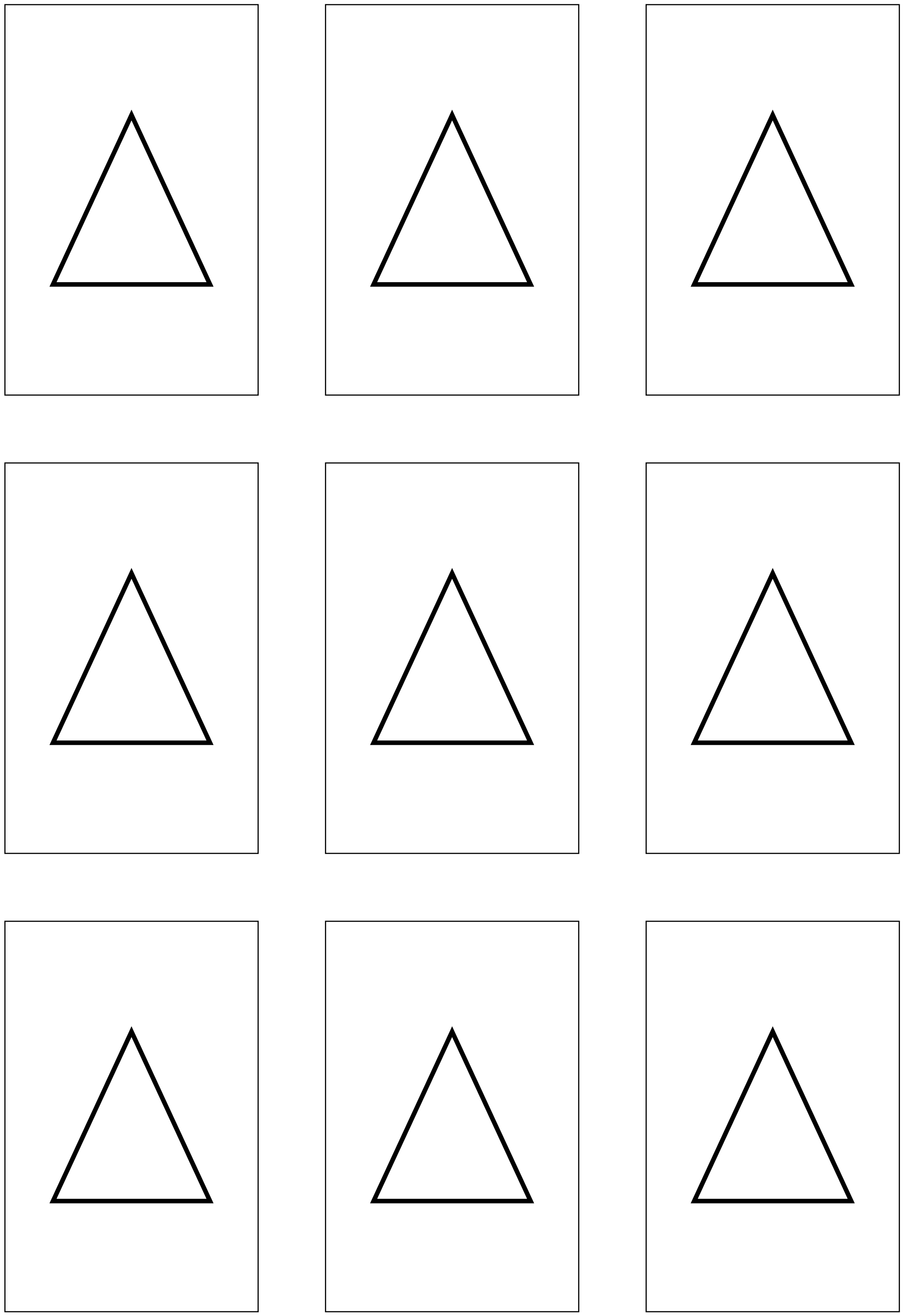
Polydron Cards

GeoRel2.BLM2 (a)

Polydron Cards



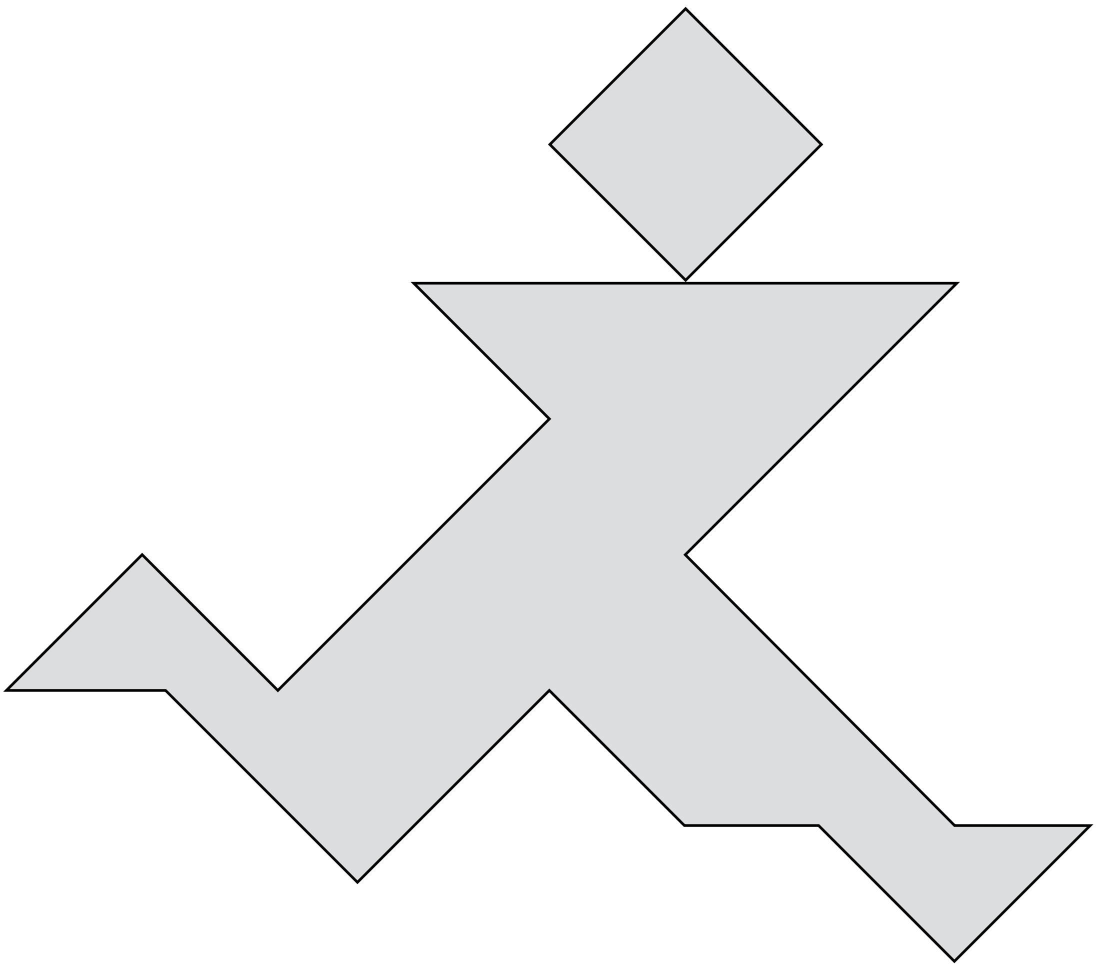
Polydron Cards



Tangram Puzzles

Use all seven tangram pieces to form the figure below.

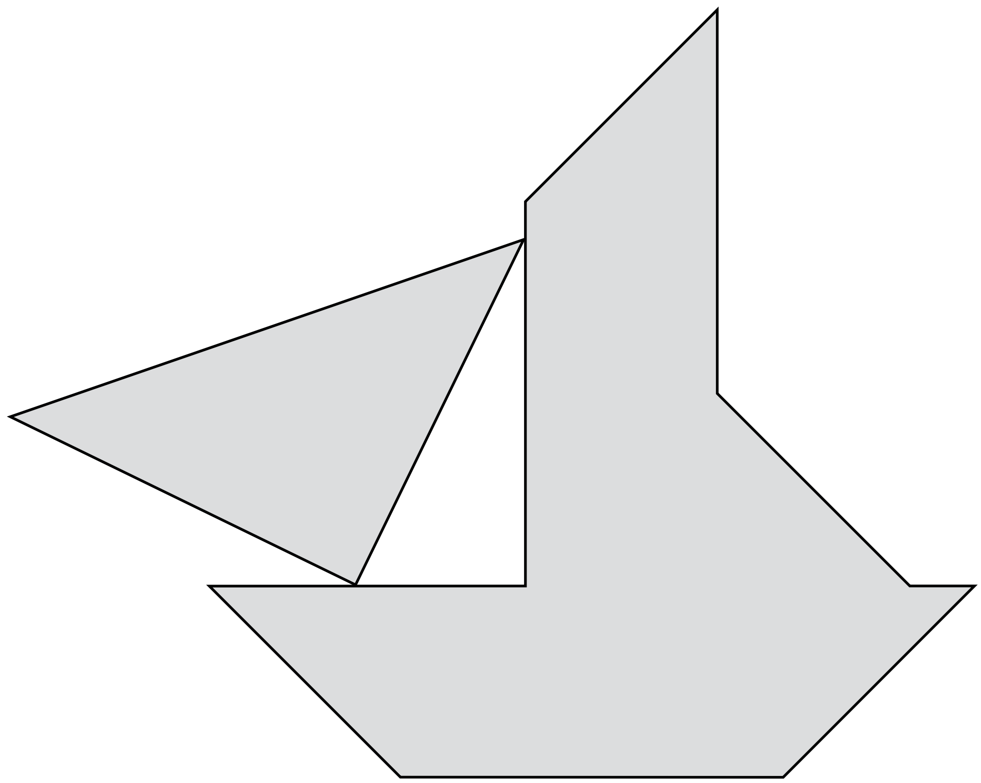
What am I?



Tangram Puzzles

Use all seven tangram pieces to form the figure below.

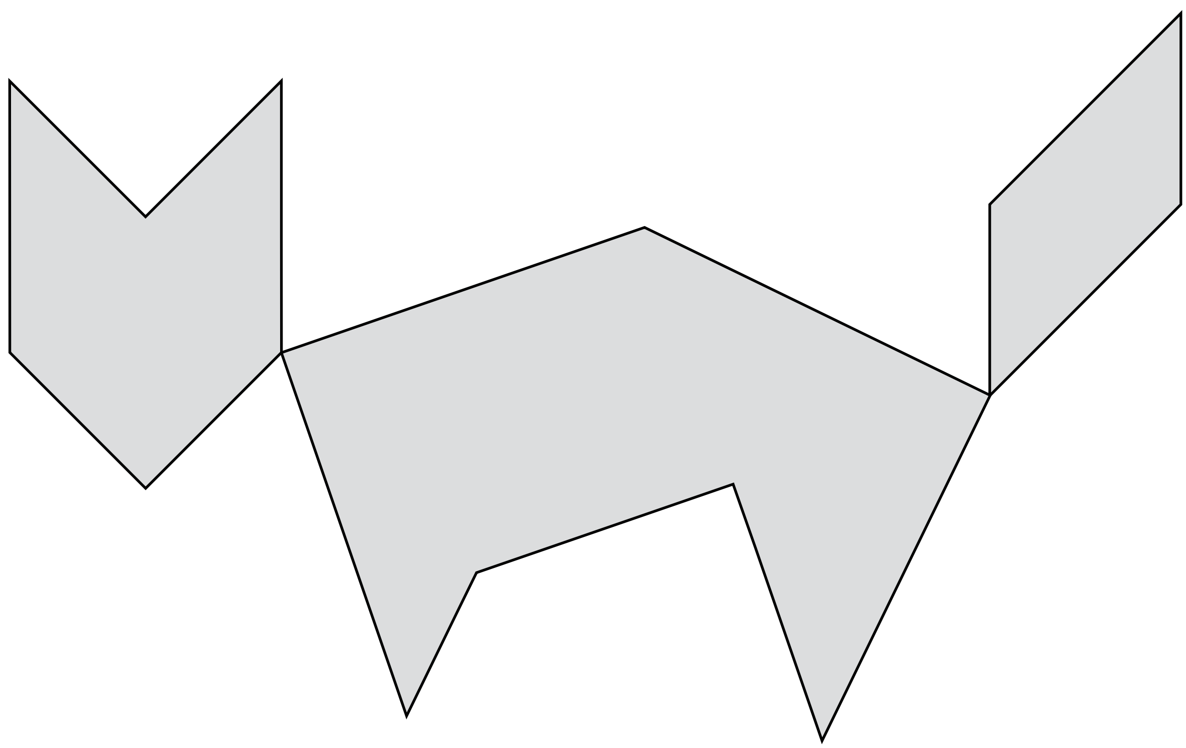
What am I?



Tangram Puzzles

Use all seven tangram pieces to form the figure below.

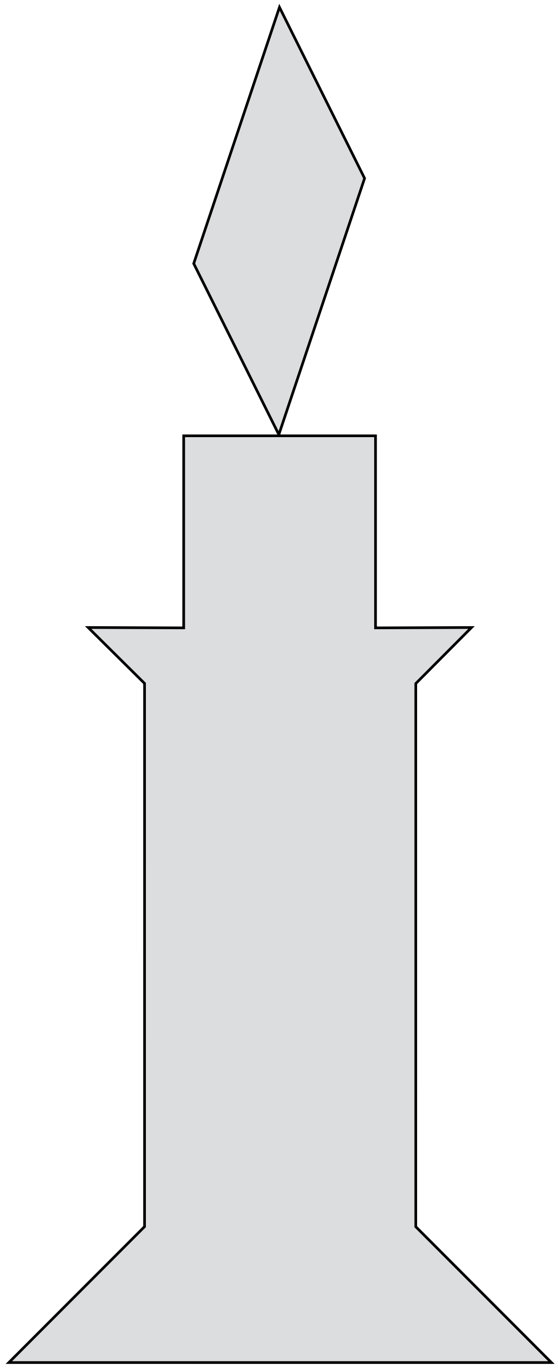
What am I?



Tangram Puzzles

Use all seven tangram pieces to form the figure below.

What am I?



Quick Views

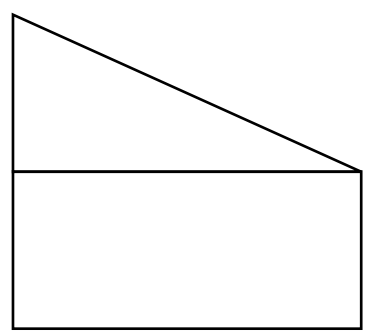
Dear Parent/Guardian:

Our class has been learning about shapes and how they can be put together and taken apart.

Try this activity with your child.

Cut out the two sets of shapes from the attached page. Keep one set of shapes, and give the other set to your child.

Ask your child to close his or her eyes. While your child is not looking, take two of your shapes and place them together in any way. Here is an example of how you might arrange two shapes.



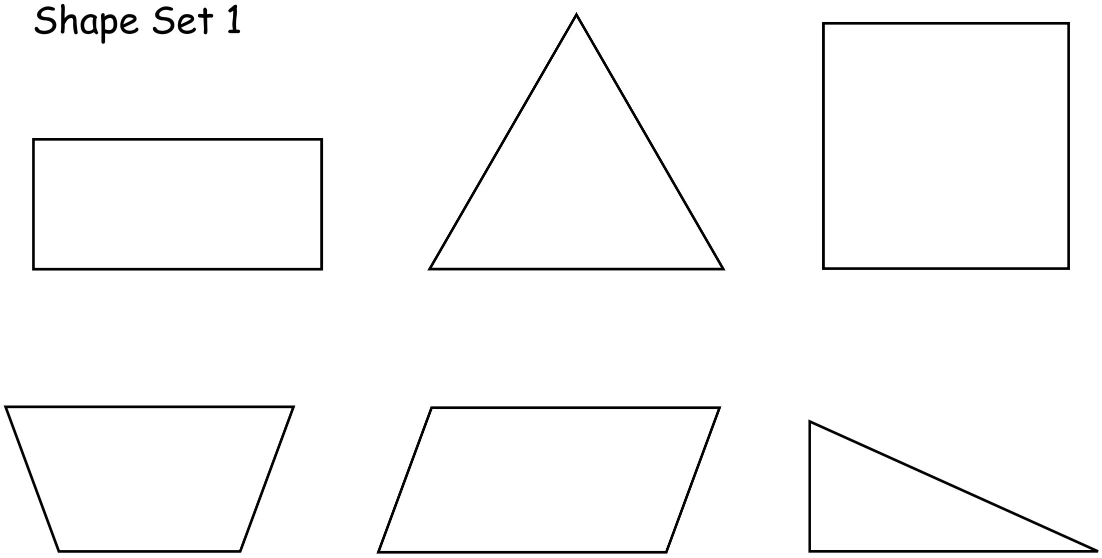
Now, ask your child to open his or her eyes and look at the arrangement. After a few seconds, cover the arrangement with a sheet of paper.

Have your child use his or her set of shapes to re-create your shape arrangement from memory. When your child has finished, show your arrangement again, and compare the two arrangements.

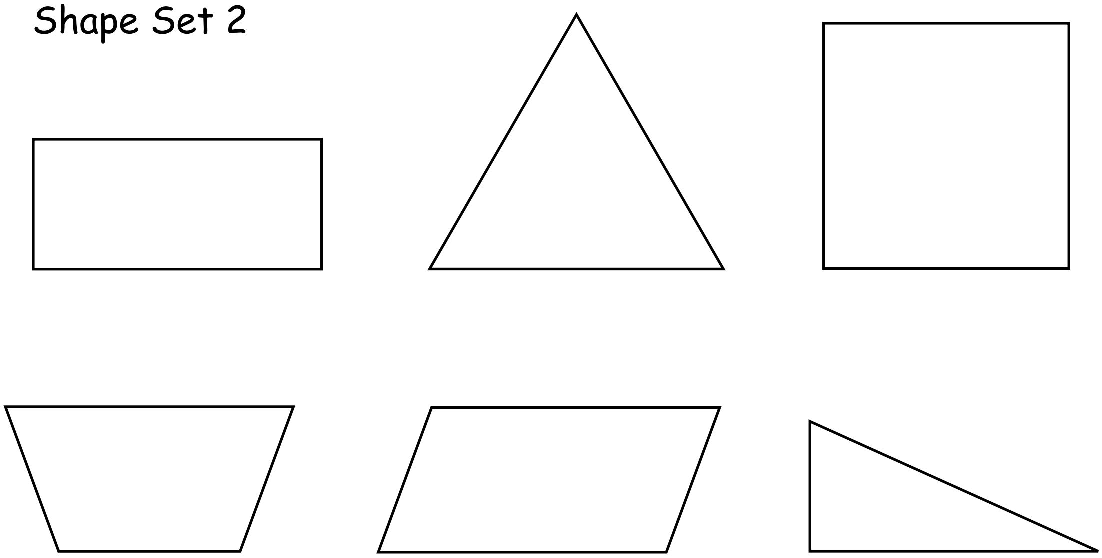
When your child is able to re-create arrangements made from two shapes, challenge him or her to re-create arrangements made from three or four shapes.

Quick Views

Shape Set 1



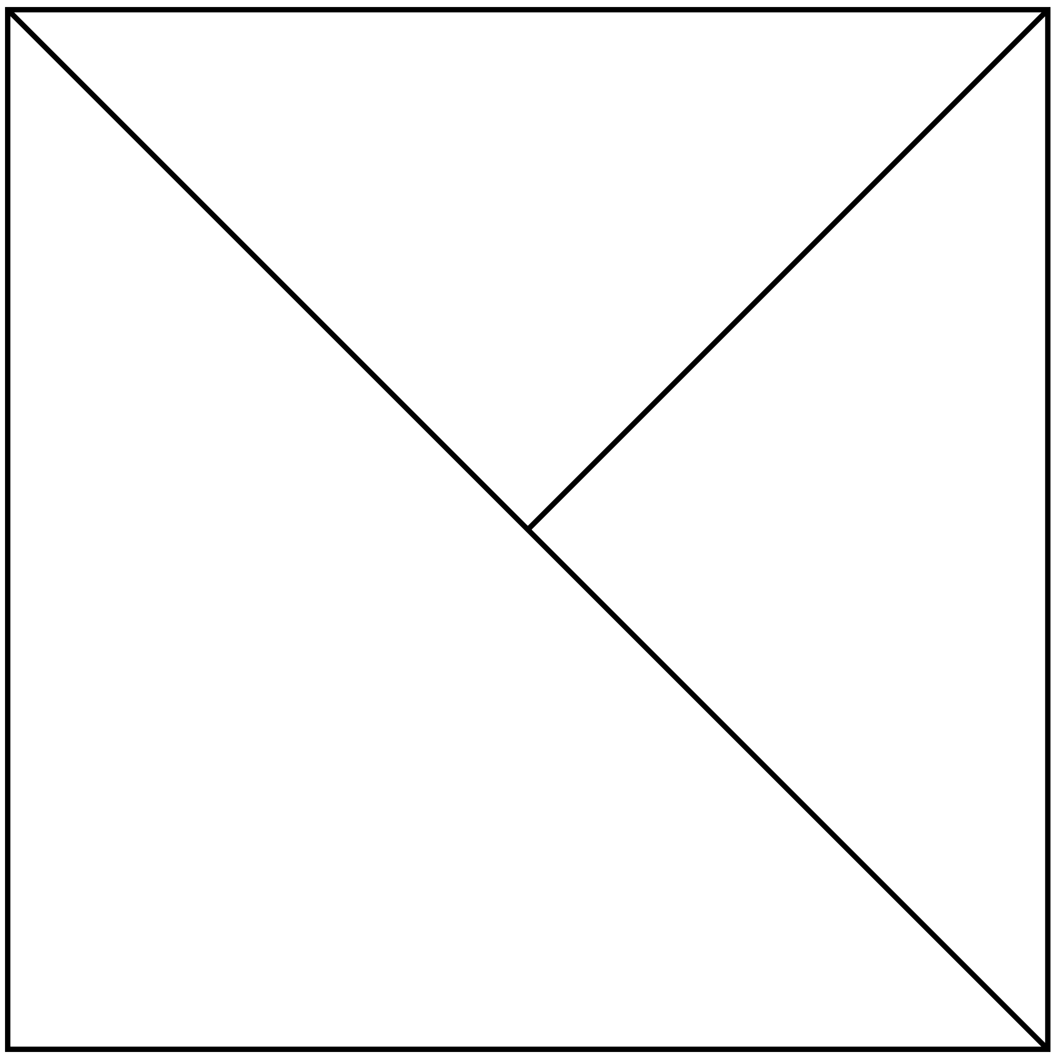
Shape Set 2



Shape Flash Cards

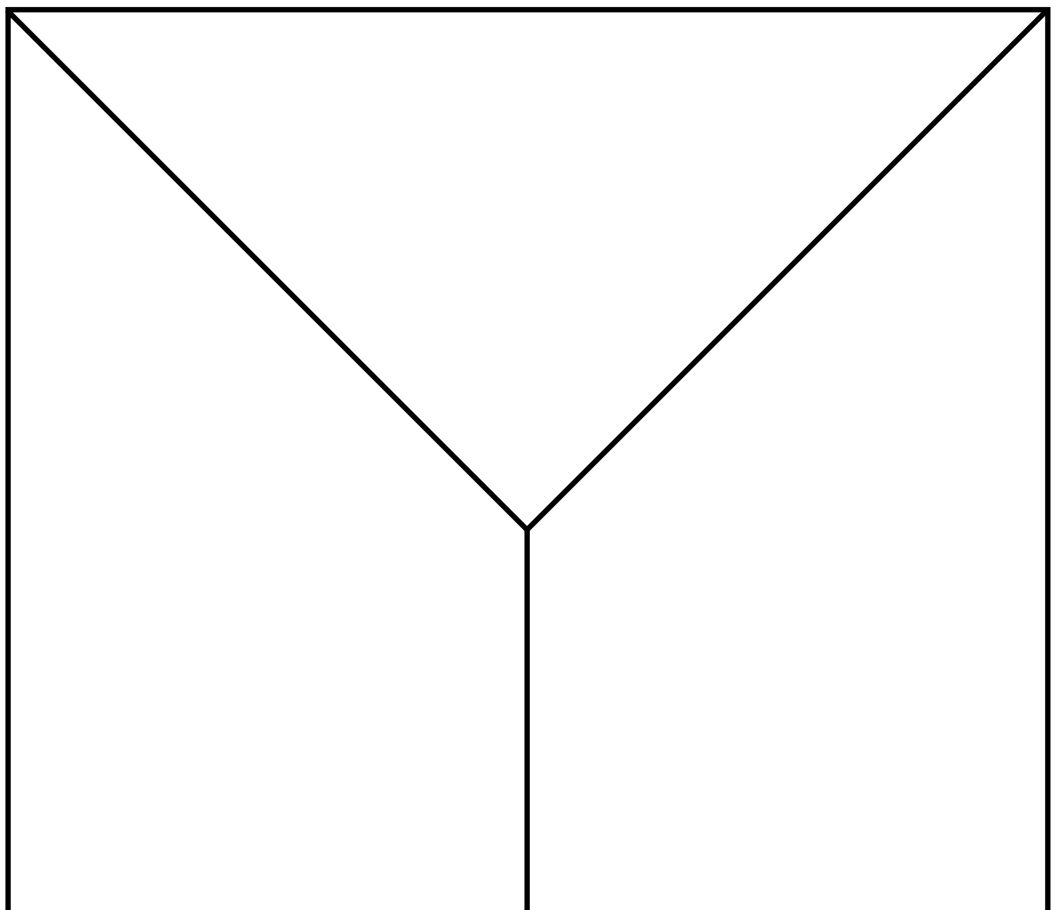
Shape Flash Cards

GeoRel2.BLM5 (b)

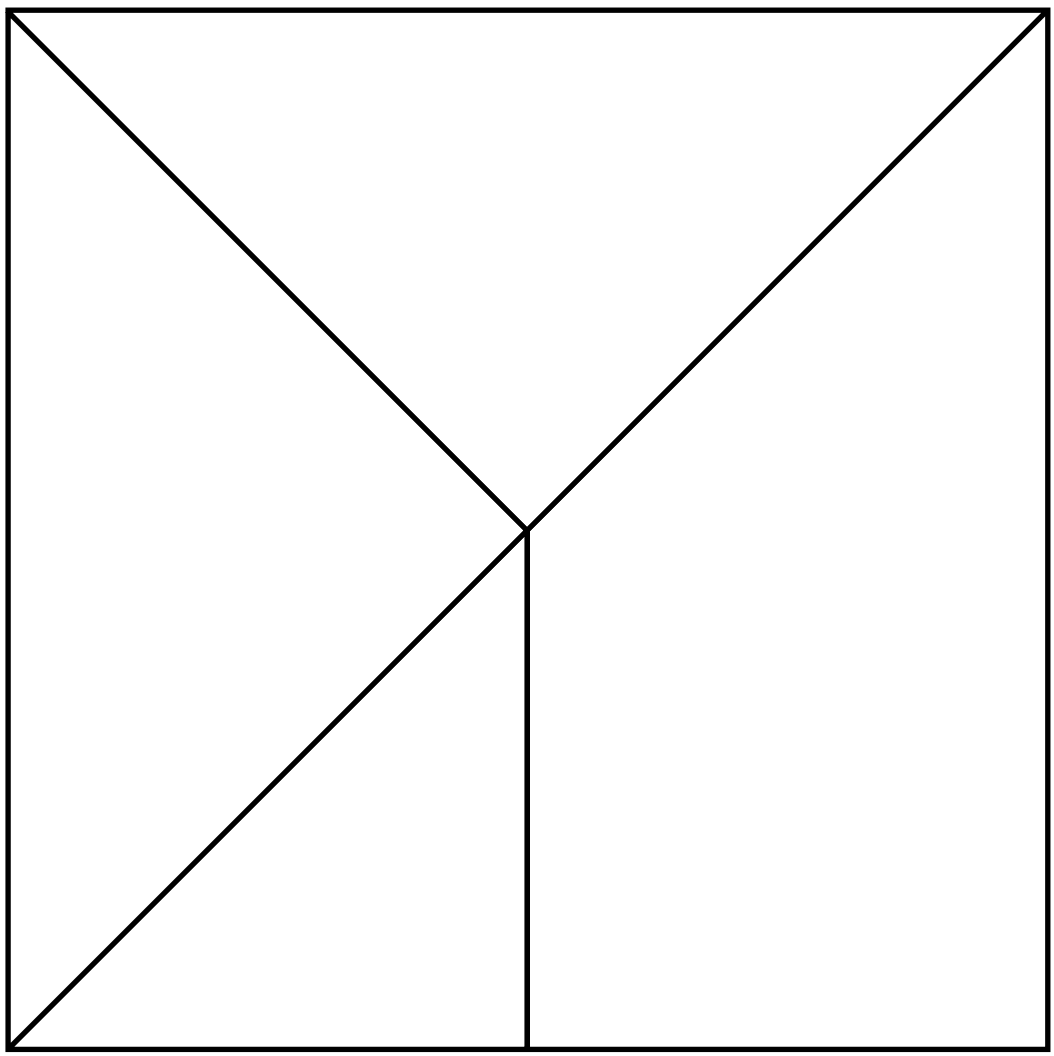


Shape Flash Cards

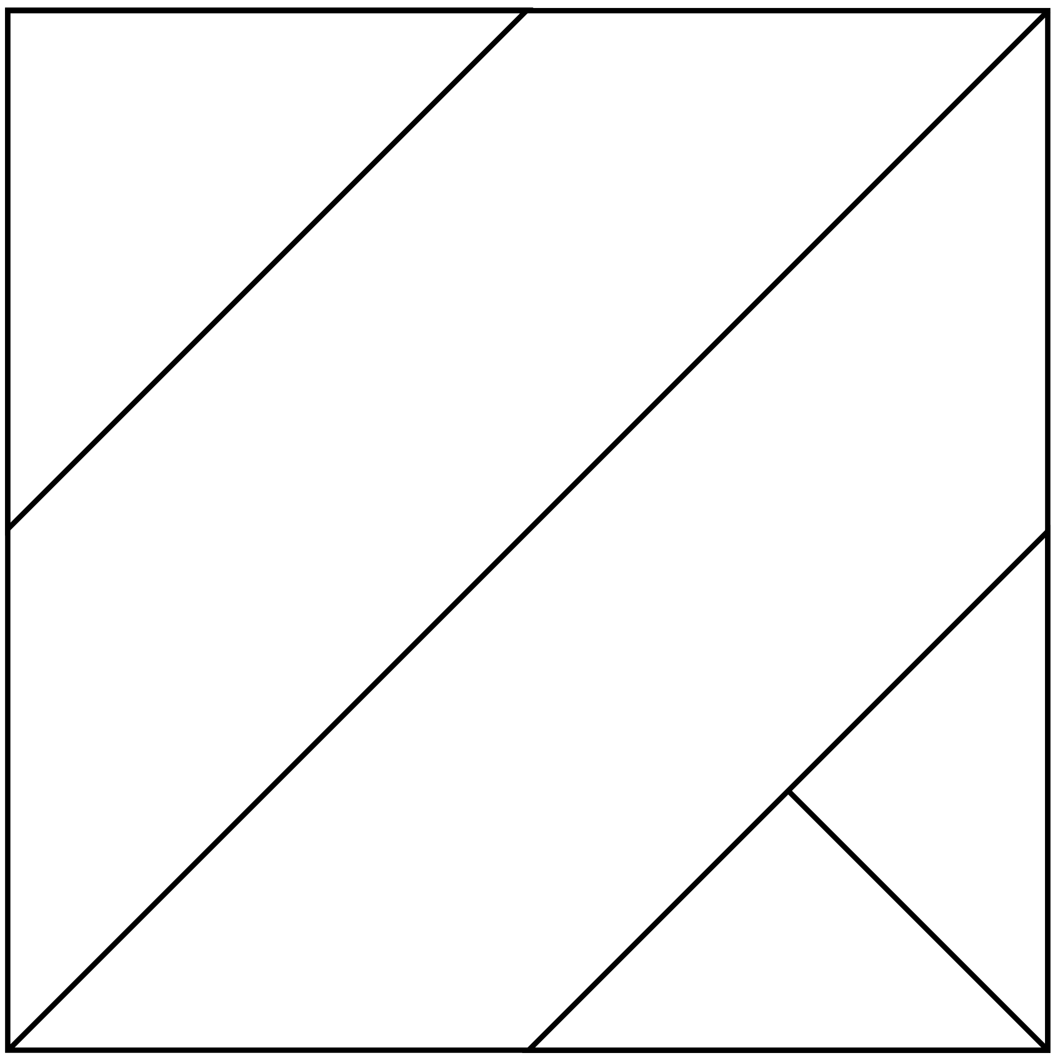
GeoRel2.BLM5 (c)



Shape Flash Cards

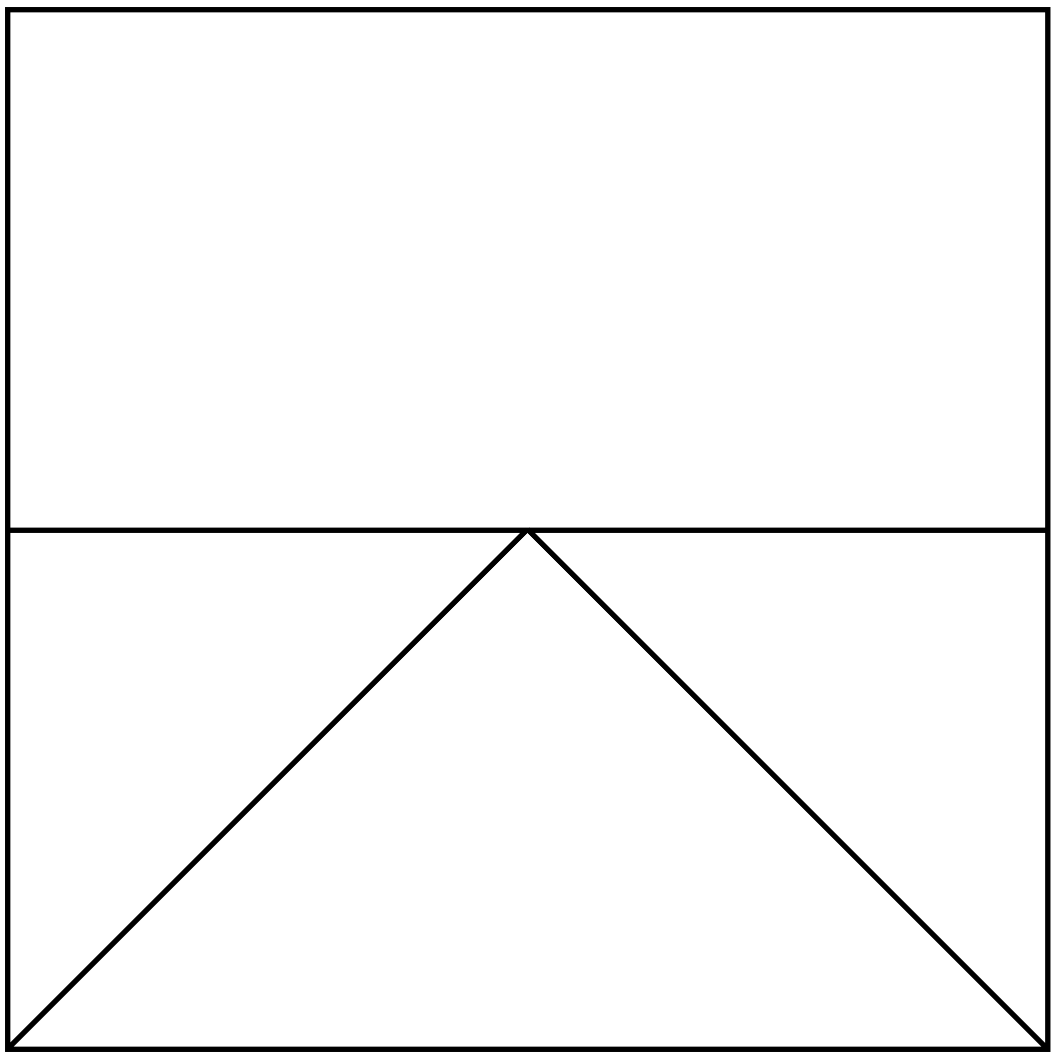


Shape Flash Cards

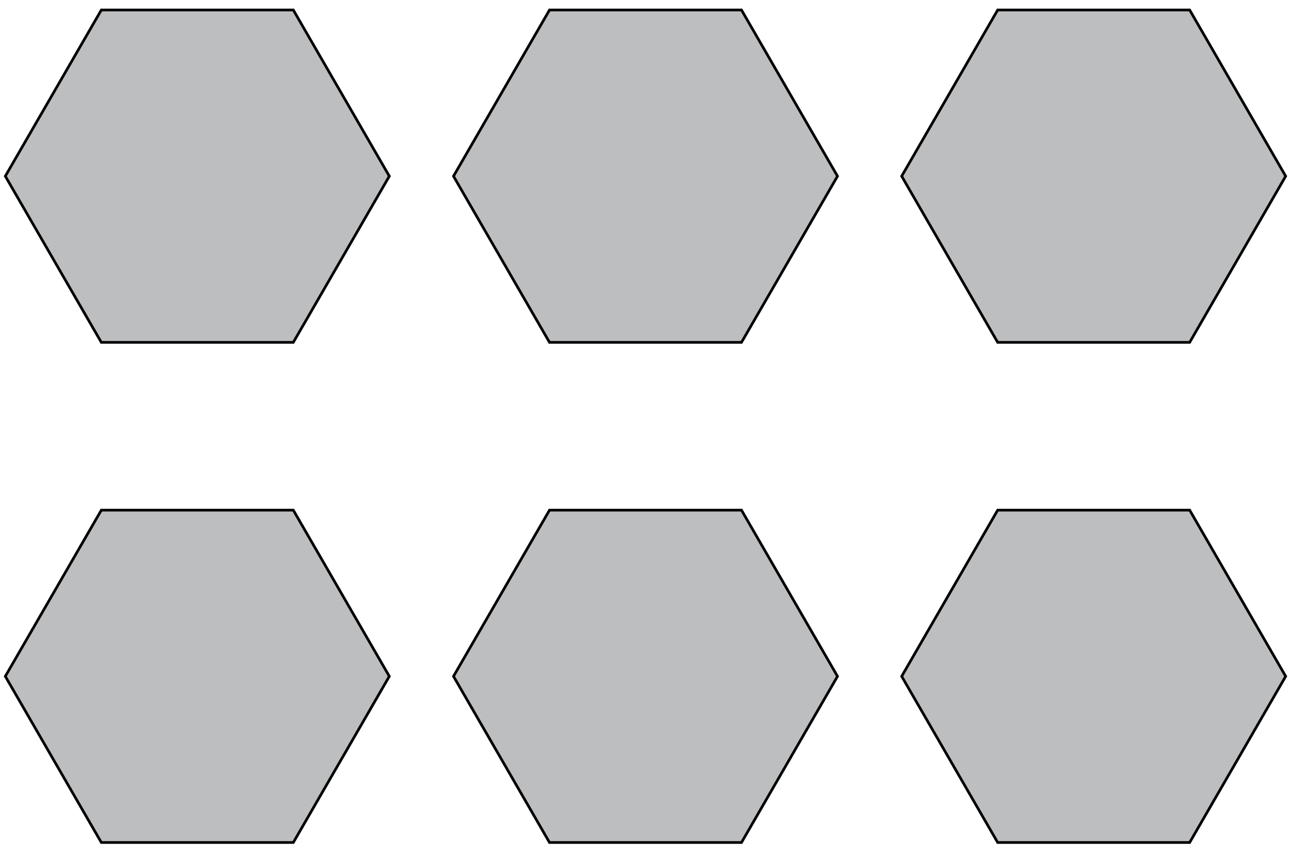


Shape Flash Cards

GeoRel2.BLM5 (f)

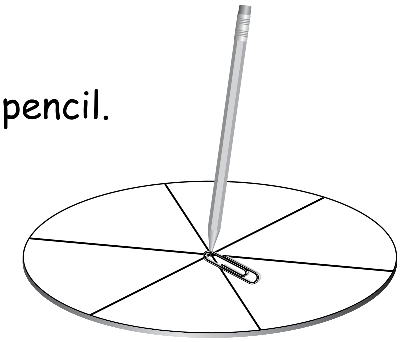


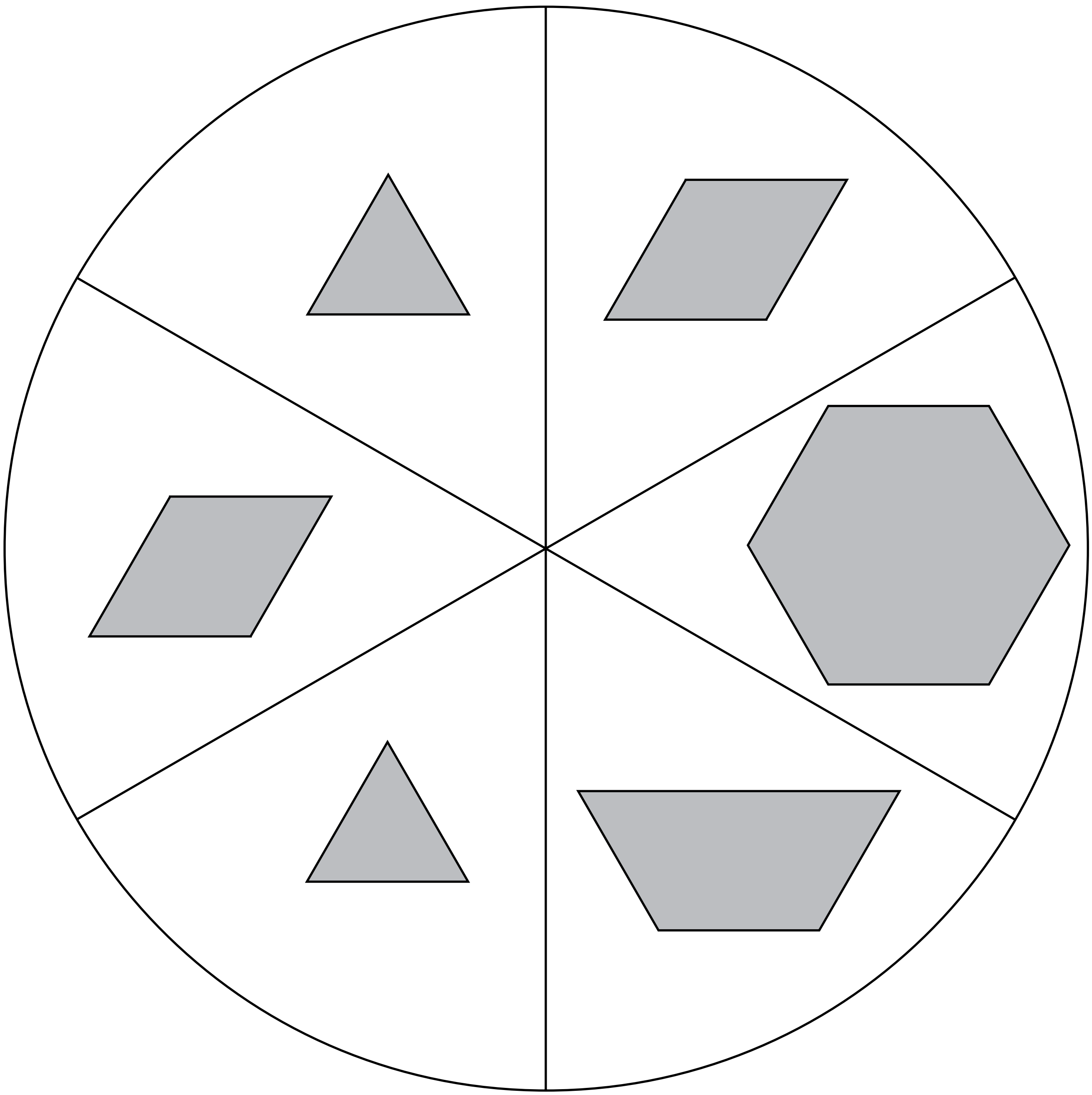
Pizza Parlour Game Board



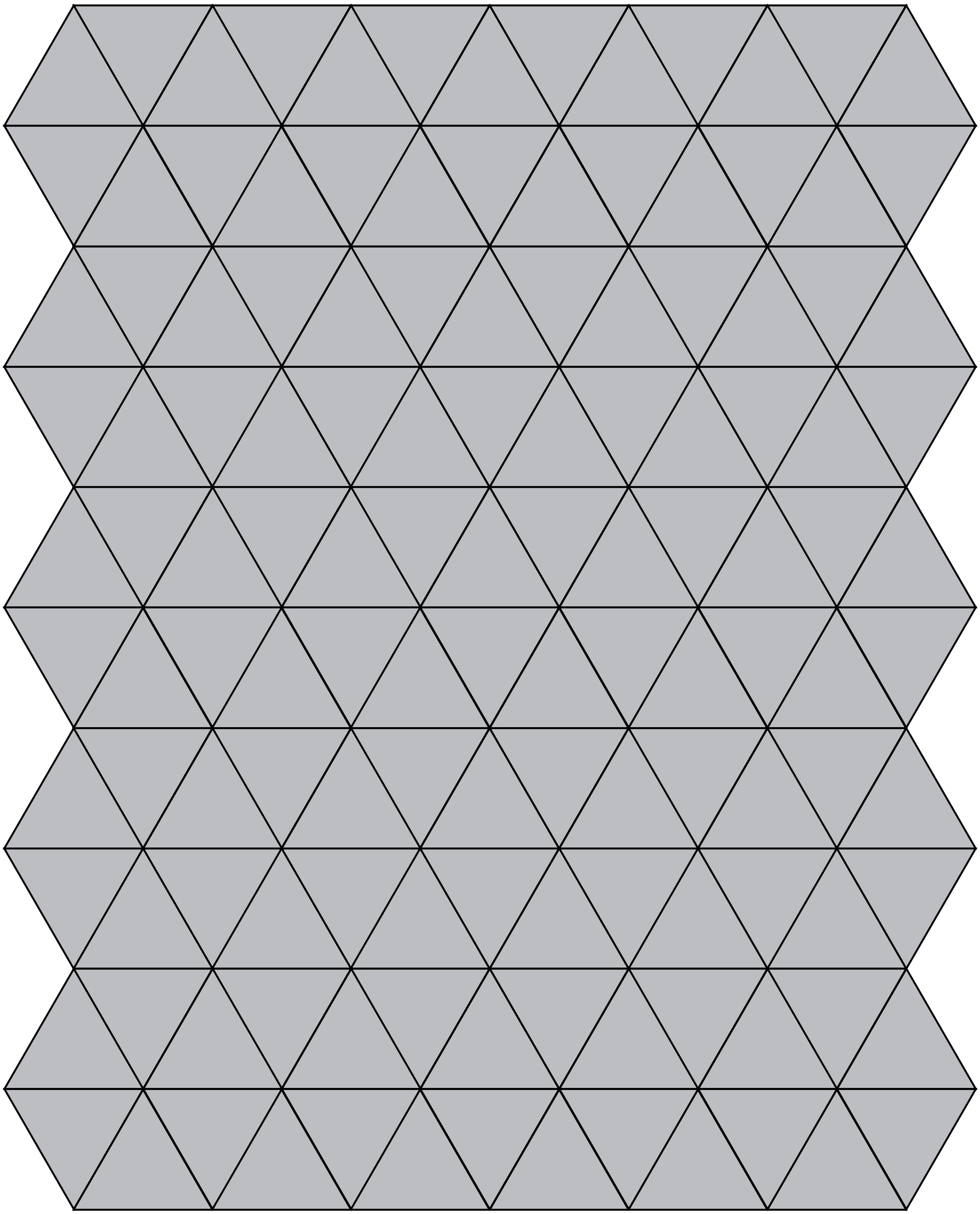
Pizza Parlour Spinner

Make a spinner using this page, a paper clip, and a pencil.





Triangle Paper



Grid Paper

Are We There Yet?

BIG IDEA **Location and Movement**

CURRICULUM EXPECTATIONS

Students will:

- describe the relative locations (e.g., beside, two steps to the right of) and the movement of objects on a map (e.g., "The path shows that he walked around the desk, down the aisle, and over to the window.").

MATERIALS

- Loc2.BLM1: Request for Stuffed Animals (1 per student)
- stuffed animals (brought to class by students; 1 per student)
- overhead projector
- transparency of Loc2.BLM2: Are We There Yet? Game Board
- Loc2.BLM2: Are We There Yet? Game Board (1 per student)
- counters (1 per student and 1 for teacher)
- spinner made with Loc2.BLM3: Are We There Yet? Spinner, a paper clip, and a pencil (1 spinner per pair of students)
- Loc2.BLM4: How Did the Shape Move? (1 per student)

ABOUT THE MATH

Before they learn to describe the location and movement of an object on a map, young students require many experiences in which they move objects in their environment and describe the objects' changes in position. Activities that provide students with opportunities to identify and describe movement using directional language (e.g., to the right of, to the left of, beside, in front of, behind) develop students' spatial sense and vocabulary.

In Getting Started, students give and follow directions on moving stuffed animals to different locations. In Working on It, students play a game in which they develop an understanding of movement on a map.

GETTING STARTED

Before this task, send home Loc2.BLM1: Request for Stuffed Animals. Ensure that stuffed animals are available in the classroom for students who are unable to bring one from home.

Have students sit on the floor facing the front of the class. Ask students to place their stuffed animals on the floor in front of them. Demonstrate how to move a stuffed animal to the left of you, while modelling appropriate language: "I moved my toy to my left". (Face the same direction as the students so that your left is also their left.) Ask students to move their stuffed animals to their left. Watch students to verify that they have placed their stuffed animal on their left side, and help any students who are experiencing difficulty. Repeat this process using such expressions as "to the right of", "in front of", "behind", and "above your head". Have student volunteers lead the class with other movement directions.

Ask students to find a partner and their own space in the classroom. Model how to play a game by asking a student to be your partner and to follow your directions (e.g., "Place your stuffed animal behind you"). Ask the student to give you the next direction. Explain that partners take turns giving each other directions for moving their stuffed animals.

WORKING ON IT

Project a transparency of Loc2.BLM2: Are We There Yet? Game Board, and place a counter on the board. Describe how the counter can be moved horizontally or vertically. Be careful in your descriptions that the movement of the projected image matches students' perspective (e.g., "up" means up from where students are sitting). Ask a student to move the counter two spaces. Ask another student to demonstrate a different way to move the counter two spaces.

Demonstrate the Are We There Yet? game. Explain that students will play the game with a partner. Tell students that the object of the game is to be the first player to move a counter from the Start to the Finish position on his or her game board. Explain the game's procedures:

- Students each place a counter on the Start square on Loc2.BLM2: Are We There Yet? Game Board.
- Players take turns spinning the spinner, made from Loc2.BLM3: Are We There Yet? Spinner, a paper clip, and a pencil, and moving their counter horizontally or vertically.
- Players may not move their counter on top of objects on the map (e.g., shaded rectangles with pictures of a bench, a pool, a tree).
- If a player is unable to move his or her counter the number of spaces indicated on the spinner, his or her turn ends.
- Players continue to spin, moving their counter towards the Finish position. Players must continue to move until they are successful. For example, if a student who is two squares from the Finish square spins "3 spaces", he or she must move three squares in some direction.

While students play the game, ask them questions, such as:

- "Where is your counter now?"
- "Why did you move your counter in this direction?"
- "Where would your counter be if you moved it three spaces to the right?"
- "How could you move your counter so that it is close to the bench?"
- "Did you make a move that you now wish you had done in a different way? Why?"

REFLECTING AND CONNECTING

After students have played the game, ask them questions, such as the following:

- "What was challenging about this game?"
- "What strategies did you use in this game?"
- "What are some ways you moved your counter on the game board?"

Project a transparency of Loc2.BLM2: Are We There Yet? Game Board. Place a counter on the map and ask students to describe its location in different ways (e.g., "The counter is to the left of the pool." "It is between the tree and the pool." "It is near the tree." "It is three squares below the bench."). Emphasize the positional language that students use to describe location.

ADAPTATIONS/EXTENSIONS

Some students may have difficulty with the game. Suggest that they use a simpler spinner (e.g., a spinner indicating movement of only one or two spaces) and a smaller map.

Challenge students by asking them to create their own game board with different obstacles or to develop another spinner with more specific directions (e.g., move three spaces vertically). Suggest that students include diagonal movements for a greater challenge.

MATH LANGUAGE

- above
- in front of
- behind
- to the right
- to the left
- vertically
- horizontally
- forward
- backwards
- sideways
- up
- down

SAMPLE SUCCESS CRITERIA

- moves the counter on the map the appropriate number of spaces
- describes the location of the counter on the map using appropriate language (e.g., "My counter is to the right of the slide.")
- describes the movement of the counter on the map using appropriate language (e.g., "I moved my counter three spaces down and one square to the right.")
- creates symmetrical designs using a variety of tools
- describes symmetrical designs using appropriate language

HOME CONNECTION

Send home Loc2.BLM4: How Did the Shape Move? In this Home Connection task, parents or guardians move a shape and students try to describe the movements.

LEARNING CONNECTION 1

Find the Doughnut

Materials

- transparent geoboard
- overhead projector
- 5 x 5 geoboards (1 per student)
- washers (1 per student and 1 for teacher)

Away from students' view, place a washer, representing a doughnut, on one peg on a transparent geoboard on the overhead projector. Give students clues to help them locate the "doughnut". For example, you could say, "The doughnut is in the second row. It is near the right end of that row." Ask students to show where they think the doughnut is located by placing a washer on their geoboards. Turn on the overhead projector, and have students check to see whether their doughnut is in the correct position.

LEARNING CONNECTION 2

Treasure Hunt

Materials

- small object, such as a paper clip or pencil (1 per pair of students)

Have pairs of students participate in a classroom treasure hunt. Have one student hide a small object in the classroom. Ask the student to provide oral directions that will help his or her partner find the hidden object. The student may use directions such as "take two steps to the right", "take four steps backwards", and so on, to lead his or her partner to the "treasure". Then have students switch roles.

LEARNING CONNECTION 3

Symmetry on the Screen

Materials

- "Pattern Blocks" or "Notepad" learning tools at Mathies.ca
- computer(s)

Ask students to work with a partner. Have students use the "Pattern Blocks" or "Notepad" learning tools at Mathies.ca to make symmetrical designs. Ask students to draw a vertical line on the computer screen (a line of reflection or symmetry) and draw simple shapes on one side of the line. Then have their partner draw the shapes on the other side of the line to create a symmetrical design. Encourage students to describe the position of the shapes they add to the symmetrical design (e.g., "I drew a triangle under the square").

LEARNING CONNECTION 4

Symmetrical Shapes

Materials
- geoboards (1 per student)
- geobands (elastic bands) (1 per student)
- Miras (1 per student)
- dot paper (4 sheets per student)
- 2 different-coloured pencil crayons (2 colours per student)

For each challenge that follows, have students:
- make the shape on the geoboard;
- use a Mira to find the lines of symmetry;
- copy the shape onto the dot paper;
- draw the line(s) of symmetry in a different colour.

Present the following challenges to students. Give directions orally or on task cards:
- Make a quadrilateral with one line of symmetry.
- Make a hexagon with no lines of symmetry.
- Make a triangle with one line of symmetry.

Request for Stuffed Animals

Dear Parent/Guardian:

We will be learning about location and movement in geometry.

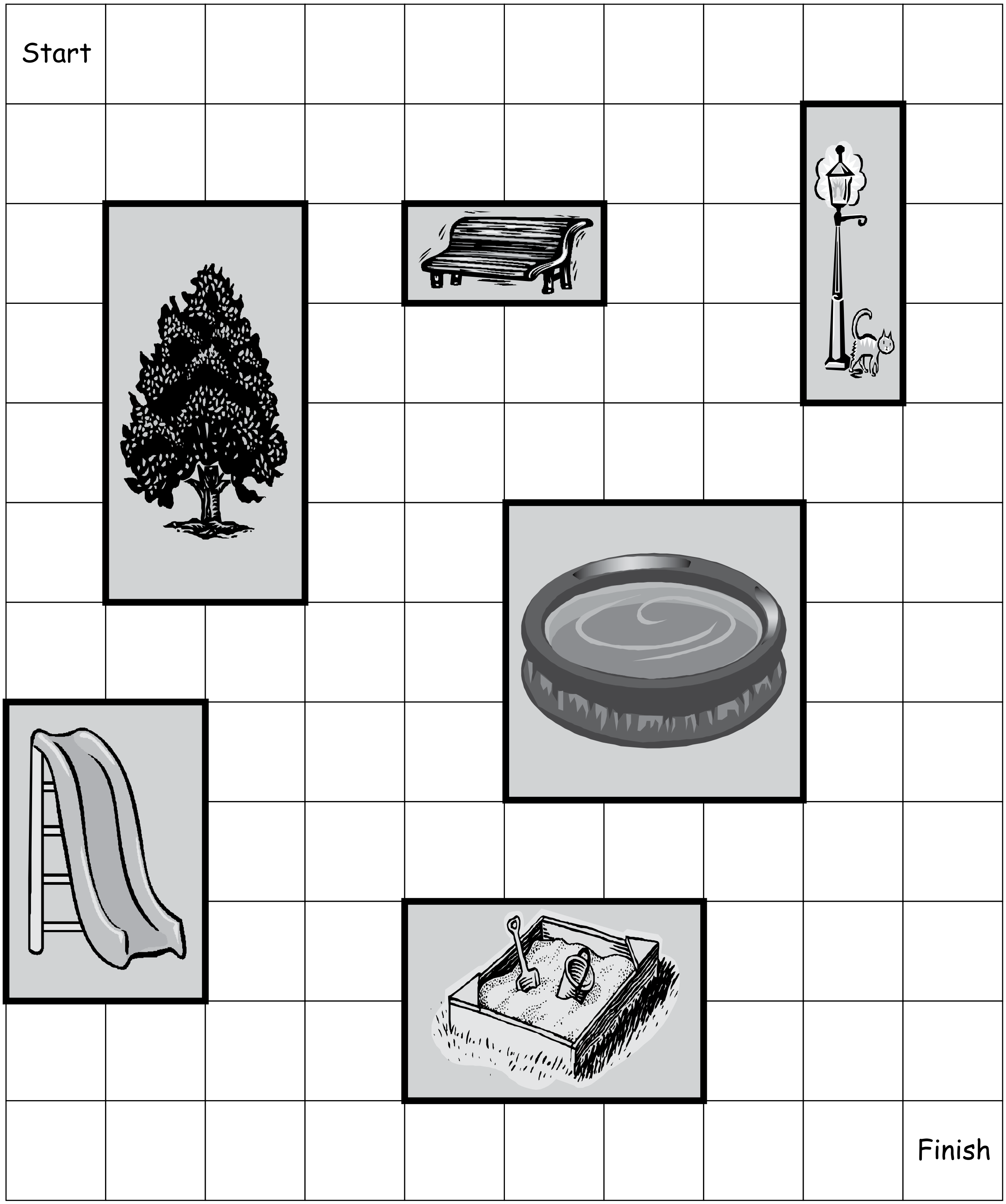
To help students understand important ideas about location and movement, we will work on activities in which students manipulate objects. One of the activities involves movements using stuffed animals.

Please allow your child to bring a stuffed animal to school this week. I can assure you that students will be asked to use the stuffed animals responsibly and to keep them in good condition.

If you have an extra stuffed animal for a child without one, please send it to school as well.

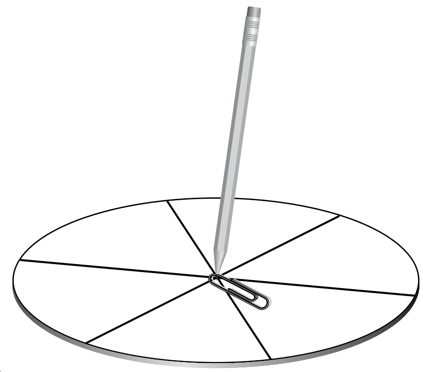
Thank you for your help.

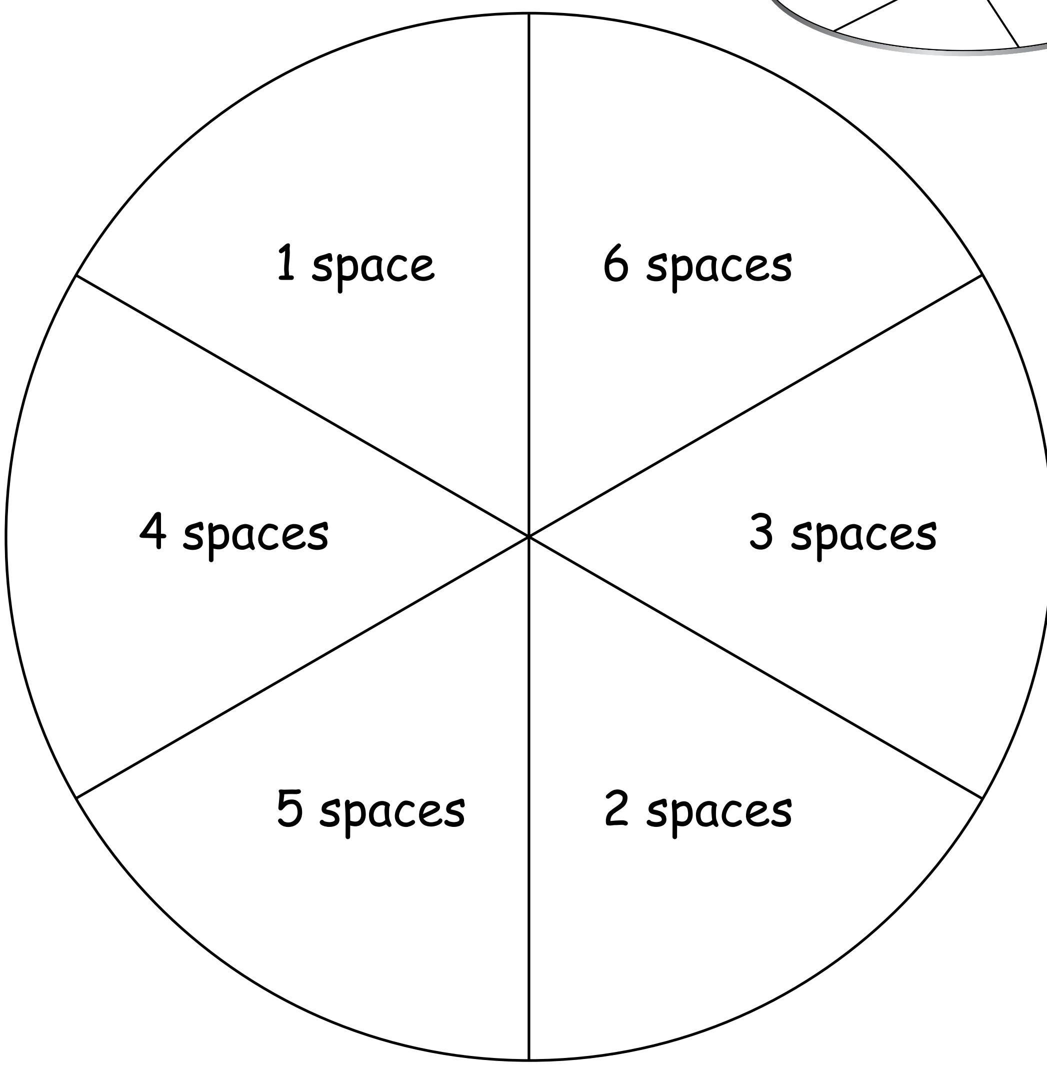
Are We There Yet? Game Board



Are We There Yet? Spinner

Make a spinner using this page, a paper clip, and a pencil.





How Did the Shape Move?

Dear Parent/Guardian:

Our class is exploring activities that develop spatial sense. When we move objects in our world, we can use language to describe these movements.

Sit beside your child. Place an object in front of both of you. Give your child directions as to how to move the object, such as:

- "Move it to your right side."
- "Move it in front of you."
- "Move it behind you."
- "Move it above your head."
- "Move it under you."

Switch roles and have your child provide the directions while you move the object.

You could also play Hot or Cold.

Somewhere in the room, hide an object for your child to find. Have your child move up to five steps at a time and describe the movements to you. For example, your child might say, "I am taking three steps forward". After your child has taken the three steps, ask him or her to pause while you tell whether he or she is "hot or cold ". If your child is near the object, he or she is "hot". If your child is far away from the object, he or she is "cold". As your child moves closer to the object, he or she becomes "warm" or "warmer". As your child moves farther from the object, he or she becomes "cool" or "cooler".

Continue until your child is "on fire" and finds the object you hid.

C. Grade 3 Learning Activities

Appendix Contents

Geoboard Gems

BIG IDEA *Geometric Properties of Two-Dimensional Shapes*

CURRICULUM EXPECTATIONS

Students will:

- identify and compare various polygons (i.e., triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons) and sort them by their geometric properties (i.e., number of sides; side lengths; number of interior angles; number of right angles);
- identify congruent two-dimensional shapes by manipulating and matching concrete materials (e.g., by translating, reflecting, or rotating pattern blocks).

MATERIALS

- 5 x 5 geoboards (1 per student)
- geobands (elastic bands) (1 per student)
- chart paper
- index cards (1 per student)
- Prop2D3.BLM1: Geoboard Gems (1 per student)
- scissors
- Prop2D3.BLM2: Toothpick Shapes Game (1 per student)

ABOUT THE MATH

Experiences in examining and describing two-dimensional shapes help students to recognize the properties of shapes and to understand that all shapes within a category share common properties. For example, students learn that all triangles, regardless of their form, size, or orientation, have three sides and three vertices. Students who demonstrate the ability to identify shapes by their properties, rather than by their general appearance alone, have progressed from the visualization level to the analysis level, according to van Hiele's levels of geometric thought (see p. 14).

Geoboards are effective instructional tools to help students examine and describe two-dimensional shapes. In this task, students create shapes on geoboards and classify the shapes according to number of sides. By comparing the shapes within a category (triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons), students observe that the shapes share a common property (i.e., the same number of sides) but that the shapes can have different forms.

The task also provides opportunities for students to describe and analyse shapes as they:

- write clues about geoboard shapes they create;
- identify a specific geoboard shape in an assortment of shapes by listening to clues about the shape;
- construct shapes on geoboards according to a set of clues.

GETTING STARTED

Provide each student with a 5 x 5 geoboard and a geoband. Instruct students to create a shape that has from three to eight straight sides.

Tell students that their shapes belong to one of six families: the Triangles, the Quadrilaterals, the Pentagons, the Hexagons, the Heptagons, or the Octagons. Explain that each shape family is having a party, so all family members need to get together. Instruct students to identify their geoboard shape and then to walk around the room looking for family members. When students have found all their family members, they gather together with their geoboards.

Discuss the geoboard shapes in each shape family by asking students questions, such as the following:

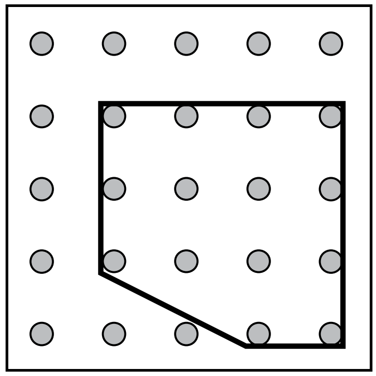
- "Which family does your shape belong to?"
- "What do all your family members have in common?"
- "What are some differences among your family members?"

Ask students: "Suppose you met a shape that did not know which family it belonged to. How could you help the shape decide which family to join?" Discuss the need to count the sides in order to identify a shape.

WORKING ON IT

Have students gather and bring their geoboard shapes. Show one student's geoboard shape to the class, and ask students to describe it. Record their statements on chart paper. For example, the following statements could be made for the shape illustrated on the next page:

- The shape is a pentagon.
- The shape has five vertices.
- Three angles are right angles.
- There are four pins in the middle of the shape.
- Two sides are the same length.



Have students turn to a partner and describe their geoboard shapes. They can refer to the recorded statements for ideas on how to describe their shapes.

Next, ask students to use their geoboards and make a different shape that has from three to eight straight sides. Have them record a description of their shape on an index card.

When students have finished writing their descriptions, choose six geoboards that show different shapes. Place the geoboards on the ledge of the board. Keep the index card descriptions hidden. Choose the index card for one of the geoboard shapes, and read the description to the class. Ask students to listen carefully to the description and try to determine the corresponding geoboard. Pause after reading each statement on the card to give students time to analyse the geoboard shapes with the description in mind. After reading some of the statements, point to one of the geoboards, and ask students to explain whether the shape could be the one being described.

Finish reading all the statements on the index card, and then ask students to choose the geoboard shape that they think is described and to justify their choice. When students agree on a geoboard shape, ask them to describe it in ways that are not recorded on the index card.

Next, change the order of the geoboards on the ledge, read the description on another index card, and have students identify the matching geoboard shape.

Give back the geoboards and ask students to create another shape that has from three to eight straight sides. Have them draw their shape on the dot paper section of Prop2D3.BLM1: Geoboard Gems and record clues about their shape on the lined section of the sheet. Have students cut the paper into two parts along the dotted line.

Ask students to find a partner. Have them keep their dot paper shapes face down and exchange the written "Clues" sections with their partner. Have students read the clues and try to make the described shape on a geoboard. Next, ask students to compare their completed geoboard shape with the one drawn on their partner's dot paper to see whether the shapes are congruent. If the shapes are not congruent, ask students to analyse and discuss the differences and make appropriate changes to the geoboard shape.

REFLECTING AND CONNECTING

Ask the following questions to help students think about the task:

- "Were you able to make a geoboard shape that was congruent to the dot paper shape? Why or why not?"
- "What was challenging about following your partner's clues?"
- "What kinds of clues did you need to give to your partner so that he or she was able to create a congruent shape?"

Ask other questions to help students reflect on the properties of two-dimensional shapes:

- "How do you identify a shape? For example, how do you identify a pentagon?"
- "What shape is a stop sign? How do you know that a stop sign is an octagon?"
- "Do all octagons look like a stop sign? How are all octagons the same? How can octagons be different?"
- "How can you describe a two-dimensional shape?" (number of sides, number of vertices, number of right angles, side length)

Show students two different geoboard shapes from different families, (e.g., a pentagon and a hexagon). Say: "Look at these two shapes. How are they the same? How are they different?" Repeat with two different geoboard shapes from the same family (e.g., two different pentagons).

ADAPTATIONS/EXTENSIONS

Some students may have difficulty following the clues. Ask their partner to help them make the shapes on the geoboards.

Some students may require clearly stated directions. To help these students, prepare clue cards for simple shapes ahead of time. If students require oral directions, you, or a student, could read the clues aloud.

Challenge students by asking them to make two different shapes on two geoboards. Have these students record descriptions of how the shapes are the same and how they are different.

MATH LANGUAGE

- triangle
- quadrilateral
- pentagon
- hexagon
- heptagon
- octagon
- vertex/vertices
- right angles
- congruent
- polygon

SAMPLE SUCCESS CRITERIA

- identifies two-dimensional shapes using properties (e.g., number of sides, side lengths, number of interior angles, number of right angles)
- describes two-dimensional shapes using appropriate geometric vocabulary
- sorts two-dimensional shapes by their geometric properties (i.e., number of sides, side lengths, number of interior angles, number of right angles)

HOME CONNECTION

Send home Prop2D3.BLM2: Toothpick Shapes Game. In this Home Connection game, students and their parents/guardians make two-dimensional shapes using toothpicks.

LEARNING CONNECTION 1

Cutting Corners

Materials

- scissors (1 per student)
- rectangular sheets of scrap/GOOS paper (1 per student)

Provide each student with a pair of scissors and a sheet of scrap/GOOS paper. Ask students to identify the shape of the sheet of paper (rectangle or quadrilateral). Next, instruct students to cut a corner from the sheet of paper. (The cut should be straight.) Have students count the number of sides on their sheet of paper and identify its shape (pentagon).

Have students cut off another square corner from their sheet of paper. Ask them to count the number of sides and to identify the shape of the paper. Do the same for the remaining two corners. The second cut produces a hexagon, the third cut produces a heptagon, and the fourth cut produces an octagon.

Challenge students to make a straight cut on their octagon to create a nine-sided polygon (a nonagon). You can continue to have students making cuts to make shapes with ten, eleven, and twelve sides. Students may be interested to learn the names of these shapes: decagon, hendecagon, and dodecagon.

LEARNING CONNECTION 2

Circle Sort

Materials
- 5 x 5 geoboards (1 per student)
- geobands (1 per student)

Have students sit in a circle. Provide each student with a geoboard and geoband. Ask students to make a shape on their geoboard. Ask ten students to place their geoboards in the middle of the circle. Have students look at the ten geoboards and think about how they could sort the shapes. Ask a student to sort according to his or her own sorting rule. Have the other students examine the sorted shapes and try to determine the sorting rule.

Allow other students to sort the geoboard shapes in other ways and their classmates to determine the sorting rule. After each sort, select an additional geoboard shape from another student. Ask students, "Can this shape be included in your sort? Why or why not?"

LEARNING CONNECTION 3

In-Pins

Materials
- 5 x 5 geoboards (1 per student)
- geobands (1 per student)

Provide each student with a geoboard and a geoband. Ask students to construct a triangle with one interior pin. Explain that the geoband must not touch the interior pin. Students can compare their shape with a partner's.

Challenge students to create other shapes with interior pins (e.g., a triangle with two interior pins, a quadrilateral with three interior pins, a hexagon with one interior pin).

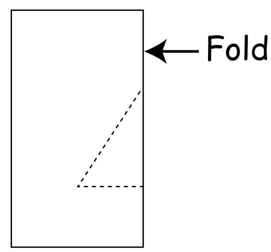
LEARNING CONNECTION 4

Cut and See

Materials

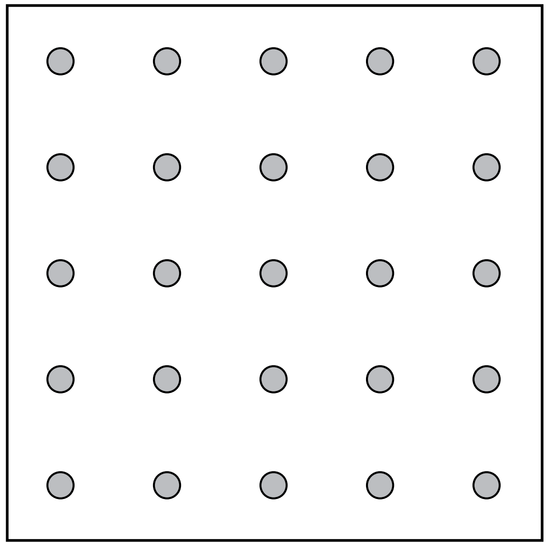
- rectangular pieces of scrap paper (1 per student)
- scissors

Provide students with a sheet of scrap paper and a pair of scissors. Ask students to fold the paper in half and to cut out a shape on the fold that will result in a triangle when the shape is unfolded.



Challenge students to cut out other shapes on the fold that will create a quadrilateral, a pentagon, and a hexagon when the shape is unfolded.

Geoboard Gems



Clues

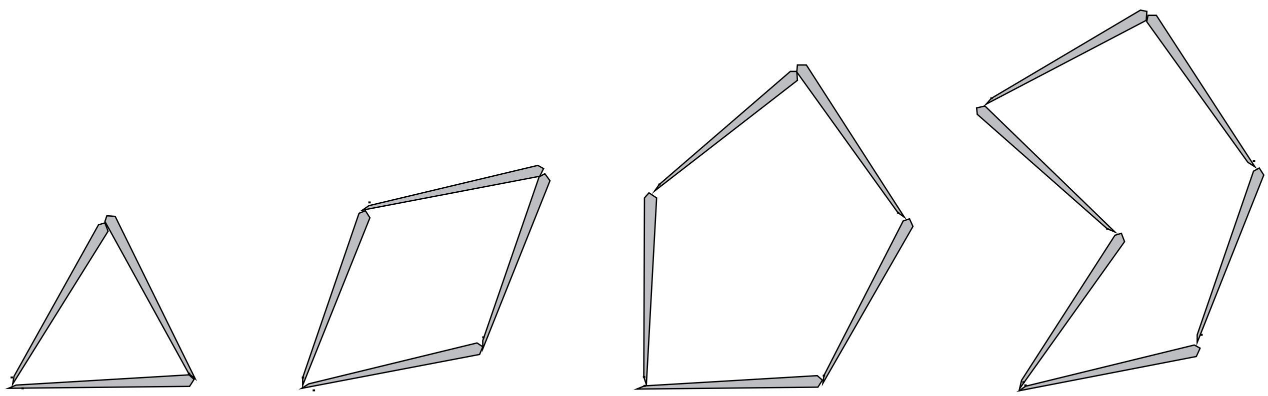
Prop2D3.BLM1

Toothpick Shapes Game

Dear Parent/Guardian:

We have been learning about two-dimensional shapes at school. Play the Toothpick Shapes Game with your child to help him or her review different types of shapes.

Players make triangles, quadrilaterals, pentagons, and hexagons with toothpicks that touch at the ends. Here are some examples:



Triangle: Three Sides	Quadrilateral: Four Sides	Pentagon: Five Sides	Hexagon: Six Sides

If players use three toothpicks, the shape of the triangle is as shown above. If players use four, five, or six toothpicks, they do not have to make the shapes exactly as shown above. Players may make any shape with four, five, and six toothpicks, but the shape must be closed (it may not have gaps between toothpicks).

Players take turns rolling a die. Players take the number of toothpicks indicated by the die and make a shape using the toothpicks.

If the die shows a 1 or 2, the player does not take any toothpicks, and the turn passes to the other player.

The first player to make all four shapes (triangle, quadrilateral, pentagon, hexagon) wins the game.

Nets or Not

BIG IDEA ***Geometric Properties of Three-Dimensional Figures***

CURRICULUM EXPECTATIONS

Students will:

- compare and sort prisms and pyramids by geometric properties (i.e., number and shape of faces, number of edges, number of vertices), using concrete materials;
- construct rectangular prisms (e.g., using given paper nets; using Polydrons), and describe geometric properties (i.e., number and shape of faces, number of edges, number of vertices) of the prisms.

MATERIALS

- triangular prism made from Polydron pieces (for teacher demonstration)
- 8.5 in. x 11 in. (letter-sized) paper (several sheets per group)
- Polydron sets (or Frameworks)
- three-dimensional solid figure of a rectangular prism
- scissors (1 pair per group)
- rulers (1 per group)
- pencils (1 per group)
- chart paper
- three-dimensional solid figure of a triangular prism
- net of a rectangular prism made from Polydron pieces
- square-based pyramid (optional)
- triangle-based pyramid (optional)
- Prop3D3.BLM1: Shapes in Boxes (1 per student)

ABOUT THE MATH

In Grade 3, students are introduced to nets of three-dimensional figures. They learn that nets are composed of two-dimensional shapes and that nets can be folded to create three-dimensional figures. At this grade level, students are not expected to create paper nets themselves. They are expected, however, to build rectangular prisms from nets and to use nets to explore the properties of prisms (e.g., the number and shape of their faces).

In this task, students work with Polydron pieces that represent the faces of prisms. With the pieces connected in different configurations, students try to visualize whether each arrangement can be folded to form a prism. This experience helps students to understand that a net is not simply composed of the two-dimensional faces of a figure arranged in any configuration, but that the position of the faces on the figure determines how the faces can be arranged in its corresponding net.

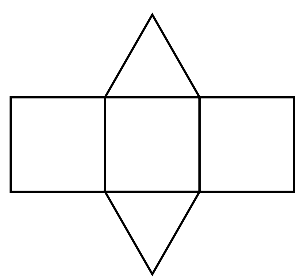
The examination of nets and three-dimensional models helps students identify the properties of prisms (e.g., the shapes of the faces, the number of edges, the number of vertices). The instructional goal is not for students to memorize the number of faces, edges, and vertices of three-dimensional figures, but for them to develop the ability to analyse and describe figures effectively.

The investigation of triangular and rectangular prisms leads to a discussion about the properties of prisms in general. Students begin to understand that the structure for all prisms is similar: Prisms have two congruent, parallel faces, and rectangles form their other faces. Prisms take their names from the shape of the congruent and parallel faces (e.g., prisms with two congruent and parallel triangles are triangular prisms).

Students should investigate and discuss the similarities and differences between prisms. In doing so, students will determine the properties of rectangular prisms. Assessment for this task focuses on the student's ability to describe the properties of rectangular prisms.

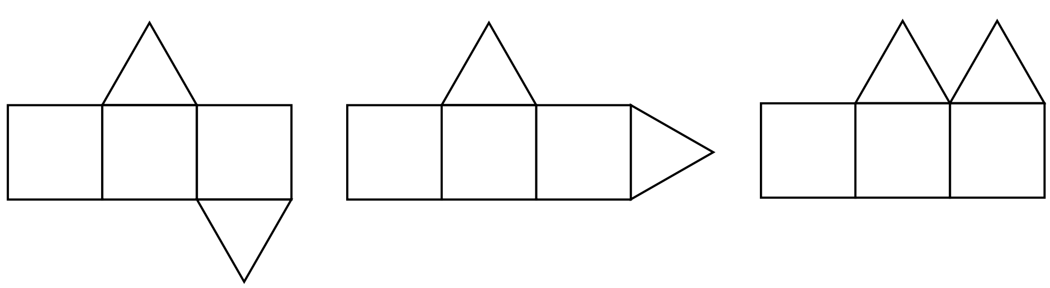
GETTING STARTED

Show students a triangular prism made using Polydron pieces. Draw attention to the properties of a triangular prism by asking students to name the three-dimensional figure and to identify its faces (two triangles and three rectangles). Now, unsnap the Polydron pieces so that they lie flat but are still connected, as shown in the following example.



Explain to students that a net is a flat arrangement of connected two-dimensional shapes that can be folded to create a three-dimensional figure.

Detach one of the triangles and ask students, "Is it possible to reattach this triangle to any side of one of the other Polydron pieces and still have a net for a triangular prism?" Show students different configurations by attaching the triangle to different sides.



Ask students to predict whether each configuration can be folded to create a triangular prism. Fold the Polydron shapes to test students' predictions. Discuss how all the configurations contain the same Polydron pieces but how only those that can be folded to form a triangular prism are nets.

WORKING ON IT

Arrange students in groups of three or four. Ask groups to make a list of the six Polydron shapes they will need to construct a rectangular prism (i.e., six squares, or two squares and four rectangles). Allow students to view a model of a rectangular prism to help them identify the appropriate Polydron pieces.

Invite a student from each group to gather the Polydron pieces on his or her group's list and to snap the Polydron pieces together to construct a rectangular prism. Allow groups to revise their lists if they omitted or incorrectly identified any Polydron pieces.

When groups have constructed a rectangular prism, instruct them to unsnap the six Polydron pieces so that none of them are connected. Explain the following task:

- Have each student, in turn, snap together all six Polydron pieces in any arrangement and show the configuration to group members.
- Ask each student in the group to state either "net" or "not a net" after viewing the Polydron arrangement and trying to visualize whether it can be folded to form a rectangular prism.
- Have students fold the Polydron arrangement to verify their predictions.

Next, have each group trace around one of their Polydron arrangements and cut out the shape they have traced. Have students use a ruler and pencil to draw the interior folding lines.

On the board or chart paper, create two columns. Label these sections "Net" and "Not a Net". Ask each group, in turn, to show their cut-out shape to the class. Students look at the shape and try to visualize whether the shape can be folded to make a rectangular prism. Ask students to give a thumbs-up sign if they think the shape is a net for a rectangular prism or a thumbs-down sign if they think it is not. Ask a student to fold the shape to verify whether it creates a rectangular prism. Post each shape on the board or the chart paper in its proper column.

When all the shapes have been categorized as either "Net" or "Not a Net", ask students:

- "What is a net?"
- "How are a rectangular prism and one of its nets the same? How are they different?"
- "How are the shapes in the Net column the same as the shapes in the Not a Net column? How are they different?"
- "How are all the shapes in the Net column alike? What differences do you notice?"

- "Are there congruent shapes? How do you know that the shapes are congruent?"
- "How can you tell, just by looking at a shape, whether or not it is a net for a rectangular prism?"

REFLECTING AND CONNECTING

Bring the class together, and display a three-dimensional model of a rectangular prism and a net for a rectangular prism. Ask:

- "On which form, the model or the net, is it easier for you to identify the different kinds of faces of a rectangular prism? Why?"
- "On which form, the model or the net, is it easier for you to count the number of edges on a rectangular prism? Why?"
- "On which form, the model or the net, is it easier for you to count the number of vertices on a rectangular prism? Why?"

For each question, allow students to take either the model or the net and demonstrate how they would use it to identify the kinds of faces or to count edges and vertices. Students may feel that counting vertices is easier with the three-dimensional model, because they don't need to think about what "corners" on the net will meet when it's folded. Others may say that seeing the shapes of faces is easier with the net, because the net is flat and they don't need to rotate it to view all the faces. Most students will say that it is easier to count the edges on the three-dimensional model, because all edges are not as readily apparent on the net.

As a class, create a list on chart paper of the properties of a rectangular prism. Allow students to use the models and nets of the prisms. Students may need to examine three-dimensional figures and nets to find the number of faces, edges, and vertices.

Rectangular Prism

- 6 rectangular faces
- 12 edges
- 8 vertices

ADAPTATIONS/EXTENSIONS

Some students may have difficulty recognizing whether a configuration of Polydron pieces is a net. Encourage other group members to help these students. Groups should encourage these students to manipulate the Polydron configuration before they decide whether it is a net.

Challenge students to examine a square-based pyramid and a triangle-based pyramid and use Polydron pieces to create the figures and to find as many different nets as possible.

MATH LANGUAGE

- three-dimensional figure
- two-dimensional shape
- triangle
- rectangle
- square
- triangular prism
- rectangular prism
- net
- face
- edge
- vertex/vertices
- congruent
- prism
- parallel
- pyramid
- square-based pyramid
- triangle-based pyramid

SAMPLE SUCCESS CRITERIA

- constructs rectangular prisms from nets
- recognizes nets for rectangular prisms
- describes the geometric properties of rectangular prisms (e.g., the number and shapes of their faces, number of edges, number of vertices)
- describes nets for prisms using geometric properties

HOME CONNECTION

Send home Prop3D3.BLM1: Shapes in Boxes. In this Home Connection task, students and their parents/guardians unfold boxes and identify the two-dimensional shapes they find in the nets.

LEARNING CONNECTION 1

Decorated Boxes

Materials

- Prop3D3.BLM2a-e: Nets for Figures (1 net per student)
- scissors
- markers, crayons, pencil crayons
- tape or glue

Provide students with copies of nets from Prop3D3.BLM2a-e: Nets for Figures. Have students select one of the nets, cut it out, and – without taping or gluing it together – fold it to form a box.

Have students choose a kind of material, product, or object (e.g., food, toy, school supply) that could be stored in their box. Encourage students to unfold the net and use markers, crayons, or pencil crayons to decorate their boxes in ways that depict the proposed contents. Then have students refold the net and tape or glue their decorated boxes together.

LEARNING CONNECTION 2

Box Elimination

Materials

- Prop3D3.BLM3: Request for Boxes (1 per student)
- a collection of boxes, including cubes, cylinders, square-based pyramids, rectangular prisms, and triangular prisms (brought in by students)

Before this task, send home Prop3D3.BLM3: Request for Boxes, and collect boxes brought to class by students.

Display four to six boxes. Describe one of the boxes by giving clues, such as the following:

- "This box has a square face."
- "It has an even number of faces."
- "It has twelve edges."
- "It could hold a tennis ball but not a basketball."
- "It can be stacked."
- "It has more than one pair of congruent parallel faces."

After each clue is given, instruct students to eliminate a box that does not match the clue. For example, students could eliminate a cylinder following the first clue given above.

Have students continue to eliminate boxes until one box is left.

LEARNING CONNECTION 3

Prism Investigations

Materials

- Polydron sets

Show a triangular prism made with Polydron pieces, and then ask students to use Polydron pieces to construct a triangular prism. Discuss the faces of a triangular prism (two triangles, three rectangles) and their arrangement in the figure (i.e., the two triangles are parallel, and rectangles connect the triangles).

Next, show a rectangular prism, and have students create their own. Again, discuss the arrangement of the faces in the prism.

Have students select a pentagonal Polydron piece. Ask them to select the other pieces needed to build a pentagonal prism. Have them construct it. Ask students to explain how they knew which pieces to select.

Have students select a hexagonal Polydron piece and connect it to other Polydron pieces to construct a hexagonal prism.

Encourage students to make generalizations about prisms by asking questions, such as:

- "How are triangular, rectangular, pentagonal, and hexagonal prisms alike?" (They all have rectangular faces. They all have congruent faces at opposite ends.)
- "How are the prisms different?" (The congruent faces at opposite ends – triangles, rectangles, pentagons, hexagons – are different for each prism.)
- "How can you determine the number of rectangles that connect the faces at opposite ends of a prism?" (The number of rectangles equals the number of sides of one of the end faces. For example, there are three rectangles in a triangular prism.)
- "What are the faces of an octagonal prism? How do you know?" (The name of the prism suggests that there are two octagons. There are eight rectangles, one for each side of an octagon.)

LEARNING CONNECTION 4

Prism Power

Materials

- number cubes with numbers 1 to 6 (1 per pair of students)
- Polydron sets

Have students play this game in pairs. The goal of the game is to construct as many prisms as possible. Tell students to take turns rolling a number cube and collecting the number of Polydron pieces indicated by the number cube. Explain that players may select any Polydron piece and that each player gets five turns. The game can be played in two ways:

1. After each turn, have students examine the pieces they have accumulated and construct a prism if possible.
2. Have students assemble as many prisms as possible from all the accumulated Polydron pieces after the fifth roll of the number cube.

LEARNING CONNECTION 5

Let's Build!

Materials

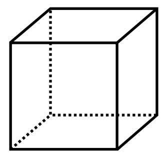
- Prop3D3.BLM4: Let's Build! Cards (1 per student)
- Polydron sets or Frameworks
- three-dimensional figures (for display)

Have students work independently or with a partner. Ask them to select a Let's Build! card, read the clues, and construct a three-dimensional figure using Polydron pieces or Frameworks. Encourage students to refer to models of three-dimensional figures to help them construct the figures.

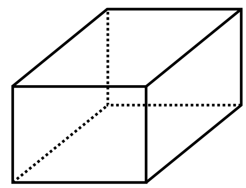
Shapes in Boxes

Dear Parent/Guardian:

We have been learning about three-dimensional figures, such as cubes and rectangular prisms.



Cube

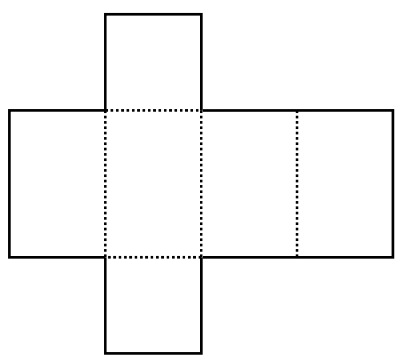


Rectangular Prism

We have been examining the shapes in three-dimensional figures. For example, there are six squares on a cube.

Try this activity with your child.

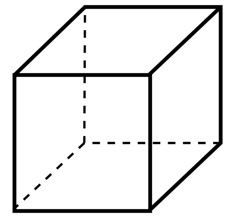
Find an empty box, such as a cereal box, a facial tissue box, or a box of chocolates. Unfold the box carefully by detaching the tabs that hold the box together. Then flatten the box. Your flattened box might look something like this:

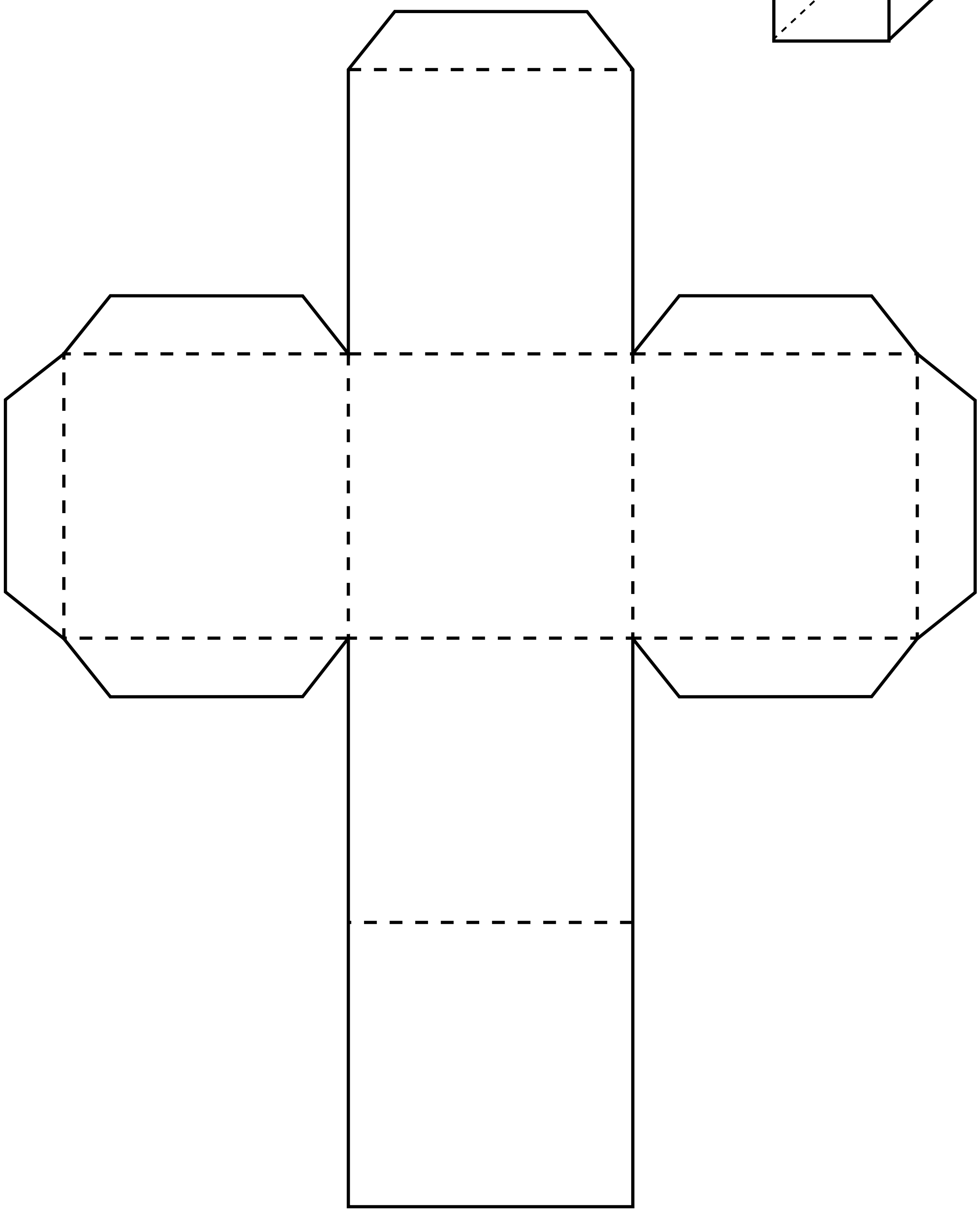


Help your child examine the flattened box, and ask him or her to identify the different shapes. For example, your child might see rectangles and squares. Have your child label the different shapes.

Try the activity with a variety of boxes.

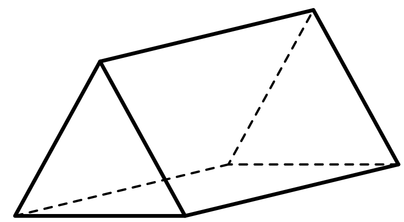
Nets for Figures – Net for a Cube

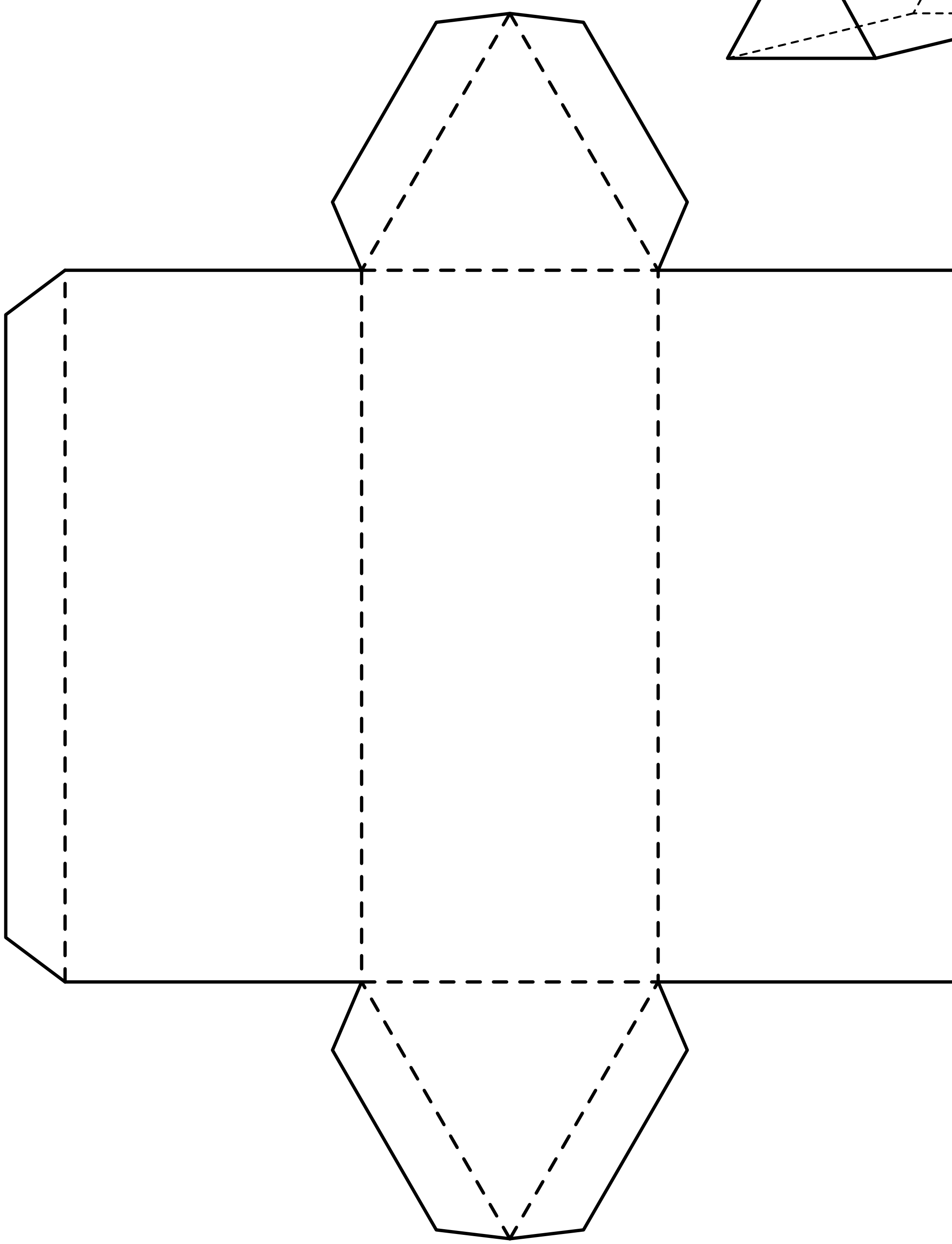




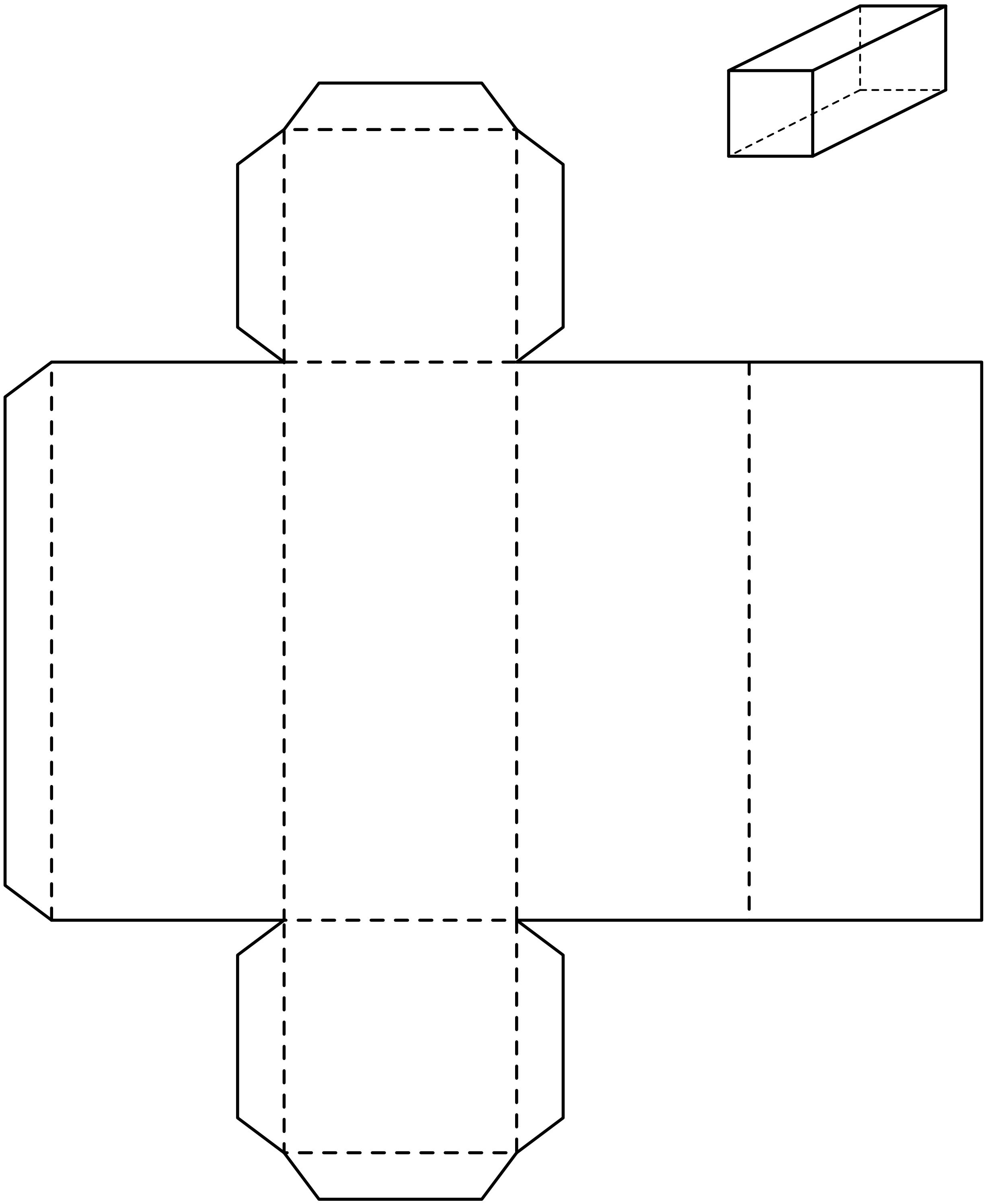
Nets for Figures –
Net for a Triangular Prism

Prop3D3.BLM2 (b)



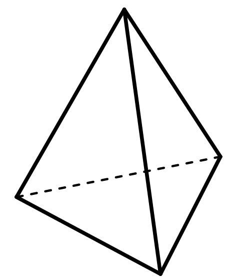


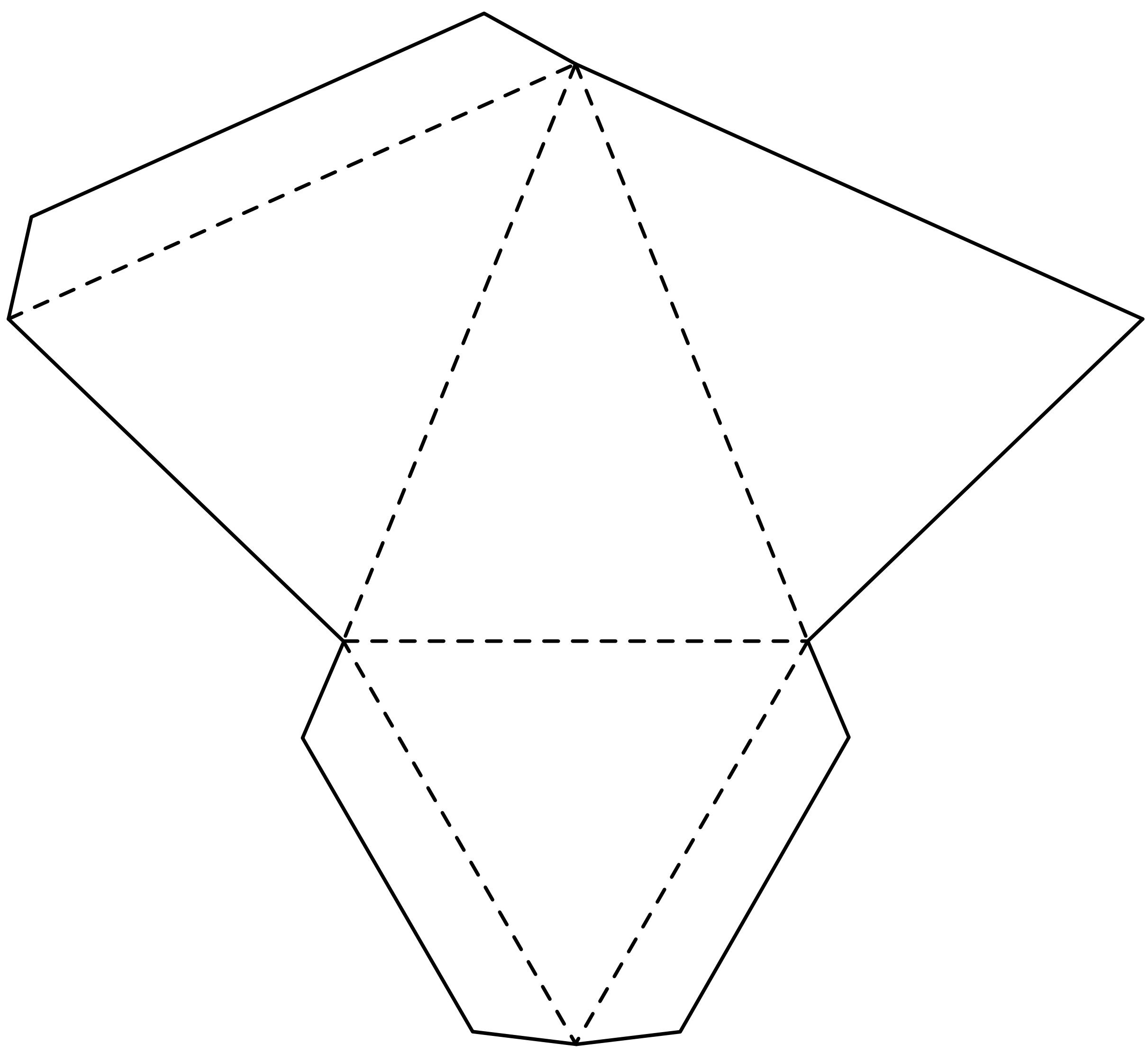
Nets for Figures –
Net for a Rectangular Prism



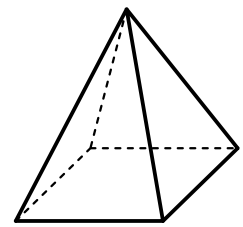
Prop3D3.BLM2 (c)

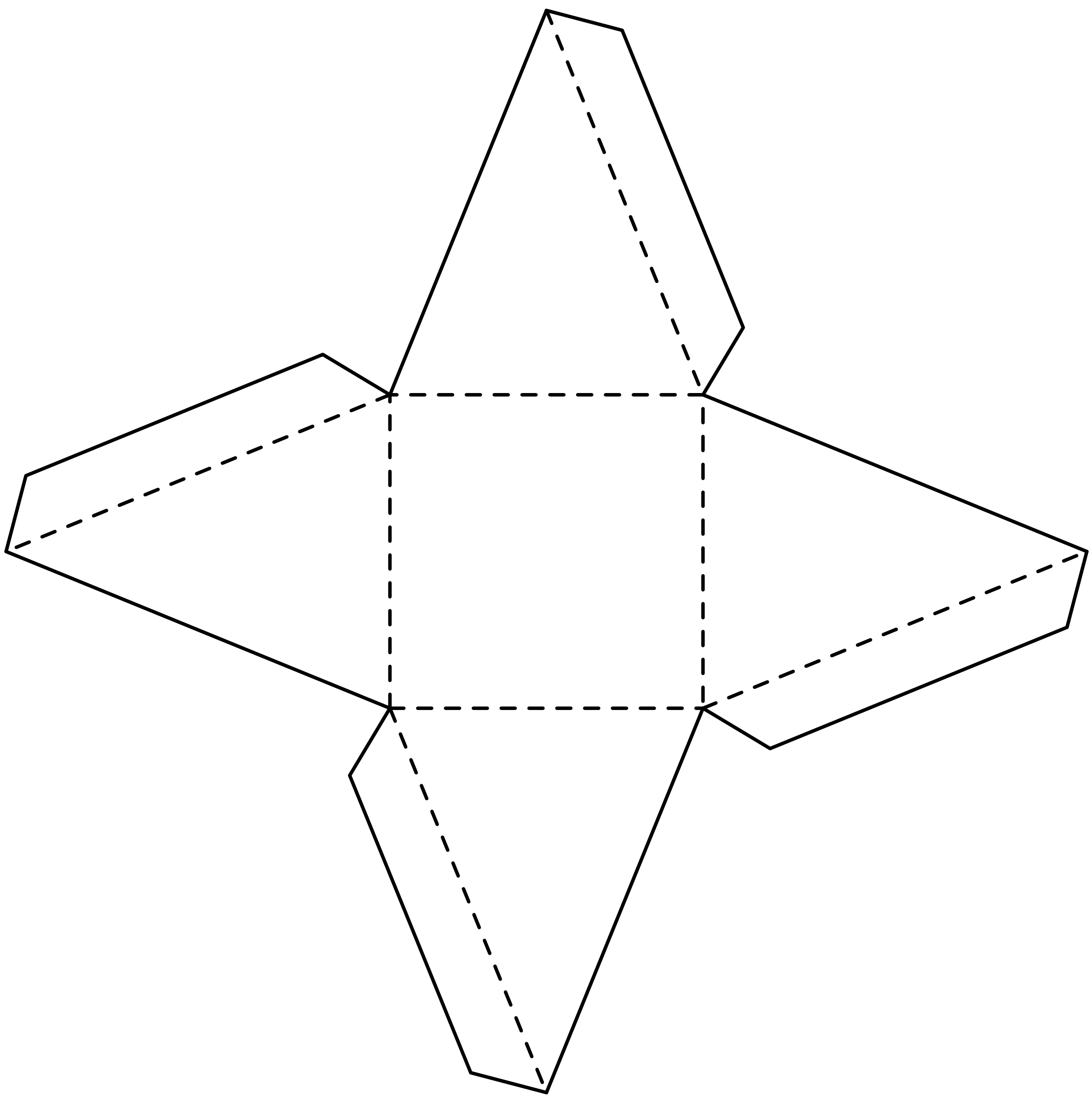
Nets for Figures – Net for a Triangle-Based Pyramid





Nets for Figures –
Net for a Square-Based Pyramid

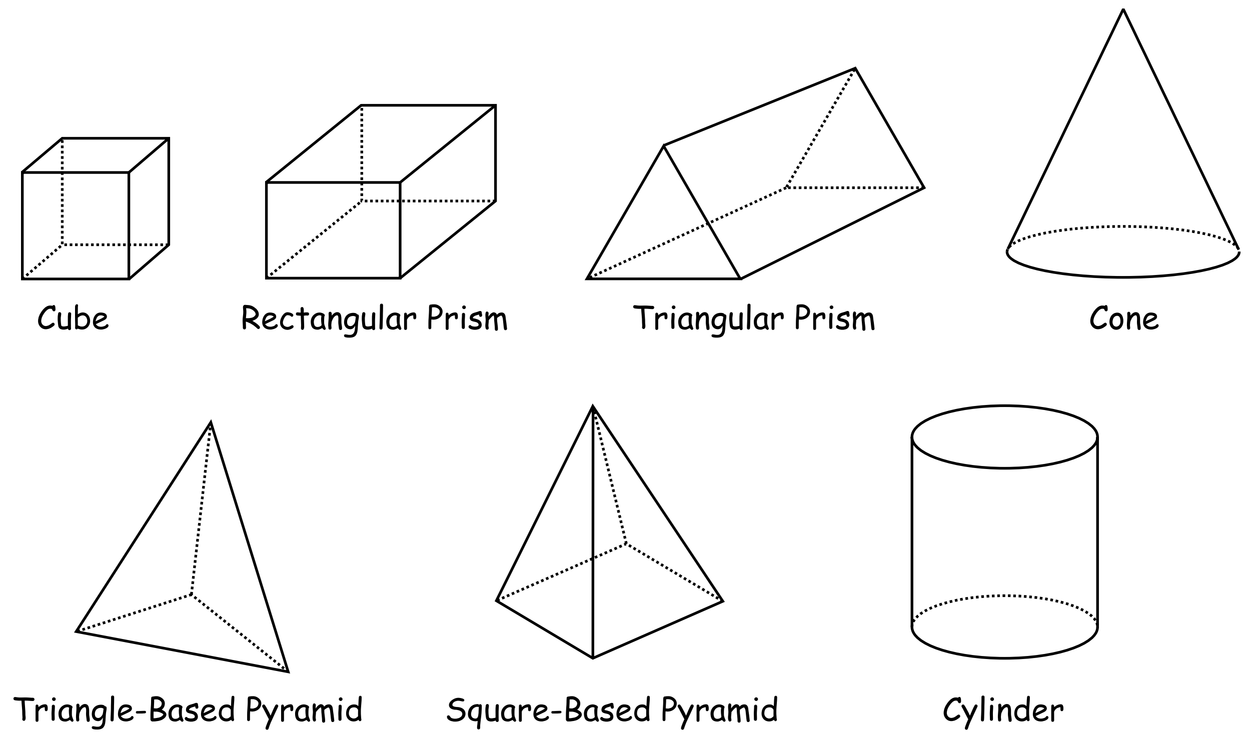




Request for Boxes

Dear Parent/Guardian:

We have been learning about three-dimensional figures in math. Here are some of the three-dimensional figures we are studying:



We will be working with boxes that are three-dimensional figures.

You can help us! We would appreciate if you could send any empty boxes that look like three-dimensional figures to class with your child.

Thank you in advance for the boxes you are able to provide for our math activity.

Let's Build! Cards

Let's Build!
Challenge Card #1

I have 12 edges.

I have 8 vertices.

I have 6 faces.

BUILD ME!

Let's Build!
Challenge Card #2

I have 9 edges.

I have 6 vertices.

I have 5 faces.

BUILD ME!

Let's Build!
Challenge Card #3

I have 6 edges.

I have 4 vertices.

I have 4 faces.

BUILD ME!

Let's Build!
Challenge Card #4

I have 8 edges.

I have 5 vertices.

I have 5 faces.

BUILD ME!

Shapes From Shapes

BIG IDEA ***Geometric Relationships***

CURRICULUM EXPECTATIONS

Students will:

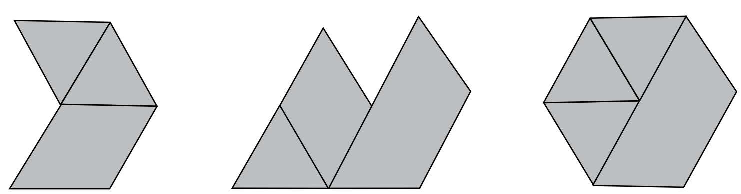
- solve problems requiring the greatest or least number of two-dimensional shapes (e.g., pattern blocks) needed to compose a larger shape in a variety of ways (e.g., to cover an outline puzzle) (**Sample problem:** Compose a hexagon using different numbers of smaller shapes.);
- identify congruent two-dimensional shapes by manipulating and matching concrete materials (e.g., by translating, reflecting, or rotating pattern blocks).

MATERIALS

- pattern blocks
- overhead projector
- chart paper (1 sheet per group)
- pattern block stamps, pattern block stickers, or copies of pattern block shapes from GeoRel3.BLM1a–f: Pattern Block Shapes
- markers
- pencil crayons or crayons
- GeoRel3.BLM2a–b: Tricky Triangles (1 per student)

ABOUT THE MATH

An understanding of geometric relationships includes the ability to perceive how shapes can be combined to create other shapes. In this task, students work with pattern blocks (triangle, square, trapezoid, hexagon, and two sizes of rhombuses) to investigate ways in which these shapes can be arranged to form triangles, quadrilaterals, pentagons, and hexagons. For example, students could arrange pattern blocks in the following ways to create hexagons:



This task helps to reinforce students' understanding of geometric relationships that exist among polygons:

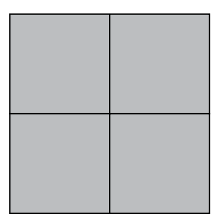
- All polygons are closed two-dimensional (plane) shapes with only straight sides. The number of sides in a polygon determines its category (e.g., a four-sided polygon is a quadrilateral).
- All polygons within a category have the same number of sides (e.g., all hexagons have six sides); however, the forms of polygons within a category can vary from one shape to the next. In the preceding illustration, the pattern blocks create hexagons; however, the forms of the hexagons are clearly different.
- Polygons are congruent if they are exactly the same shape and size.

GETTING STARTED

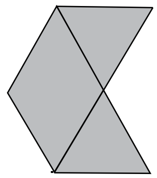
Place the six different pattern block shapes on the overhead projector, one at a time, and ask students to identify each shape (triangle, square, trapezoid, hexagon, small rhombus, large rhombus).

Next, explain to students that they are going to investigate ways in which pattern blocks can be combined to make polygons. Review the meaning of polygon, and clarify that a polygon is a closed two-dimensional shape with only straight sides. Show an example of a shape created using pattern blocks by placing two squares on the overhead projector and sliding them together to form a rectangle.

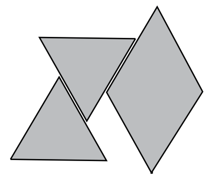
As well, show how four squares can be arranged to form a larger square.



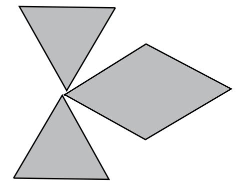
Place three different pattern blocks (e.g., two triangles and one large rhombus) on the overhead projector. Explain to students that the blocks can be arranged to create other shapes and that any arrangement is acceptable if the sides of the blocks are completely touching. Show examples of both acceptable and unacceptable arrangements.



Acceptable Arrangement

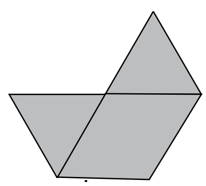


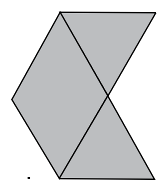
Unacceptable Arrangement



Unacceptable Arrangement

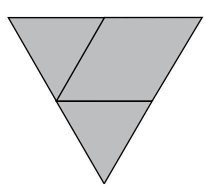
Invite a student to create a shape using the three pattern blocks. Ask students to count the number of sides and to identify the shape. Slide the arrangement to a corner of the overhead projector and place three of the same kinds of pattern blocks on the projector. Explain to students that the next shape should be made from the three pattern blocks shown but that it should not be congruent to the first one. Demonstrate that congruent shapes, such as the following, are the same size and shape even though they may be oriented differently.



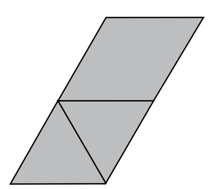


Invite other students to create other non-congruent shapes with three of the same kinds of pattern blocks. As each shape is made, leave it intact on the overhead projector so that students can check that their shape is not congruent to ones that have been assembled.

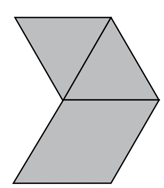
Discuss the different configurations students made with the pattern blocks, and ask them to identify the type of shape created by each arrangement. For example, students might have arranged two triangles and one large rhombus to form the following shapes:



Triangle



Quadrilateral



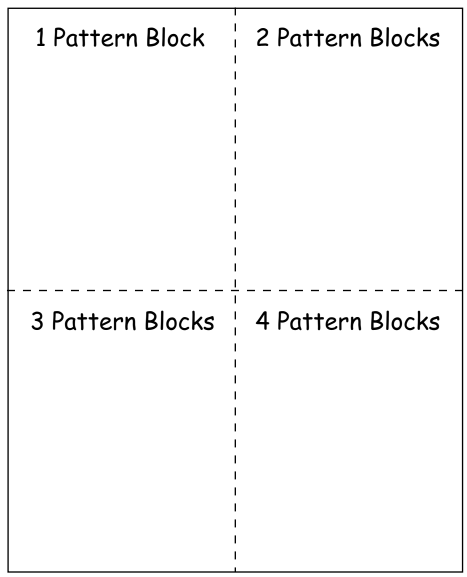
Hexagon

Have other students create a variety of shapes using a different set of three pattern blocks.

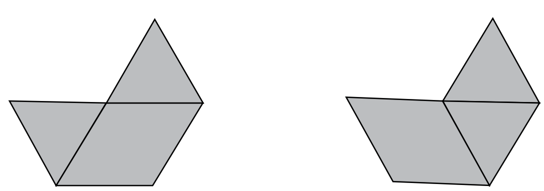
WORKING ON IT

Explain to the class that different groups of students will be making triangles, quadrilaterals, pentagons, and hexagons using from one to four pattern blocks.

Arrange students in four groups and assign a different shape (triangle, quadrilateral, pentagon, hexagon) to each group. Provide each group with a sheet of chart paper, and instruct students to make four sections on their paper by folding it into quarters. Have students label the sections of the paper: 1 Pattern Block, 2 Pattern Blocks, 3 Pattern Blocks, and 4 Pattern Blocks, as shown in the diagram.



As students find different ways to create their assigned shape using one to four pattern blocks, have them record the shapes in the appropriate section of their chart paper. They can trace around each pattern block, use pattern block stamps or stickers, or cut out and glue shapes from GeoRel3.BLM1a–f: Pattern Block Shapes. Have students colour the smaller shapes that compose the new shapes on their chart paper to match the pattern block colours. The new shapes can be congruent or non-congruent, as long as the pattern blocks are in different places. For example, the shapes shown below are congruent, but the pattern blocks are in different locations.



During the task, remind students that they should create and record the shapes within the appropriate section of the chart.

It may be necessary to encourage participation by all group members. For example, you might suggest that students accept different responsibilities (e.g., creating the assigned shape with pattern blocks, recording the pattern block shapes, finding a way to create a different form of the assigned shape, colouring the shapes) and that they change roles throughout the task.

REFLECTING AND CONNECTING

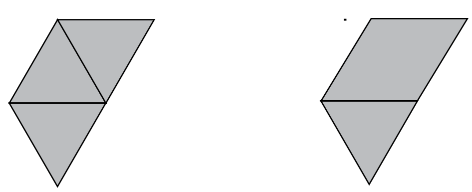
After students have completed their investigation, bring them together to share their findings. Ask students to show on chart paper the shapes their group recorded and to explain how they created the shapes using different numbers of pattern blocks. Ask students in each group questions, such as:

- "What part of your investigation was easy? What part was challenging?"
- "Was it possible to create your shape using one, two, three, and four pattern blocks?"
- "Did you find more than one way to create your shape using one, two, three, or four pattern blocks?"
- "Which pattern block shape did you use most often to create your assigned shape? Why do you think you used this pattern block more often than the others?"
- "How did finding one way to make a shape help you find other ways to make the shape?"
- "How are all of the shapes you created alike? How are they different?"

ADAPTATIONS/EXTENSION

Some students may have difficulty with this task. Since hexagons can be formed easily using different combinations of pattern blocks, assign the hexagon to these students.

Allow students who experience difficulties to create their assigned shape using any number of pattern blocks. After completing the shape, encourage them to substitute smaller pattern blocks for a larger shape (or vice versa) in order to use the desired number of blocks. For example, if students create a quadrilateral with three triangles, they could exchange two triangles for a rhombus, thereby using two pattern blocks, as shown in the diagram.



It may also benefit students to keep assembled pattern block shapes intact so that they can compare new shapes with those they have already created. They can refer to completed shapes to determine whether there are other combinations of pattern blocks that they could use.

Challenge students to create each kind of shape (triangle, quadrilateral, pentagon, hexagon) using the fewest pattern blocks possible. Because the set of pattern blocks includes a triangle and a hexagon, the fewest blocks would be one block for each of these shapes. Students could also try to create each shape using up to 25 pattern blocks.

Challenge students by asking them to create similar shapes (shapes that have the same form but that may have different sizes) using different numbers of pattern blocks. For example, students could make squares using one, four, nine, and sixteen square pattern blocks.

MATH LANGUAGE

- triangle
- square
- rectangle
- trapezoid
- rhombus
- polygon
- quadrilateral
- pentagon
- hexagon
- congruent
- non-congruent

SAMPLE SUCCESS CRITERIA

- understands the relationships of smaller to bigger shapes in a set of pattern blocks or tangram pieces
- identifies and describes polygons according to the number of sides
- identifies congruent shapes

HOME CONNECTION

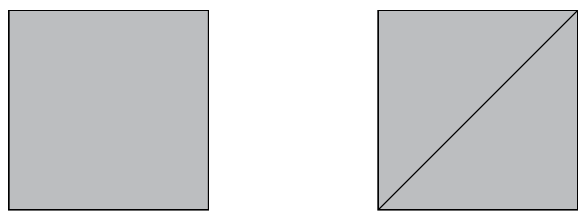
Send home GeoRel3.BLM2a–b: Tricky Triangles. This Home Connection task provides an opportunity for students and their parents/guardians to solve puzzles by finding how a shape is composed of triangles.

LEARNING CONNECTION 1

Quadrilateral Quest

Materials
- tangram sets (1 per student)
- sheets of paper (several per student)
- pencils

Ask students to select the square and two small triangles from a tangram set. Instruct them to use the three tans to create as many different quadrilaterals as possible. (Students can use one, two, or three tans to make each shape.) Have students record the quadrilaterals they create by tracing around each tan and labelling the kind of quadrilateral it is (e.g., rectangle, parallelogram, trapezoid). The quadrilaterals can be congruent, as long as they use the tans in different places, as shown below.



LEARNING CONNECTION 2

Tangram Twister

Materials
- spinners made with GeoRel3.BLM3: Tangram Twister Spinner, a paper clip, and a pencil (1 spinner per group)
- number cubes with numbers 1 to 6 (1 per group)
- tangram sets (1 per group)

Have students play this game with two or three classmates. Tell students that each player, in turn, spins the spinner and rolls the number cube. Explain that the spinner indicates the type of shape the player needs to create; the number cube specifies the number of tans the student must use to create the shape. For example, if the spinner lands on the rectangle and the number cube indicates 2, the student needs to create a rectangle using any two tans. Have students score a point each time they are able to create the shape.

If a student is unable to make a shape using the number of tans indicated by the number cube, the turn passes to the next player.

Suggest that the game ends when one player earns ten points.

LEARNING CONNECTION 3

Piece by Piece

Materials

- 1 three-dimensional figure made from Polydron pieces
- paper bag
- Polydron sets

Before this task, construct a three-dimensional figure (e.g., a triangular prism) using Polydron pieces and place it in a paper bag.

Show the bag to students and tell them that it contains a three-dimensional figure made with Polydron pieces. Tell students that you are going to identify one face of the hidden figure. Identify the face (e.g., a rectangle) and have students pick up a Polydron piece with that shape. Then ask students to speculate on what the hidden figure might be.

Continue to ask students to pick up other Polydron pieces that are faces of the figure in the bag. With each new Polydron piece, have students connect the pieces they have gathered and make conjectures about the hidden figure.

Let students know when they have accumulated all the faces of the hidden figure, and have them determine the hidden figure before you remove it from the bag.

LEARNING CONNECTION 4

Congruence Capers

Materials

- coloured tiles, tangram pieces, pattern blocks, or attribute blocks (3 or 4 per student)
- barrier (e.g., file folder, binder) (1 per pair of students)

Have students work with a partner. Ask students to construct a shape using three or four colour tiles (tangram pieces, pattern blocks, attribute blocks) on one side of a barrier so that their partner is unable to see the tiles. Explain that when students have finished making a shape, they instruct their partner on how to create a congruent shape on the other side of the barrier. Then, have students remove the barrier to check whether the shapes are congruent.

LEARNING CONNECTION 5

Congruent or Non-congruent?

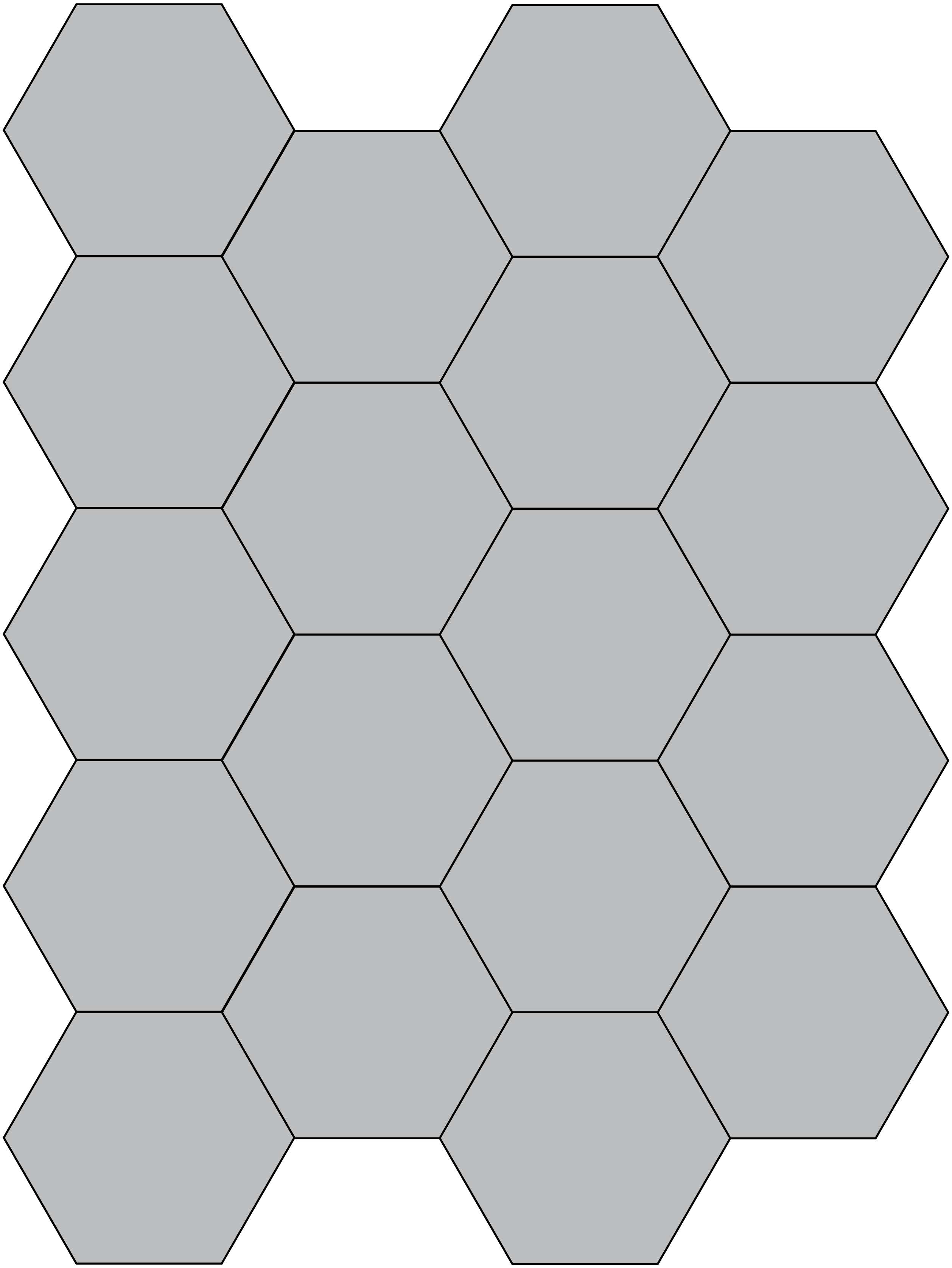
Materials
- 5 x 5 geoboards (1 per student)
- geobands (elastic bands) (1 per student)

Provide each student with a geoboard and a geoband. Instruct students to create a shape. Select two geoboards, show them to the class, and ask, “Are these shapes congruent or non-congruent?” Ask students to explain how they know whether the shapes are congruent or non-congruent. Choose another two geoboard shapes and ask students to judge whether the shapes are congruent or not.

With some of the non-congruent shapes, ask students to explain what they could do to one shape to make both shapes congruent.

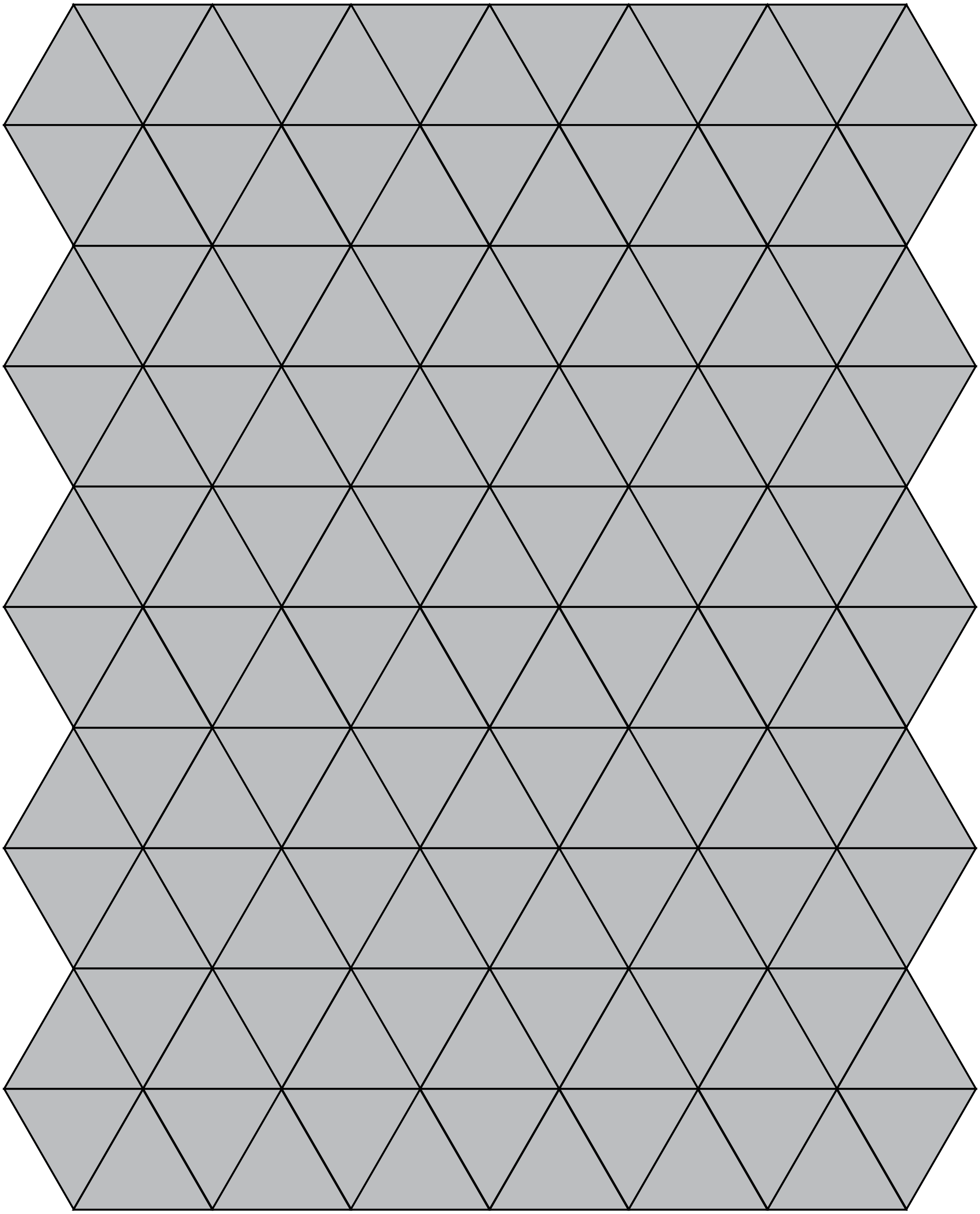
Pattern Block Shapes – Hexagons

GeoRel3.BLM1 (a)

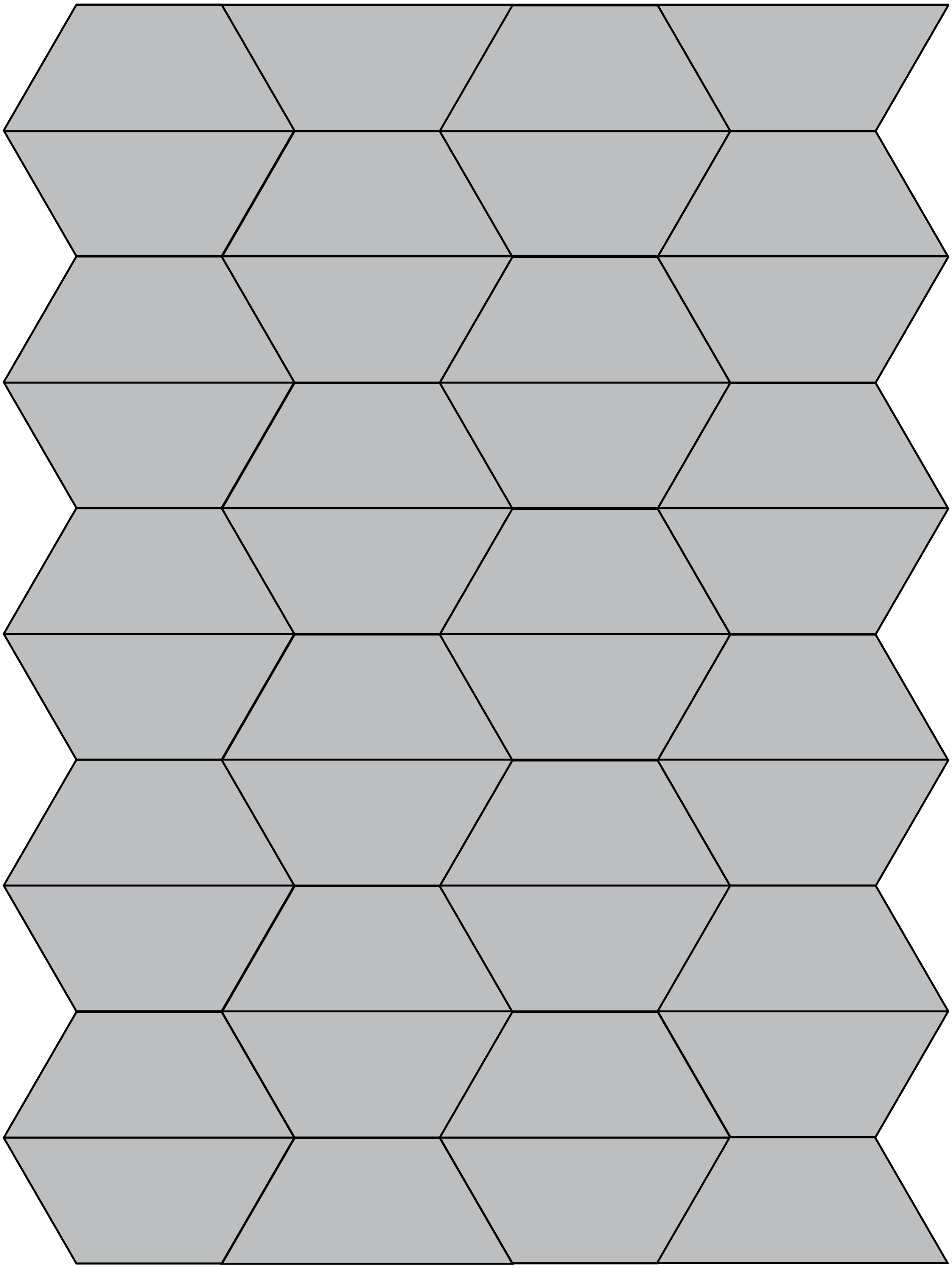


Pattern Block Shapes – Triangles

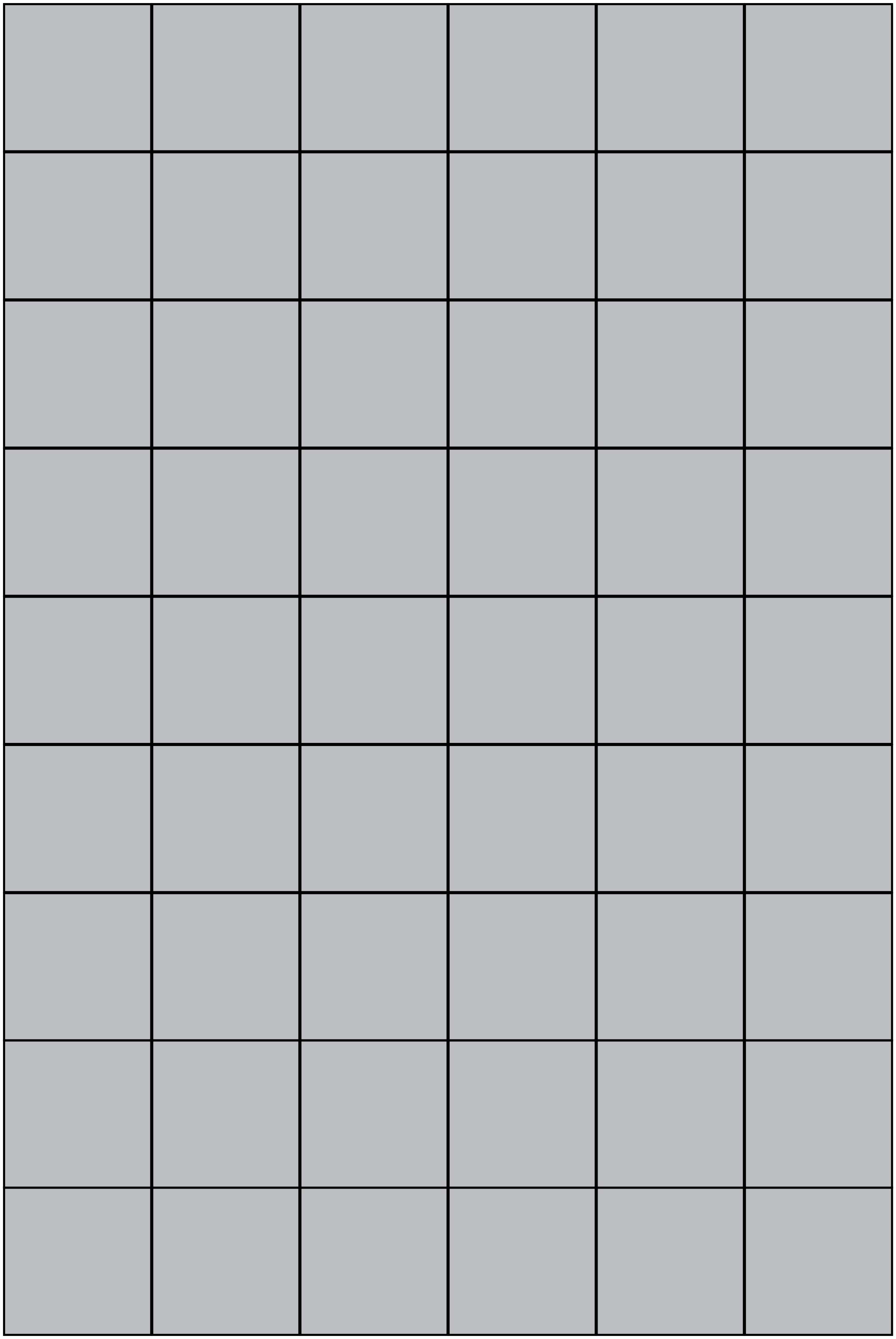
GeoRel3.BLM1 (b)



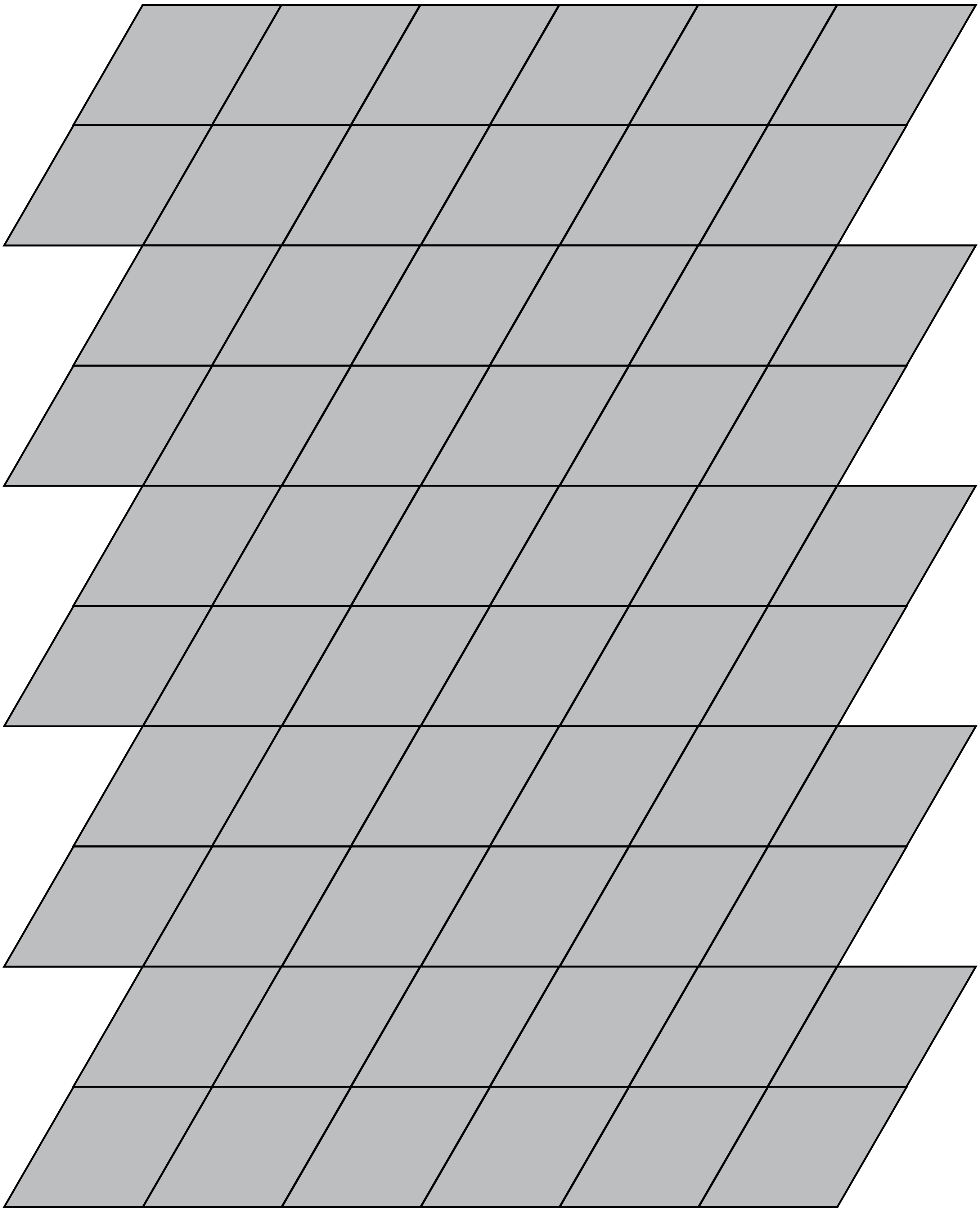
Pattern Block Shapes – Trapezoids



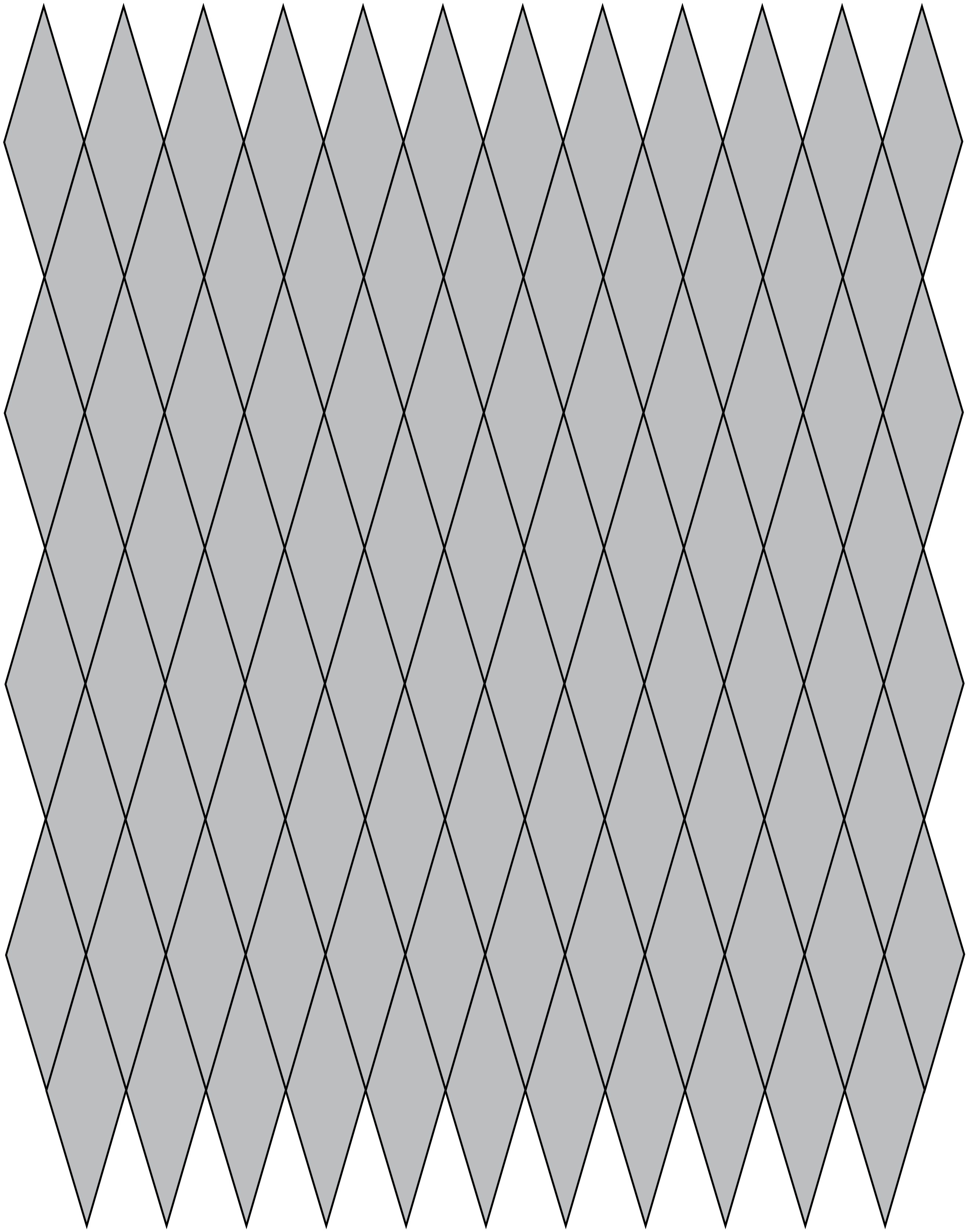
Pattern Block Shapes – Squares



Pattern Block Shapes – Large Rhombuses



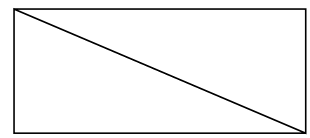
Pattern Block Shapes – Small Rhombuses



Tricky Triangles

Dear Parent/Guardian:

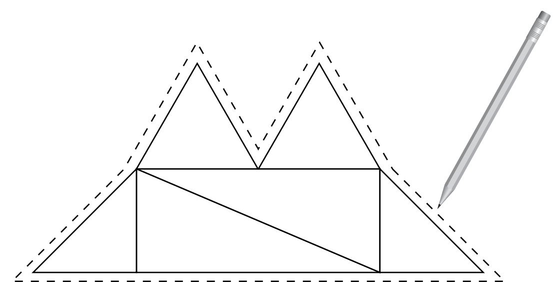
We have been learning about combining shapes to make larger shapes. For example, two triangles can be arranged to make a rectangle, as shown at right:



Here is an activity about combining shapes that you can do with your child.

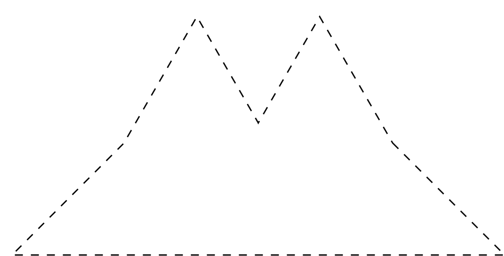
Cut out the triangles on the attached page. Ask your child to look away so as not to see what you are doing.

Arrange the shapes on a blank piece of paper to make a single shape. Any arrangement is acceptable. Next, use a pencil to trace around the outside of the arrangement to create a puzzle.



After you have traced around the arrangement of triangles, remove the triangles so that only the outline of the shapes is visible.

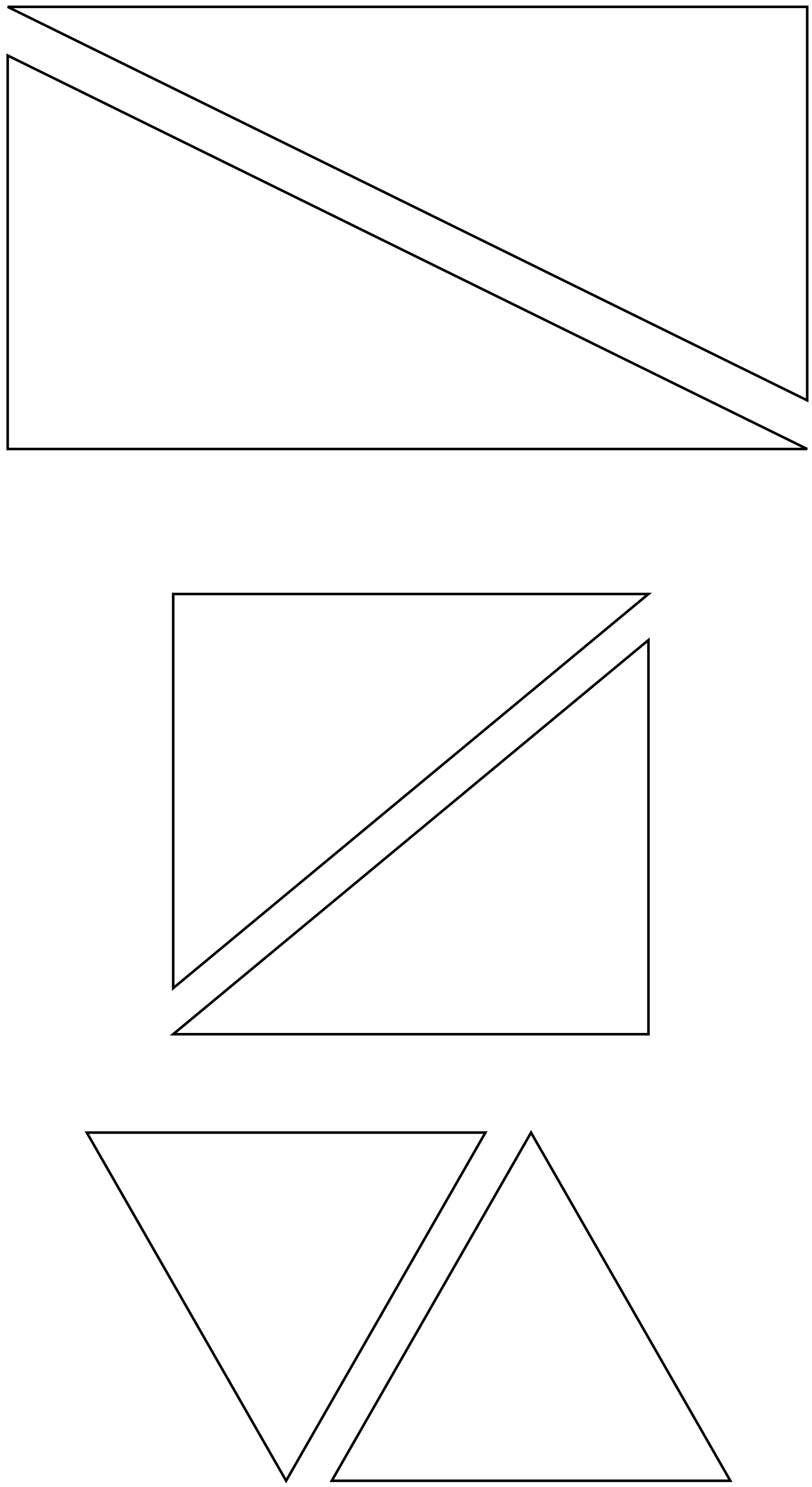
Ask your child to look at the outline and try to place the triangles so that they fit inside the puzzle.



Give your child opportunities to create puzzles for you to solve.

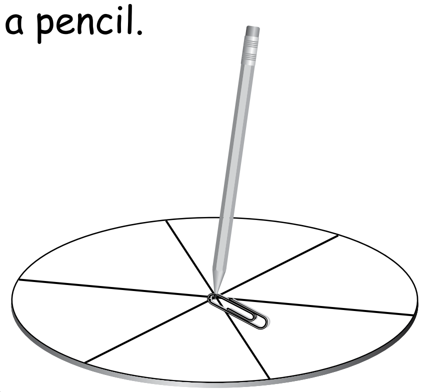
Have fun solving the puzzles with the Tricky Triangles!

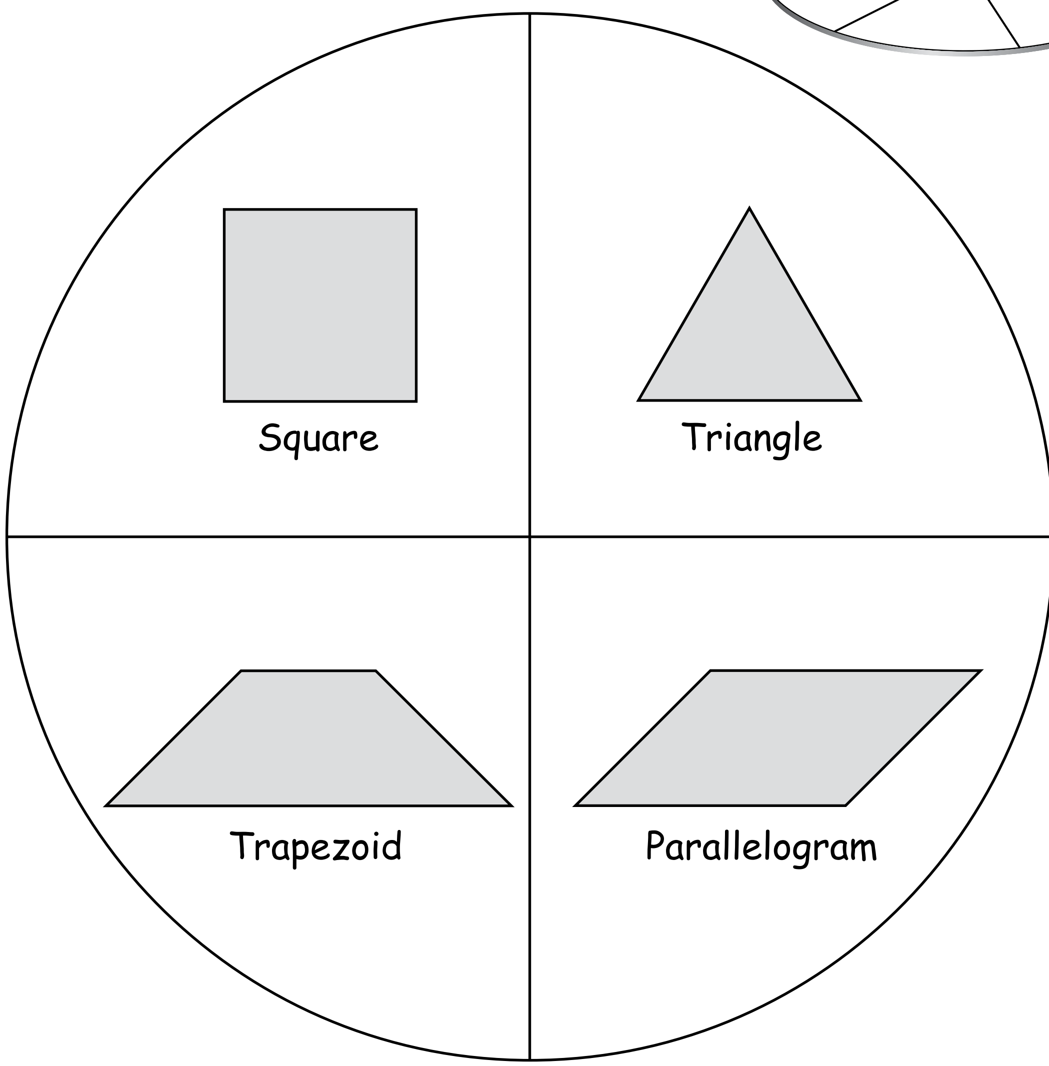
Tricky Triangles



Tangram Twister Spinner

Make a spinner using this page, a paper clip, and a pencil.





Quite the Quilts

BIG IDEA **Location and Movement**

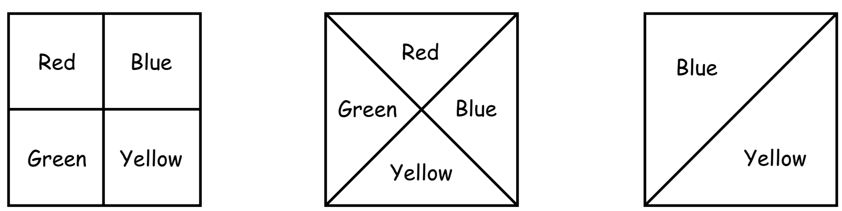
CURRICULUM EXPECTATIONS

Students will:

- identify flips, slides, and turns, through investigation using concrete materials and physical motion, and name flips, slides, and turns as reflections, translations, and rotations (e.g., a slide to the right is a translation; a turn is a rotation).

MATERIALS

- a picture book about quilts, such as *Sam Johnson and the Blue Ribbon Quilt* by Lisa Campbell Ernst or *Selina and the Bear Paw Quilt* by Barbara Smucker
- 30 cm x 30 cm sheets of red, yellow, and blue construction paper (for teacher demonstration)
- 30 cm x 30 cm square designs made from construction paper (resembling quilt squares); these are made before explaining the task



- pencils
- scrap paper (to design the squares)
- 10 cm x 10 cm sheets of construction paper (a variety of colours)
- scissors
- glue
- tape
- Loc3.BLM1: Quite the Quilts Game Board (1 per student)
- spinners made with Loc3.BLM2: Quite the Quilts Spinner, a paper clip, and a pencil (1 spinner per pair of students)
- Loc3.BLM3a–b: Rotating Spoons (1 per student)

ABOUT THE MATH

Students in the primary grades begin to develop an understanding of transformational geometry (the study of motion) as they explore translations (slides), reflections (flips), and rotations (turns) with concrete materials.

In Grade 3, students learn about transformational geometry through a variety of concrete learning experiences in which they experiment with and explore rotations (turns), translations (slides), and reflections (flips).

In this task, quilts provide a context for investigating concepts about rotations. Students experiment with quarter turns, two quarter turns, three quarter turns, and four quarter (full) turns, and examine the results of each rotation. They learn that rotations are made around a point in one direction. They discover that the orientation of a shape may change as a result of it being rotated. Since this geometrical task is an early experience in performing and describing rotations, this task has students performing rotations in the clockwise direction, which is more familiar to students.

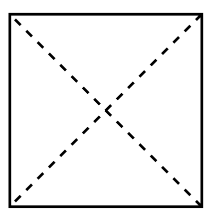
In Grade 3, students are assessed on their abilities to identify and describe rotations (turns), translations (slides), and reflections (flips), rather than on their skills in performing these transformations accurately.

GETTING STARTED

Read a story about a quilt, such as *Sam Johnson and the Blue Ribbon Quilt* by Lisa Campbell Ernst (New York: Lothrop, Lee & Shepard, 1983) or *Selina and the Bear Paw Quilt* by Barbara Smucker (Toronto: Lester Publishing, 1995). Have students describe the quilts illustrated in the story and explain how the quilts were created (i.e., by sewing together small pieces of fabric to form identical quilt squares and then sewing together the squares in an array). Show a quilt to students, if possible, and discuss how the quilt is assembled. Ask students to describe patterns in the quilt.

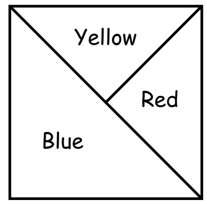
Demonstrate to students how to create a paper quilt square:

- Fold a red 30 cm x 30 cm sheet of construction paper along its diagonals. Cut along the folded lines to create four congruent triangles.

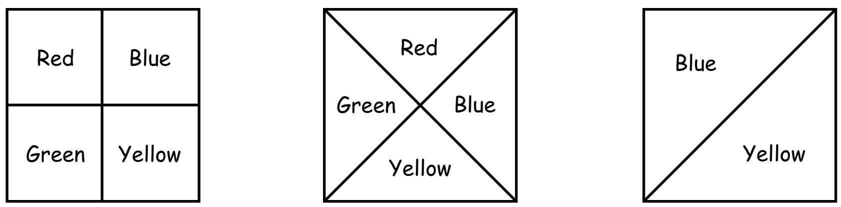


- Fold and cut a yellow 30 cm x 30 cm sheet of construction paper in the same way.

- Glue one yellow triangle and one red triangle onto a blue 30 cm x 30 cm piece of construction paper as shown below:



Show students other simple quilt square designs that you have made from construction paper, such as those shown below. Discuss how the pieces of construction paper are glued together to create each design.

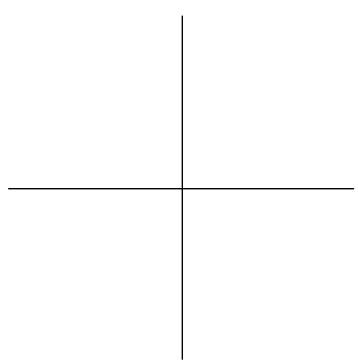


Tell students that they will construct four identical quilt squares using construction paper. Ask students to first draw the design for their squares and to label each piece in the design with its colour. Allow students to copy one of the designs you have shown or to create a different simple design.

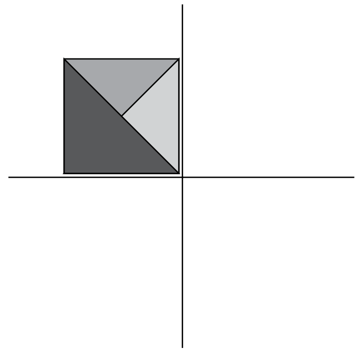
Check to ensure that students have drawn a simple design, and then allow students to collect the materials needed to create their four squares (10 cm x 10 cm sheets of coloured construction paper, scissors, glue).

Monitor students' work as they build their quilt squares. Assist students, if necessary, to make identical squares.

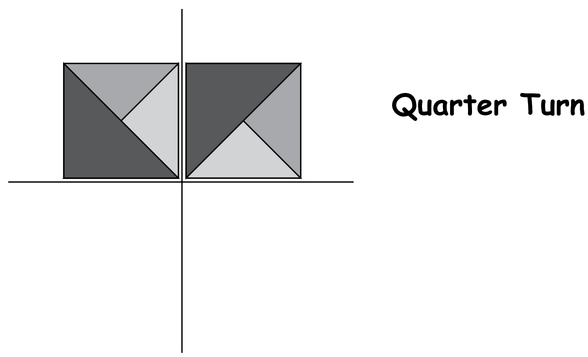
When students have finished making their paper quilt squares, have the class investigate rotations. Begin by drawing vertical and horizontal axes on the board.



Ask a student if you may borrow his or her four quilt squares. Tape one of the quilt squares in the upper left quadrant on the board.

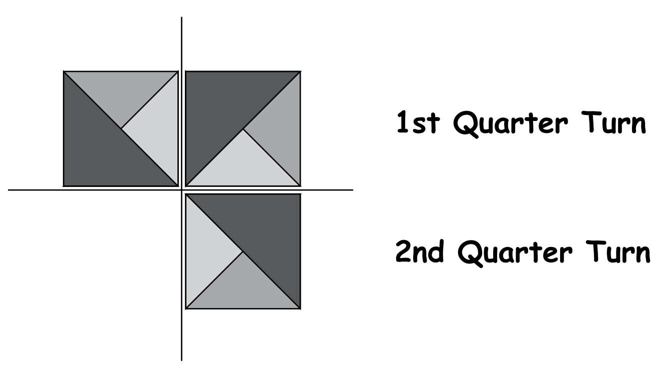


Hold a second quilt square directly on top of the square taped to the board. Ask students, “How could I rotate this quilt square onto the next (upper right) section?” Have student volunteers show how to perform the rotation. Tape the quilt square in the upper right quadrant.



Ask students, “Why would we call this rotation a quarter turn?” Liken the quarter turn to the movement of the minute hand on a clock from the upright position to the quarter-past-the-hour position. Also connect to the fact that the square has moved 90°, or the distance of a right angle. Record “Quarter Turn” next to the square.

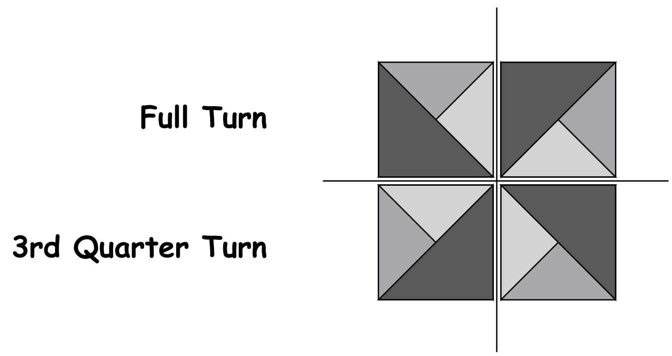
Next, hold a third square on top of the rotated square and ask them to predict what will happen when the square is rotated again, this time from quarter past-the-hour, to half-past-the hour. Tape the square in the correct position in the bottom right quadrant. Record “2nd Quarter Turn” next to the square.



At this point in the lesson, ask students:

- "What do you need to think about when you make a rotation?" (the direction of the rotation, the degree of rotation)
- "Where is the rotation point on the board?" (where the two lines or axes intersect)
- "Which part of the square touches this point during a rotation?" (the bottom right corner of the original square)

Have students predict what the next square will look like if the third square is rotated from the half-past-the hour to the quarter-to-the-hour position. Tape it in the bottom left quadrant. Record "3rd Quarter Turn" next to the square. Ask students to explain a three quarter turn.



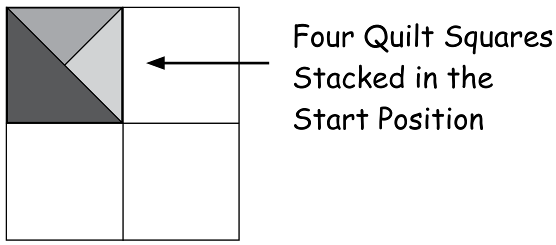
Ask students to describe what would happen if the third square was rotated from the quarter-to-the-hour to the hour position. Discuss how the square would return to its original position and that it would have rotated the whole way around, or made a "Full Turn".

Remove the taped squares from the board and return them to the student. Invite other students to demonstrate how their square can be rotated three times to make a full turn.

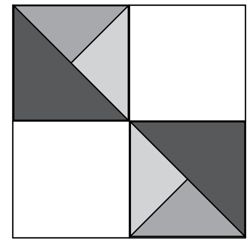
WORKING ON IT

Ask a student to help you demonstrate the Quite the Quilts game.

- Have students play the game with a partner. Each player needs a copy of Loc3.BLM1: Quite the Quilts Game Board.
- Tell both players to stack their four quilt squares in the Start quadrant of their own game board. Players must orient all four squares in the same way.
- Explain that players take turns spinning the spinner (made from Loc.BLM2: Quite the Quilts Spinner). After each spin, players rotate the quilt square from the Start quadrant clockwise onto another quadrant according to the kind of rotation indicated by the spinner. For example, if the spinner indicates two quarter turns, the player rotates the quilt square in the Start quadrant by two quarter turns.
- If a player spins a rotation that has already occurred, then play moves to the next player.
- Play continues until one player completes the game board.



Game Board at the
Beginning of a Game



Game Board After the
Top Quilt Square Has
Been Rotated
Two Quarter Turns

- Ask players to check their partner's rotations to ensure that they have been completed correctly.
- If the rotation indicated by the spinner has already been completed, the player may not rotate a quilt square. The next player gets to spin.
- The game finishes when a player has covered all four quadrants of his or her game board by completing each type of turn shown on the spinner.

Arrange students in pairs, and invite them to play the game.

After students have played the game a few times, ask them to glue their quilt squares onto the Quite the Quilts game board to show a full rotation.

REFLECTING AND CONNECTING

Have pairs of students share their completed game boards with another pair of students. Then ask the pairs to volunteer to describe their Quite the Quilts game board to the class.

Ask students:

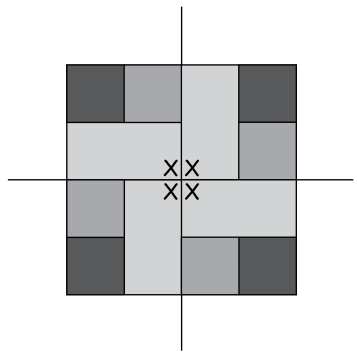
- "What strategy did you use to make sure you rotated the quilt squares correctly?" (e.g., placing a finger on the corner of the square that touched the point of rotation, and anchoring the corner as they rotated the square; visualizing how one part of the square moves to a different position)
- "What patterns do you see in your quilt design?"
- "What are other examples of rotations in real life?" (e.g., cars making left or right turns, figure skaters spinning, basketball players pivoting)

Students could cut out the quilt squares from their game boards. Their individual quilt squares could be combined in an array on a bulletin board to create a class quilt.

ADAPTATIONS/EXTENSIONS

Some students may have difficulty performing rotations. Show these students how to place a finger on the rotation point in order to anchor the corner of the quilt square as they rotate it.

It may help these students to use a simple quilt-square design and to mark an X in the corner that touches the point of rotation. After they have completed the rotations, they can check to make sure that the X on each quilt square is still touching the rotation point, as shown in the diagram.



Challenge students by having them rotate their quilt squares in a counterclockwise direction. Or invite students to switch quilt squares with their partner in the Quite the Quilts game.

MATH LANGUAGE

- turn (rotation)
- quarter turn (rotation)
- two quarter turns (rotation)
- three quarter turns (rotation)
- full or complete turn (rotation)
- point of rotation
- clockwise
- counterclockwise

SAMPLE SUCCESS CRITERIA

- identifies rotations
- performs clockwise rotations using increments of one quarter
- understands that rotations involve turning an object around a point (rotation point)
- completes designs around a line of symmetry

HOME CONNECTION

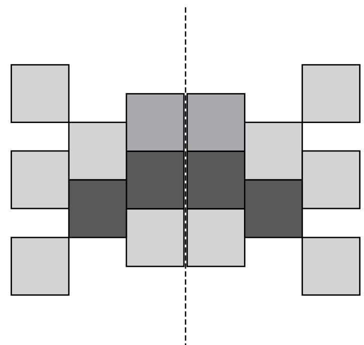
Send home Loc3.BLM3a-b: Rotating Spoons. This Home Connection game helps to reinforce students' understanding of turns (rotations).

LEARNING CONNECTION 1

Make the Other Half

Materials
- colour tiles (6 to 10 per student)
- Loc3.BLM4: Line of Symmetry (1 per pair of students)

Have students work with a partner. Tell one student to arrange six to ten colour tiles in a pattern on one side of the line of symmetry on Loc3.BLM4: Line of Symmetry. Have the partner complete the symmetrical design by placing the matching colour tiles on the other side of the line of symmetry.



Ask students to explain how they know that the completed design is symmetrical.

LEARNING CONNECTION 2

Fancy Borders

Materials
- drawing/word processing software
- computer(s)

Have students experiment with the rotation feature in the drawing/word processing software. Allow students to select an image or create one of their own. By selecting the rotation option, students can experiment with rotations.

Explain to students that they can design a patterned border on their page by repeatedly duplicating an image, rotating it, and dragging it into position. Have students explain how they used turns/rotations to create the border.

LEARNING CONNECTION 3

Pathways

Materials
- Loc3.BLM5: Pathways (1 per student)
- counters (1 per student)

Provide each student with a copy of Loc3.BLM5: Pathways and a counter. Tell students to imagine that the counter represents a person.

Have students place the "person" in the school, then ask, "What pathway could the person take to go from the school to the craft store?" Encourage students to explain pathways, such as "down 1 space, then 3 spaces to the left", and to move the counter accordingly.

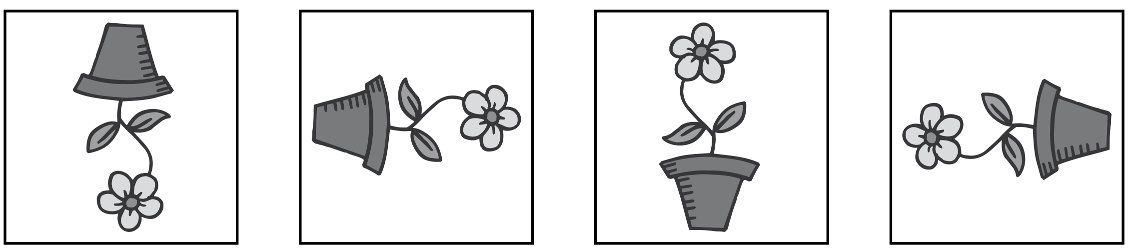
Ask students to describe the pathways between other locations. Allow students to describe different possible pathways for the same locations.

LEARNING CONNECTION 4

Right Side Up

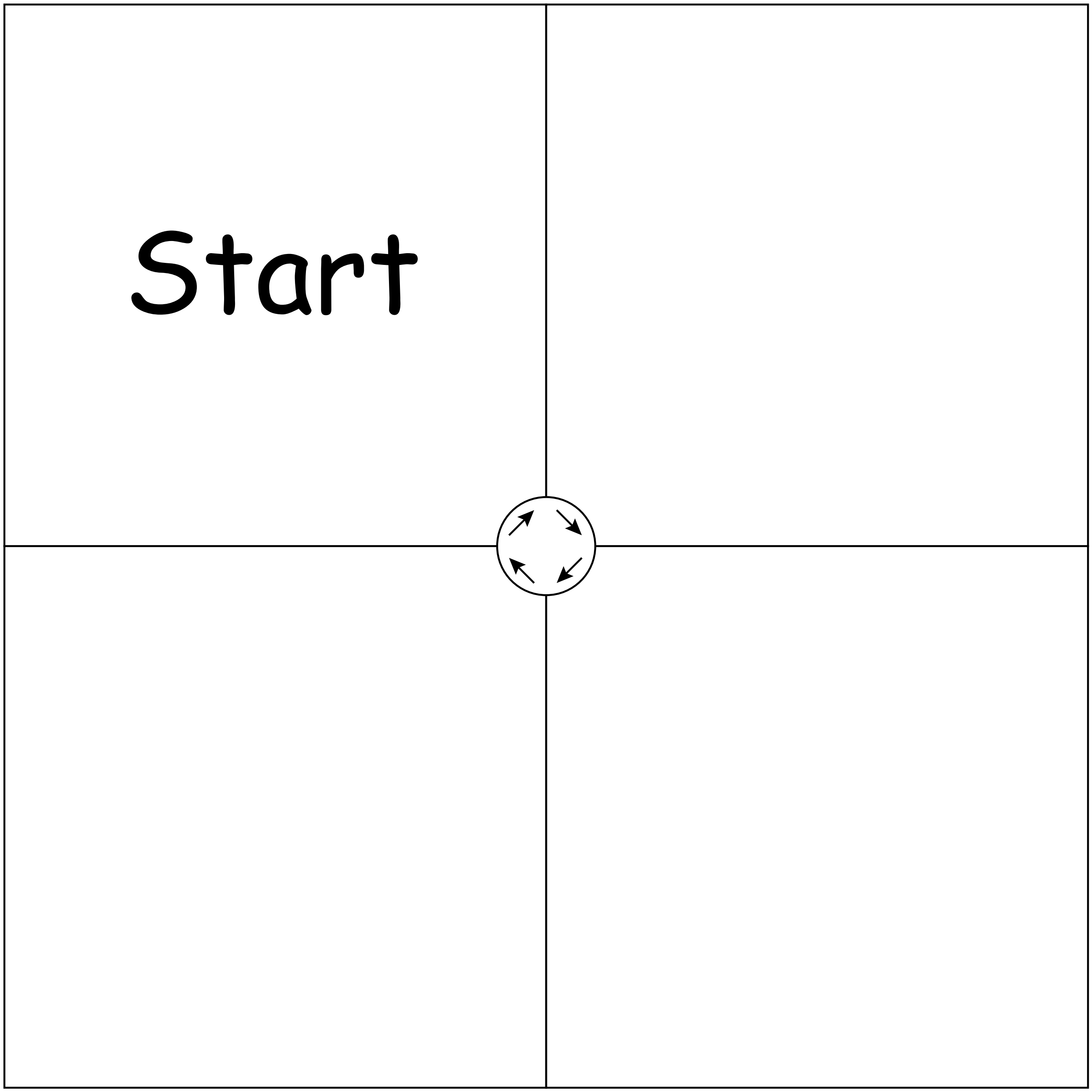
Materials
- Loc3.BLM6: Right Side Up (1 per pair of students)
- scissors (1 per pair of students)

Provide each pair of students with Loc3.BLM6: Right Side Up, and have them cut out the flowerpot cards. Tell students to scramble the cards, stack them, and deal each player four cards, face down in a row. Explain that when all the cards have been dealt, players flip over each card without rotating it in any way.



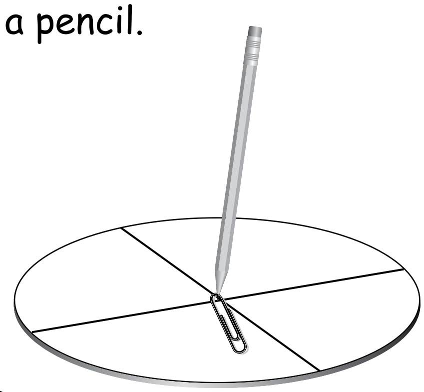
Explain that the object of the game is to have as many flowerpots as possible in an upright position after three rounds. Each player is allowed 1 quarter turn, 1 two quarter turns, and 1 three quarter turns per game in the following way:
- In the first round, students may rotate any card a quarter turn.
- In the second round, students may rotate any card by two quarter turns.
- In the third and final round, students may rotate any card by three quarter turns.
- Players may pass if they choose not to rotate a card.
- After the third round, have students check to see which player has more flowerpots in an upright position.

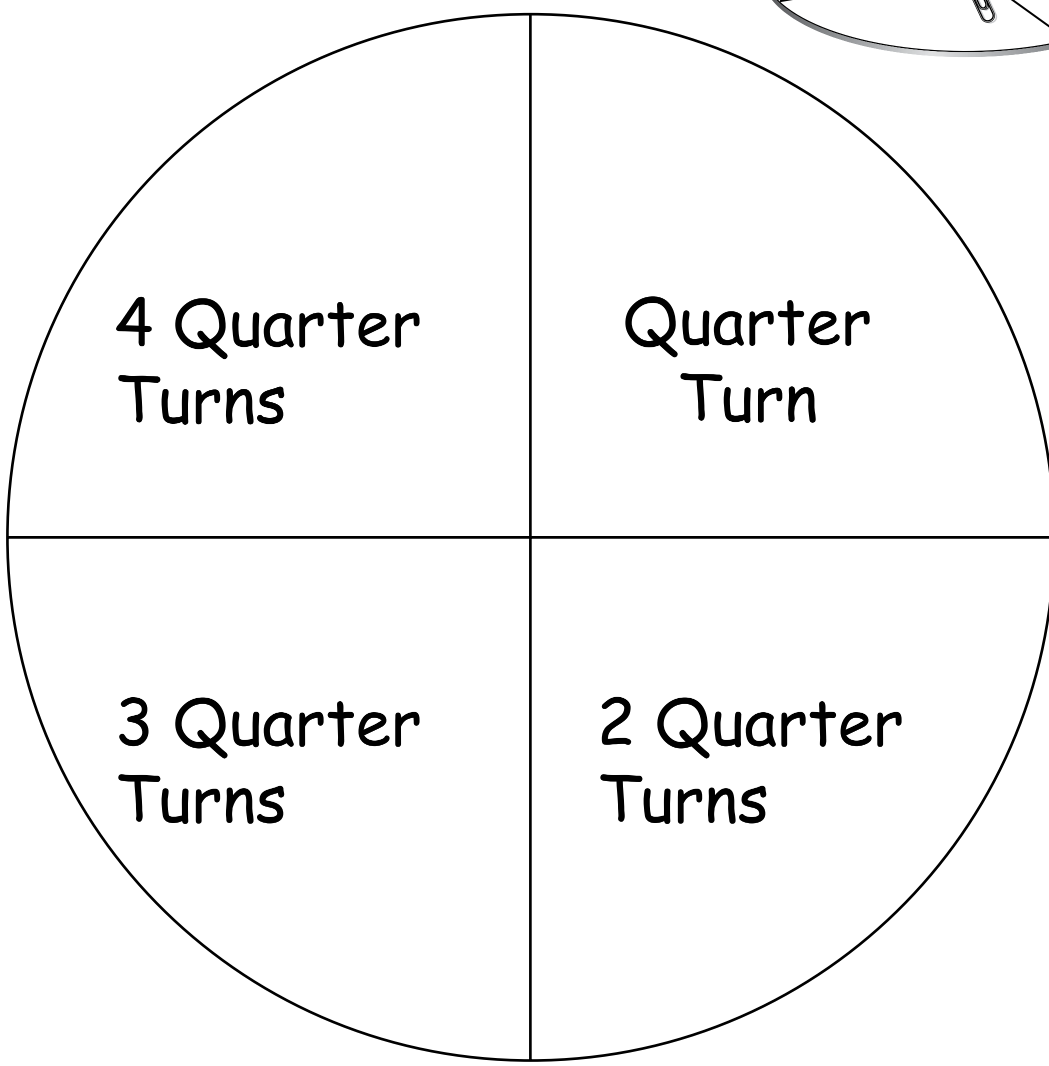
Quite the Quilts Game Board



Quite the Quilts Spinner

Make a spinner using this page, a paper clip, and a pencil.





Rotating Spoons

Dear Parent/Guardian:

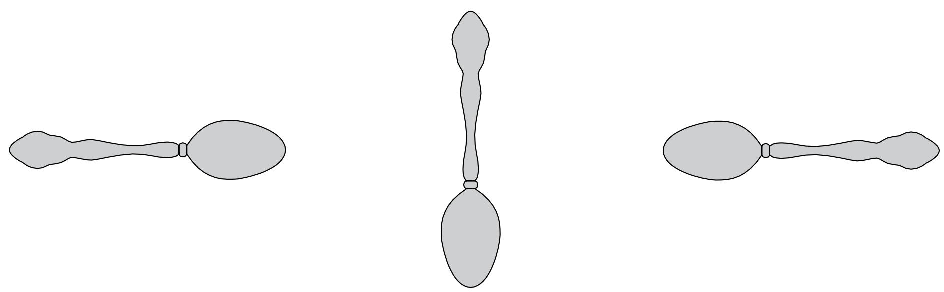
Our class has been learning about turns (or rotations) using quarter turns.

Here is a game about rotations that you can play with your child. To play the game, you will need:

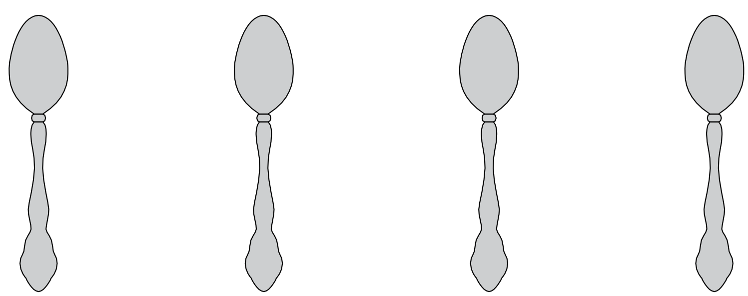
- the cards cut from the attached page
- 4 spoons for each player

Shuffle the cards, and place them in a pile face down.

Place four spoons in front of you and four in front of your child. Each spoon must be placed in one of these three positions:



The goal of the game is to be the first player to rotate his or her spoons so that they are all in this position:



One after the other, turn over the top card and perform the kind of turn indicated on the card. Players may rotate any one of their spoons. Players must rotate their spoons in a clockwise direction. If all the cards in the pile are used, shuffle the cards again and place them face down.

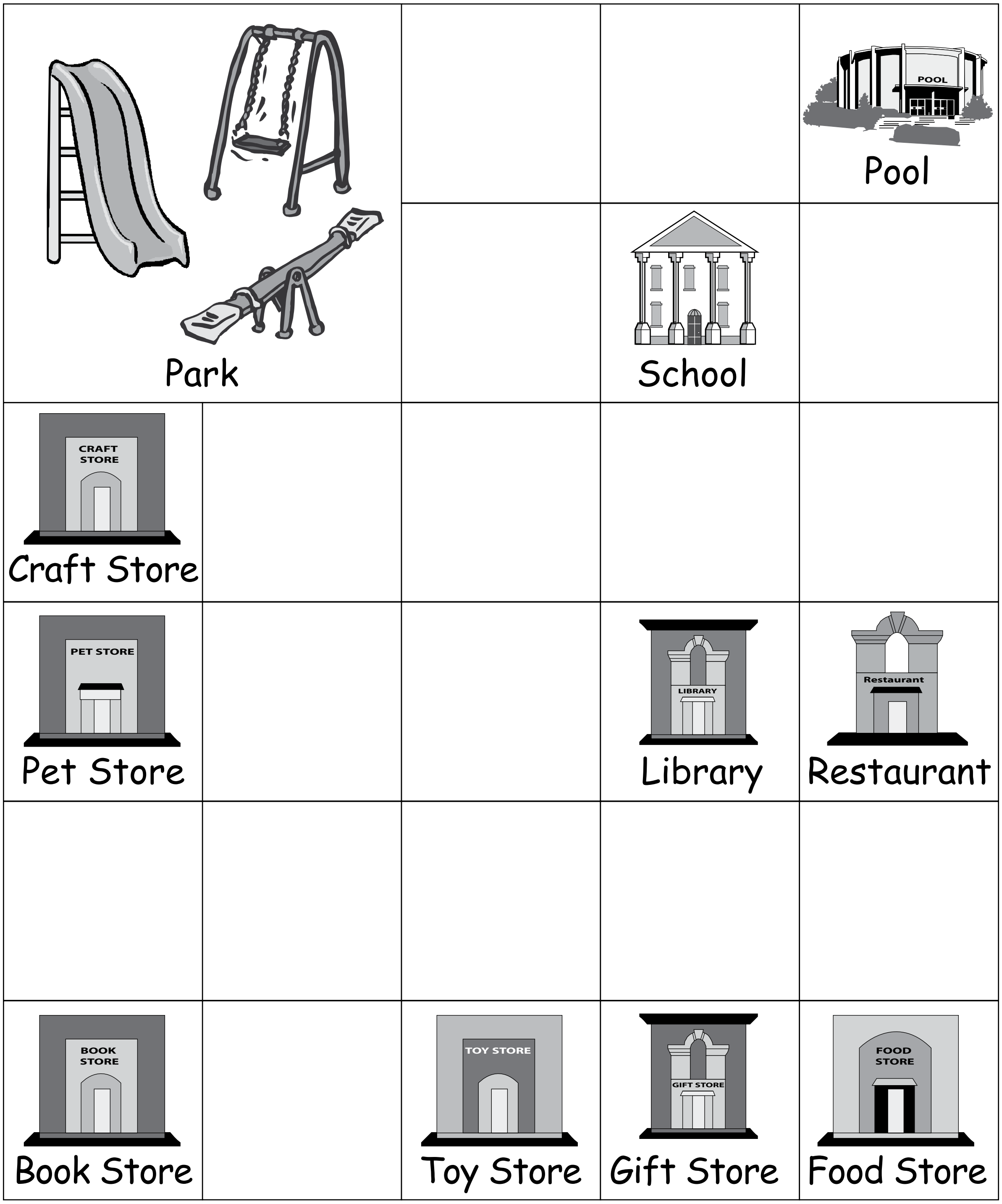
The game ends when one player has rotated all of his or her spoons so that they are in the position illustrated above.

Rotating Spoons

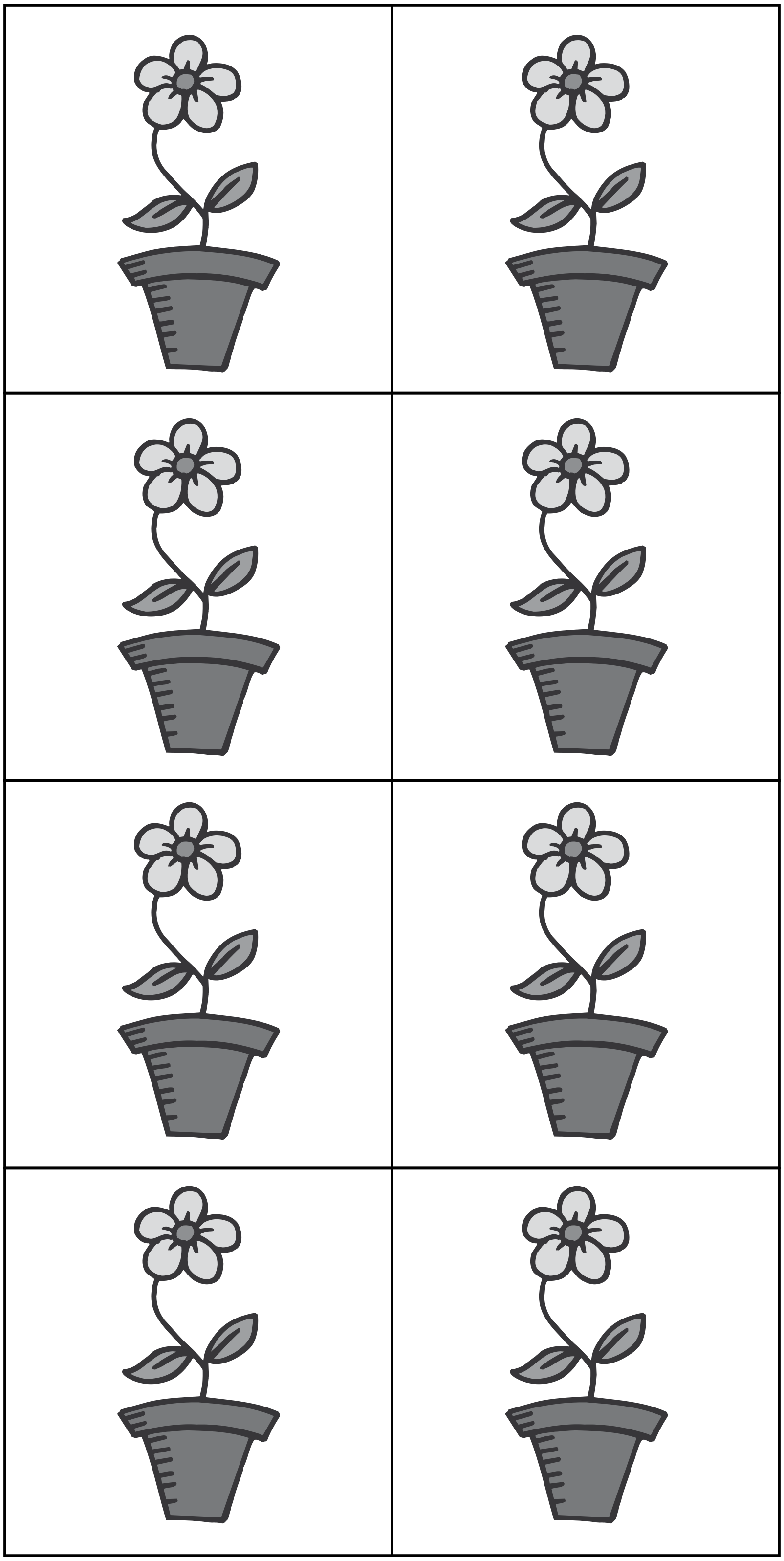
Quarter Turn	Two Quarter Turns	Three Quarter Turns
Quarter Turn	Two Quarter Turns	Three Quarter Turns
Quarter Turn	Two Quarter Turns	Three Quarter Turns

Line of Symmetry

Pathways


Park
Pool
School
Craft Store
Pet Store
Library
Restaurant
Book Store
Toy Store
Gift Store
Food Store

Right Side Up



D. Correspondence of the Big Ideas and the Curriculum Expectations in Geometry and Spatial Sense

Appendix Contents

Overall Expectations

FDK	GRADE 1	GRADE 2	GRADE 3
Students will:	Students will:	Students will:	Students will:
• describe, sort, classify, build, and compare two-dimensional shapes and three-dimensional figures, and describe the location and movement of objects through investigation	• identify common two-dimensional shapes and three-dimensional figures and sort and classify them by their attributes	• identify two-dimensional shapes and three-dimensional figures and sort and classify them by their geometric properties	• compare two-dimensional shapes and three-dimensional figures and sort them by their geometric properties
	• compose and decompose common two-dimensional shapes and three-dimensional figures	• compose and decompose two-dimensional shapes and three-dimensional figures	• describe relationships between two-dimensional shapes, and between two-dimensional shapes and three-dimensional figures
	• describe the relative locations of objects using positional language	• describe and represent the relative locations of objects, and represent objects on a map	• identify and describe the locations and movements of shapes and objects

Specific Expectations in Relation to the Big Ideas

FDK	GRADE 1	GRADE 2	GRADE 3
Geometric Properties of 2D Shapes and 3D Figures Students will:	**Geometric Properties of 2D Shapes and 3D Figures** Students will:	**Geometric Properties of 2D Shapes and 3D Figures** Students will:	**Geometric Properties of 2D Shapes and 3D Figures** Students will:
• explore, sort, and compare the attributes (e.g., reflective symmetry) and the properties (e.g., number of faces) of traditional and non-traditional two-dimensional shapes and three-dimensional figures (e.g., when sorting and comparing a variety of triangles: notice similarities in number of sides, differences in side lengths, sizes of angles, sizes of the triangles themselves; see smaller triangles in a larger triangle)	• identify and describe common two-dimensional shapes (e.g., circles, triangles, rectangles, squares) and sort and classify them by their attributes (e.g., colour; size; texture; number of sides), using concrete materials and pictorial representations (e.g., "I put all the triangles in one group. Some are long and skinny, and some are short and fat, but they all have three sides.")	• distinguish between the attributes of an object that are geometric properties (e.g., number of sides, number of faces) and the attributes that are not geometric properties (e.g., colour, size, texture), using a variety of tools (e.g., attribute blocks, geometric solids, connecting cubes) • identify and describe various polygons (i.e., triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons) and sort and classify them by their geometric properties (i.e., number of sides or number of vertices), using concrete materials and pictorial representations (e.g., "I put all the figures with five or more vertices in one group, and all the figures with fewer than five vertices in another group.")	• identify and compare various polygons (i.e., triangles, quadrilaterals, pentagons, hexagons, heptagons, octagons) and sort them by their geometric properties (i.e., number of sides; side lengths; number of interior angles; number of right angles)

continued . . .

FDK	GRADE 1	GRADE 2	GRADE 3
Geometric Properties of 2D Shapes and 3D Figures Students will:	**Geometric Properties of 2D Shapes and 3D Figures** Students will:	**Geometric Properties of 2D Shapes and 3D Figures** Students will:	**Geometric Properties of 2D Shapes and 3D Figures** Students will:
• investigate and explain the relationship between two-dimensional shapes and three dimensional figures in objects they have made (e.g., explain that the flat surface of a cube is a square)	• trace and identify the two-dimensional faces of three-dimensional figures, using concrete models (e.g., "I can see squares on the cube.") • identify and describe common three-dimensional figures (e.g., cubes, cones, cylinders, spheres, rectangular prisms) and sort and classify them by their attributes (e.g., colour; size; texture; number and shape of faces), using concrete materials and pictorial representations (e.g., "I put the cones and the cylinders in the same group because they all have circles on them.")	• identify and describe various three-dimensional figures (i.e., cubes, prisms, pyramids) and sort and classify them by their geometric properties (i.e., number and shape of faces), using concrete materials (e.g., "I separated the figures that have square faces from the ones that don't.")	• compare and sort prisms and pyramids by geometric properties (i.e., number and shape of faces, number of edges, number of vertices), using concrete materials
	• describe similarities and differences between an everyday object and a three-dimensional figure (e.g., "A water bottle looks like a cylinder, except the bottle gets thinner at the top.")	• create models and skeletons of prisms and pyramids, using concrete materials (e.g., cardboard; straws and modelling clay), and describe their geometric properties (i.e., number and shape of faces, number of edges)	• construct rectangular prisms (e.g., using given paper nets; using Polydrons), and describe geometric properties (i.e., number and shape of faces, number of edges, number of vertices) of the prisms
	• locate shapes in the environment that have symmetry, and describe the symmetry		
			• use a reference tool (e.g., paper corner, pattern block, carpenter's square) to identify right angles and to describe angles as greater than, equal to, or less than a right angle (**Sample problem:** Which pattern blocks have angles bigger than a right angle?)
			• compare various angles, using concrete materials and pictorial representations, and describe angles as bigger than, smaller than, or about the same as other angles (e.g., "Two of the angles on the red pattern block are bigger than all the angles on the green pattern block.")

continued . . .

FDK	GRADE 1	GRADE 2	GRADE 3
Geometric Relationships Students will:	**Geometric Relationships** Students will:	**Geometric Relationships** Students will:	**Geometric Relationships** Students will:
• compose pictures, designs, shapes, and patterns, using two-dimensional shapes; predict and explore reflective symmetry in two-dimensional shapes (e.g., visualize and predict what will happen when a square, a circle, or a rectangle is folded in half); and decompose two-dimensional shapes into smaller shapes and rearrange the pieces into other shapes, using various tools and materials (e.g., stickers, geoboards, pattern blocks, geometric puzzles, tangrams, a computer program)	• compose patterns, pictures, and designs, using common two-dimensional shapes (**Sample problem:** Create a picture of a flower using pattern blocks.)	• compose and describe pictures, designs, and patterns by combining two-dimensional shapes (e.g., "I made a picture of a flower from one hexagon and six equilateral triangles.")	• solve problems requiring the greatest or least number of two-dimensional shapes (e.g., pattern blocks) needed to compose a larger shape in a variety of ways (e.g., to cover an outline puzzle) (**Sample problem:** Compose a hexagon using different numbers of smaller shapes.)
	• identify and describe shapes within other shapes (e.g., shapes within a geometric design)	• compose and decompose two-dimensional shapes (**Sample problem:** Use Power Polygons to show if you can compose a rectangle from two triangles of different sizes.)	
• build three-dimensional structures using a variety of materials and identify the three-dimensional figures their structure contains	• build three-dimensional structures using concrete materials, and describe the two-dimensional shapes the structures contain	• build a structure using three-dimensional figures, and describe the two-dimensional shapes and three-dimensional figures in the structure (e.g., "I used a box that looks like a triangular prism to build the roof of my house.")	• identify and describe the two-dimensional shapes that can be found in a three-dimensional figure (**Sample problem:** Build a structure from blocks, toothpicks, or other concrete materials, and describe it using geometric terms, so that your partner will be able to build your structure without seeing it.)
	• cover outline puzzles with two-dimensional shapes (e.g., pattern blocks, tangrams) (**Sample problem:** Fill in the outline of a boat with tangram pieces.)	• cover an outline puzzle with two-dimensional shapes in more than one way	

continued . . .

FDK	GRADE 1	GRADE 2	GRADE 3
Geometric Relationships Students will:	**Geometric Relationships** Students will:	**Geometric Relationships** Students will:	**Geometric Relationships** Students will:
			• explain the relationships between different types of quadrilaterals (e.g., a square is a rectangle because a square has four sides and four right angles; a rhombus is a parallelogram because opposite sides of a rhombus are parallel)
			• describe and name prisms and pyramids by the shape of their base (e.g., rectangular prism, square-based pyramid)
			• identify congruent two-dimensional shapes by manipulating and matching concrete materials (e.g., by translating, reflecting, or rotating pattern blocks)
Location and Movement Students will:	**Location and Movement** Students will:	**Location and Movement** Students will:	**Location and Movement** Students will:
• communicate an understanding of basic spatial relationships (e.g., use terms such as "above/below", "in/out", "forward/backward"; use visualization, perspective, and movements [flips/ reflections, slides/translations, and turns/ rotations]) in their conversations and play, in their predictions and visualizations, and during transitions and routines	• describe the relative locations of objects or people using positional language (e.g., over, under, above, below, in front of, behind, inside, outside, beside, between, along)	• describe the relative locations (e.g., beside, two steps to the right of) and the movements of objects on a map (e.g., "The path shows that he walked around the desk, down the aisle, and over to the window.")	
	• describe the relative locations of objects on concrete maps created in the classroom (**Sample problem:** Work with your group to create a map of the classroom in the sand table, using smaller objects to represent the classroom objects. Describe where the teacher's desk and the bookshelves are located.)	• draw simple maps of familiar settings, and describe the relative locations of objects on the maps (**Sample problem:** Draw a map of the classroom, showing the locations of the different pieces of furniture.)	• describe movement from one location to another using a grid map (e.g., to get from the swings to the sandbox, move three squares to the right and two squares down)

continued . . .

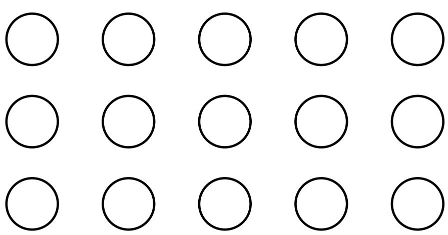
FDK	GRADE 1	GRADE 2	GRADE 3
Location and Movement Students will:	**Location and Movement** Students will:	**Location and Movement** Students will:	**Location and Movement** Students will:
	• create symmetrical designs and pictures, using concrete materials (e.g., pattern blocks, connecting cubes, paper for folding), and describe the relative locations of the parts	• create and describe symmetrical designs using a variety of tools (e.g., pattern blocks, tangrams, paper and pencil)	• complete and describe designs and pictures of images that have a vertical, horizontal, or diagonal line of symmetry (**Sample problem:** Draw the missing portion of the given butterfly on grid paper.)
			• identify flips, slides, and turns, through investigation using concrete materials and physical motion, and name flips, slides, and turns as reflections, translations, and rotations (e.g., a slide to the right is a translation; a turn is a rotation)

Glossary

Note: Words and phrases printed in boldface in the following definitions are also defined in this glossary.

angle. The amount of **rotation** between two lines that meet at a common point. See also **vertex**.

array. A rectangular arrangement of objects into rows and columns.



assessment. The process of gathering, from a variety of sources, information that accurately reflects how well a student is achieving the curriculum expectations in a subject or course. The primary purpose of assessment is to improve student learning. Assessment for the purpose of improving student learning is seen as both "assessment for learning" and "assessment as learning". As part of assessment for learning, teachers provide students with descriptive feedback and coaching for improvement.

attribute. A quantitative or qualitative characteristic of an object or a shape (e.g., colour, size, thickness). See also **property**.

attribute blocks. A **manipulative** consisting of blocks that have different **attributes**, such as shape, colour, size, and thickness.

base. In **three-dimensional figures**, the **face** that is usually seen as the bottom (e.g., the **square** face of a **square-based pyramid**, the circular face of a **cone**). In **prisms,** the two **congruent** and **parallel** faces are called bases (e.g., the triangular faces of a **triangular prism**).

big ideas. In mathematics, the important concepts or major principles. For example, the big ideas for Grades 1 to 3 in the Geometry and Spatial Sense strand of the Ontario curriculum are geometric **properties** of **two-dimensional shapes** and **three-dimensional figures**, **geometric relationships**, and **location** and movement.

circle. A **two-dimensional shape** with a curved **side**. All points on the side of a circle are equidistant from its centre.

classify. Make decisions about how to sort or categorize things. Classifying objects and numbers in different ways helps students recognize **attributes** and **properties** of objects and numbers, and develop flexible thinking.

compose. Put together. In geometry, **two-dimensional shapes** and **three-dimensional figures** can compose larger shapes and figures. See also **decompose**.

concept. See **mathematical concept**.

concrete material. See **manipulative**.

cone. A **three-dimensional figure** with a circular **base** and a curved **surface** that tapers to a common point.

context. The environment, situation, or setting in which an event or activity takes place. Real-life settings often help students make sense of mathematics.

congruence. The property of being **congruent**. **Two-dimensional shapes** or **three-dimensional figures** are congruent if they have the same size and shape.

congruent. Having the same size and shape.

cube. A **three-dimensional figure** whose six **faces** are **squares** that are **congruent**.

cylinder. A **three-dimensional figure** with two **parallel** and **congruent** circular **faces** and a curved **surface**.

decagon. A ten-sided **polygon**.

decompose. Take apart. In **geometry**, **two-dimensional shapes** and **three-dimensional figures** can be decomposed into smaller shapes and figures. See also **compose**.

diagonal symmetry. **Symmetry** in which the **line of symmetry** is diagonal. See also **horizontal symmetry** and **vertical symmetry**.

dodecagon. A twelve-sided **polygon**.

edge. The line segment at which two **faces** of a **three-dimensional figure** meet.

expectations. The knowledge and skills that students are expected to learn and to demonstrate by the end of every grade or course, as outlined in the Ontario curriculum documents for the various subject areas.

extension. A learning activity that is related to a previous one. An extension can involve a task that reinforces, builds on, or requires application of newly learned material.

face. A flat **surface** of a **three-dimensional figure**.

figure. See **three-dimensional figure**.

flip. See **reflection**.

geoboard. A **manipulative** comprising a board and pins (pegs) arranged in an **array**. Shapes can be created on a geoboard using plastic bands (geobands).

geometric solid. A **manipulative** in the shape of a **three-dimensional figure**. Common geometric solids include **spheres**, **cubes**, **prisms**, and **pyramids**.

geometry. The study of mathematics that deals with the spatial **relationships**, **properties**, movement, and location of **two-dimensional shapes** and **three-dimensional figures**. The name comes from two Greek words meaning "earth" and "measure".

hendecagon. An eleven-sided **polygon**.

heptagon. A seven-sided **polygon**.

hexagon. A six-sided **polygon**.

horizontal symmetry. **Symmetry** in which the **line of symmetry** is horizontal. See also **diagonal symmetry** and **vertical symmetry**.

investigation. An instructional activity in which students pursue a problem or an exploration. Investigations help students to develop problem-solving skills, learn new concepts, and apply and deepen their understanding of previously learned concepts and skills.

irregular polygon. A **polygon** whose **side** or **angle** measures are not equal. See also **regular polygon**.

learning styles. Different ways of learning and processing information. For instance, visual learners need to see visual representations of concepts. Auditory learners learn best through verbal instructions and discussions, and by talking things through and listening to what others have to say. Tactile/kinaesthetic learners learn best through a hands-on approach, and by exploring the physical world around them.

line of symmetry. A line that divides a shape into two parts that can be matched by folding the shape in half along this line.

manipulative. (Also called "concrete material".) An object that students handle and use in constructing their own understanding of **mathematical concepts** and skills and in illustrating their understanding. Some examples are base ten blocks, interlocking cubes, construction kits, number cubes (dice), games, **geoboards**, hundreds charts, measuring tapes, **Miras**, number lines, **pattern blocks**, spinners, and colour tiles.

mathematical concepts. The fundamental understandings about mathematics that a student develops within problem-solving **contexts**.

mathematical model. A representation of a **mathematical concept** using **manipulatives**, a diagram or picture, symbols, or real-life **contexts** or situations.

model. See **mathematical model**.

Mira. A transparent mirror used to locate **reflection** lines, reflection images, and **lines of symmetry**, and to determine **congruency** and line **symmetry**.

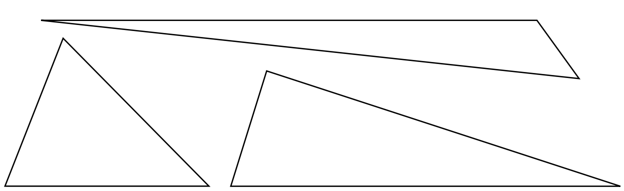
net. A pattern that can be folded to make a **three-dimensional figure**.

nonagon. A nine-sided **polygon**.

non-standard shape. See **non-traditional shape**.

non-traditional shape. (Also called "non-standard shape".) A **two-dimensional shape** that might not be identified easily because its form is different from a prototype (mental image) of the shape.

See also **traditional shape**.



Non-traditional triangles

octagon. An eight-sided **polygon**.

orientation. Direction. The orientation of a shape may change following a **rotation** or **reflection**. Its orientation does not change following a **translation**.

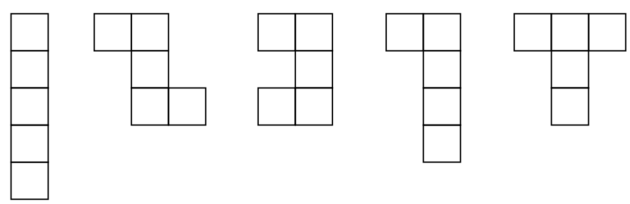
parallel. Extending in the same direction, remaining the same distance apart. Parallel lines or parallel shapes never meet because they are always the same distance apart.

parallelogram. A **quadrilateral** that has opposite **sides** that are **parallel**.

pattern blocks. A **manipulative** consisting of six different kinds of blocks, each of a **traditional shape** and colour: yellow **hexagon**, red **trapezoid**, green **triangle**, orange **square**, small beige **rhombus**, and large blue rhombus.

pentagon. A five-sided **polygon**.

pentomino. A **manipulative** consisting of arrangements of five **squares** that are **congruent** and joined along their **sides**. The following diagram illustrates five of the twelve different pentominoes.



polygon. A closed shape formed by three or more straight **sides**. Examples of polygons are **triangles**, **quadrilaterals**, **pentagons**, and **octagons**. See also **regular polygon** and **irregular polygon**.

polyhedron. A **three-dimensional figure** that has **polygons** as **faces**.

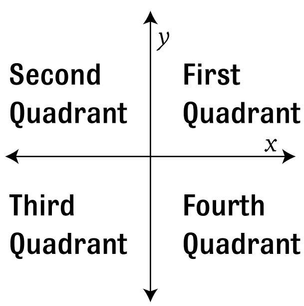
prism. A **three-dimensional figure** with two **bases** that are **parallel** and **congruent**. A prism is named by the shape of its bases, for example, **rectangular prism**, **triangular prism**.

problem solving. Engaging in a task for which the solution is not obvious or known in advance. To solve the problem, students must draw on their previous knowledge, try different strategies, make connections, and reach conclusions. Learning to solve problems by inquiry or **investigation** is very natural for young students.

property. A characteristic that determines (defines) membership in a class. See also **attribute**.

pyramid. A **three-dimensional figure** with a single **base** that is a **polygon** and other **faces** that are **triangles**. A pyramid is named by the shape of its base, for example, **square-based pyramid**, **triangle-based pyramid**.

quadrant. One of the four regions formed by the intersection of the *x*-axis and the *y*-axis in a coordinate plane.



quadrilateral. A four-sided **polygon**.

rectangle. A **parallelogram** with four **right angles**. Opposite **sides** are equal in length.

rectangular prism. A **three-dimensional figure** with two **parallel** and **congruent** rectangular **faces**. The four other faces are also rectangular.

reflection. (Also called "flip".) A **transformation** that turns a shape over an axis. The shape does not change size or shape, but it may change position and **orientation**.

regular polygon. A closed shape in which all **sides** and all **angles** are equal. See also **irregular polygon**.

relationship. In mathematics, a connection between **mathematical concepts**, or between a mathematical concept and an idea in another subject or in real life. As students connect ideas they already understand with new experiences and ideas, their understanding of mathematical relationships develops.

rhombus. A **quadrilateral** with all **sides** equal in length.

right angle. An **angle** that measures exactly 90 degrees.

rotation. (Also called "turn".) A **transformation** that turns a shape around a fixed point. The shape does not change size or shape, but it may change position and **orientation**.

shape. See **two-dimensional shape**.

side. An outer boundary (a straight or curved line) of a **two-dimensional shape**.

skeleton. A **three-dimensional figure** showing only the **edges** and **vertices** of the figure.

slide. See **translation**.

spatial sense. An intuitive awareness of one's surroundings and the objects in them.

sphere. A **three-dimensional figure** with a curved **surface**. All points on the surface of a sphere are equidistant from its centre. A sphere looks like a ball.

square. A **quadrilateral** that has four **right angles** and four equal **sides**.

square-based pyramid. A **three-dimensional figure** with a **base** that is **square** and four triangular **faces**.

standard shape. See **traditional shape**.

strand. A major area of knowledge and skills. In the Ontario mathematics curriculum for Grades 1–8, there are five strands: Number Sense and Numeration, Measurement, Geometry and Spatial Sense, Patterning and Algebra, and Data Management and Probability.

surface. The outer boundary or layer of a **three-dimensional figure**.

symmetry. The quality of a **two-dimensional shape** having two parts that match exactly, either when one half is a mirror-image of the other half (line symmetry), or when one part can take the place of another if the shape is **rotated**.

tangram. An ancient Chinese puzzle made from a **square** cut into seven pieces: two large **triangles**, one medium-sized triangle, two small triangles, one square, and one **parallelogram**.

three-dimensional figure. (Also called "figure".) An object having length, width, and depth. Three-dimensional figures include **cones**, **cubes**, **prisms**, **cylinders**, and so forth. See also **two-dimensional shape**.

tiling. The process of using repeated **congruent** shapes to cover a region completely.

traditional shape. (Also called "standard shape".) A **two-dimensional shape** that can be easily identified as a **square**, **rectangle**, **triangle**, and so on, because its form matches a prototype (mental image) of the shape. Also called a standard shape. See also **non-traditional shape**.

transformation. A change in a shape that may result in a different position, **orientation**, or size. Transformations include **translations**, **reflections**, and **rotations**.

translation. (Also called "slide".) A **transformation** that moves a shape along a straight line to a new position in the same plane. The shape does not change size, shape, or **orientation**; it changes only its position.

trapezoid. A **quadrilateral** with at least one pair of **parallel sides**.

triangle. A three-sided **polygon**.

triangle-based pyramid. A **three-dimensional figure** with a triangular **base** and three triangular **faces**.

triangular prism. A **three-dimensional figure** with two **parallel** and **congruent** triangular **faces** and three other rectangular faces.

two-dimensional shape. (Also called "shape".) A shape having length and width but not depth. Two-dimensional shapes include **circles**, **triangles**, **quadrilaterals**, and so forth. See also **three-dimensional figure**.

turn. See **rotation**.

Venn diagram. A diagram consisting of overlapping **circles** used to show what two or more sets have in common.

vertex. The common point of the segments or lines of an **angle** or of **edges** of a **three-dimensional figure**.

vertical symmetry. **Symmetry** in which the **line of symmetry** is vertical. See also **horizontal symmetry** and **diagonal symmetry**.