**Introduction**

In this section, the lessons focus on identifying, classifying, describing, and comparing plane figures. Students determine similarity and congruence of figures and work with transformations.

These lessons form an outline for your ARI classes, but you are expected to add other lessons as needed to address the concepts and provide practice of the skills introduced in the *ARI Curriculum Companion*.

Some of the lessons cross grade levels, as indicated by the SOL numbers shown below. This is one method to help students connect the content from grade to grade and to accelerate.

**Standards of Learning**

The following Standards of Learning are addressed in this section:

5.12 The student will classify  
   b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.

5.13 The student, using plane figures (square, rectangle, triangle, parallelogram, rhombus, and trapezoid), will  
   a) develop definitions of these plane figures; and  
   b) investigate and describe the results of combining and subdividing plane figures.

6.12 The student will determine congruence of segments, angles, and polygons.

6.13 The student will describe and identify properties of quadrilaterals.

7.6 The student will determine whether plane figures—quadrilaterals and triangles—are similar and write proportions to express the relationships between corresponding sides of similar figures.

7.7 The student will compare and contrast the following quadrilaterals based on properties: parallelogram, rectangle, square, rhombus, and trapezoid.

7.8 The student, given a polygon in the coordinate plane, will represent transformations (reflections, dilations, rotations, and translations) by graphing in the coordinate plane.

8.8 The student will  
   a) apply transformations to plane figures; and  
   b) identify applications of transformations.

**Table of Contents**

Lesson plans pertaining to the following Standards of Learning are found in this section. Click (or CTRL+click) on each to jump to that lesson.

- SOL 5.12b
- SOL 5.12b
- SOL 5.13a
- SOL 5.13b
- SOL 6.12, 7.6
- SOL 6.12, 7.6
- SOL 6.12
- SOL 6.12
- SOL 6.13, 7.7
- SOL 6.13, 7.7
- SOL 7.6
- SOL 7.8, 8.8
- SOL 7.8, 8.8a
- SOL 7.8, 8.8a
- SOL 8.8a
- SOL 8.8a
- SOL 8.8b

**Coming soon**
**SOL 5.12b**

**Lesson Summary**
Students are presented with a real-world problem involving the side lengths of triangles. (60 minutes)

**Materials**
“Naming Triangles” worksheets
“Tricky Triangles Recording Sheet” handouts
Pipe cleaners
Rulers

**Vocabulary**
scalene triangle. Has no congruent sides.
isosceles triangle. Has two congruent sides.
equilateral triangle. Has all sides congruent.
acute triangle. Has three acute angles.
right triangle. Has one right angle.
obtuse triangle. Has one obtuse angle.

**Warm-up**
Hand out the “Naming Triangles” worksheets, and have students complete them. Discuss the answers as a class.

**Lesson**
1. Pass out the “Tricky Triangles Recording Sheet” handouts, pipe cleaners, and rulers. Tell students that they should try to construct triangles with the side lengths listed in the table. As the students find some of the triangles impossible, have them conjecture why some are possible and some are not. Guide them to see the special relationship between any two sides of a triangle and the third side.
2. Following their hands-on experimentation, give the students the triangle inequality theorem, which states that the sum of the lengths of any two sides of a triangle is greater than the length of the third side.
3. Once students are clear on this relationship between any two sides of a triangle and the third side, present the following scenario to the students: “If a triangle has a side length of 24 cm, and another side measures 15 cm, what lengths can the other side be?” (Anything less than 39 cm)
4. Ask the students if there is a way to write the answer to this question, using a variable. Possible answers could include “The letter x must represent a number less than the sum of 24 and 15.” Once the students state the inequality in words, help them transfer this “math sentence” into an algebraic inequality: \( x < 24 + 15 \). Explain to students that this is referred to as an inequality and that the value of \( x \) has more than one correct solution.
5. Explain to students that solving an inequality is the same process as solving an equation. Have students solve this inequality by combining like terms (adding the two values): \( x < 39 \). Discuss what this means in relation to the triangle example. (The length of the third side must be less than 39 cm.)
6. Show the students a number line like the one shown below:

[Number line image]

7. Demonstrate how to graph \( x < 39 \). The circle below the number line is open to denote that the inequality cannot equal the number. If the inequality had read \( x \leq 39 \), the circle would be shaded.

**Reflection**
Have students explain in a written paragraph the difference between using an open circle and using a shaded circle in graphing an inequality. (An open circle is used to graph an inequality when the inequality
stands alone, while a shaded circle is used to graph an inequality when the inequality reads “less than or equal to” or “greater than or equal to.”}
Name: __________________________

**Naming Triangles**

Name each triangle by its angles and sides.

1. 
   ![Diagram](triangle1.png)

2. 
   ![Diagram](triangle2.png)

3. 
   ![Diagram](triangle3.png)

4. 
   ![Diagram](triangle4.png)

5. 
   ![Diagram](triangle5.png)
Name: ANSWER KEY

Naming Triangles

Name each triangle by its angles and sides.

1. isosceles, acute

2. isosceles, right

3. scalene, right

4. isosceles obtuse

5. equilateral, acute
Name: _______________________

**Tricky Triangles Recording Sheet**

Using the pipe cleaners, try to construct triangles with the given side lengths. If a triangle with the given side lengths cannot be made, answer “no.”

<table>
<thead>
<tr>
<th>Side Lengths</th>
<th>Can a triangle be made? Yes or No</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 cm, 5 cm, 8 cm</td>
<td></td>
</tr>
<tr>
<td>5 in., 8 in., 8 in.</td>
<td></td>
</tr>
<tr>
<td>8 cm, 5 cm, 15 cm</td>
<td></td>
</tr>
<tr>
<td>5 in., 6 in., 10 in.</td>
<td></td>
</tr>
<tr>
<td>11 cm, 12 cm, 14 cm</td>
<td></td>
</tr>
<tr>
<td>8 in., 8 in., 8 in.</td>
<td></td>
</tr>
</tbody>
</table>

Based on your observations, what must be true in order to construct a triangle?
Name: **ANSWER KEY**

**Tricky Triangles Recording Sheet**

Using the pipe cleaners, try to construct triangles with the given side lengths. If a triangle with the given side lengths cannot be made, answer “no.”

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</tr>
<tr>
<td>5 in., 8 in., 8 in.</td>
<td>yes</td>
</tr>
<tr>
<td>8 cm, 5 cm, 15 cm</td>
<td>no</td>
</tr>
<tr>
<td>5 in., 6 in., 10 in.</td>
<td>yes</td>
</tr>
<tr>
<td>11 cm, 12 cm, 14 cm</td>
<td>no</td>
</tr>
<tr>
<td>8 in., 8 in., 8 in.</td>
<td>yes</td>
</tr>
</tbody>
</table>

Based on your observations, what must be true in order to construct a triangle?

The triangle inequality theorem states that the sum of the lengths of any two sides of a triangle is at most greater than the length of the third side of that triangle.
SOL 5.12b

Lesson Summary
Students measure the angles inside a triangle and then classify the triangle as either acute, obtuse, or right. (60 minutes)

Materials
Protractors
“Warm-up” worksheets
“Triangle Vocabulary” handouts
“Triangle Classification” worksheets
“Triangle Classification Table” worksheets
“Reflection” worksheets

Vocabulary
polygon. A closed plane figure in which all sides are line segments.
triangle. A polygon with three sides.
acute triangle. Has three acute angles.
obtuse triangle. Has one obtuse angle.
right triangle. Has one right angle.

Warm-up
Distribute the “Warm-up” worksheets, and remind students that the sum of the measures of the three angles in a triangle equals 180°. You may wish to give them an example to help them remember this fact. Review how to find the measure of the third angle in a triangle when the other two angle measures are known. Have students complete the worksheet, and go over the answers before going on to the lesson.

Lesson
1. Distribute the “Triangle Vocabulary” handouts, and explain to or review with students that a triangle is classified by its largest angle. Go over the terms on the handout.
2. As a class, classify the four triangles on the “Warm-up” worksheet.
3. Explain and demonstrate how to extend the sides of a triangle to measure the angles and how to measure each angle inside the triangle to get all three angle measurements.
4. Distribute copies of the “Triangle Classification” and the “Triangle Classification Table” worksheets. The “Triangle Classification” worksheet is two pages and was designed to give the students space to extend the sides of the triangles for more accurate measuring.
5. Have students measure all three angles of each triangle and then classify each triangle. Have them record their answers on the “Triangle Classification Table” worksheet. Make sure students check to see that all three angles do add up to 180°.

Reflection
Have students complete the “Reflection” worksheet.
Name: ____________________

Warm-up

Find the measure of the missing angle in each triangle below. Do not use a protractor.  
*Remember: The measures of the three angles in a triangle add up to 180°.*

1. \[ \triangle \]  
   \[
   \begin{array}{c}
   \text{Measure of } \angle X = \underline{______} \\
   90^\circ \quad X
   \end{array}
   \]

2. \[ \triangle \]  
   \[
   \begin{array}{c}
   \text{Measure of } \angle B = \underline{______} \\
   56^\circ \quad 56^\circ \\
   B
   \end{array}
   \]

3. \[ \triangle \]  
   \[
   \begin{array}{c}
   \text{Measure of } \angle M = \underline{______} \\
   119^\circ \quad 35^\circ \quad M
   \end{array}
   \]

4. \[ \triangle \]  
   \[
   \begin{array}{c}
   \text{Measure of } \angle K = \underline{______} \\
   47^\circ \quad 48^\circ \quad K
   \end{array}
   \]
Name: ANSWER KEY

Warm-up

Find the measure of the missing angle in each triangle below. Do not use a protractor. 
*Remember: The measures of the three angles in a triangle add up to 180°.*

1. Measure of $\angle X = 30°$

2. Measure of $\angle B = 68°$

3. Measure of $\angle M = 26°$

4. Measure of $\angle K = 85°$
Triangle Vocabulary

**polygon**
A closed plane geometric figure in which all the sides are line segments.

**triangle**
A three-sided polygon. The sum of the three angles of a triangle equals $180^\circ$.

**acute triangle**
A triangle with three acute angles.

**obtuse triangle**
A triangle with one obtuse angle.

**right triangle**
A triangle with one right angle.

Remember: A triangle is classified by the **largest** of the three angles that form the triangle.
Triangle Classification

Measure each of the angles in each triangle using a protractor. Extend the sides if necessary. Make sure that the measures of the three angles add up to 180°. Record your answers in the Triangle Classification Table. Once you have figured out the measurement of each angle in the triangle, classify the triangle as acute, obtuse, or right.

1.

2.

3.
Name: _______________________

**Triangle Classification**

4.

![Diagram of a triangle labeled 1, 2, 3]

5.

![Diagram of a triangle labeled 1, 2, 3]

6.

![Diagram of a triangle labeled 1, 2, 3]
## Triangle Classification Table

<table>
<thead>
<tr>
<th>Triangle Number</th>
<th>Angle 1</th>
<th>Angle 2</th>
<th>Angle 3</th>
<th>Sum of the three angles</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Name: ANSWER KEY

#### Triangle Classification Table

<table>
<thead>
<tr>
<th>Triangle Number</th>
<th>Angle 1</th>
<th>Angle 2</th>
<th>Angle 3</th>
<th>Sum of the three angles</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>103°</td>
<td>49°</td>
<td>28°</td>
<td>180°</td>
<td>obtuse</td>
</tr>
<tr>
<td>2</td>
<td>30°</td>
<td>125°</td>
<td>25°</td>
<td>180°</td>
<td>obtuse</td>
</tr>
<tr>
<td>3</td>
<td>45°</td>
<td>90°</td>
<td>45°</td>
<td>180°</td>
<td>right</td>
</tr>
<tr>
<td>4</td>
<td>45°</td>
<td>65°</td>
<td>70°</td>
<td>180°</td>
<td>acute</td>
</tr>
<tr>
<td>5</td>
<td>75°</td>
<td>85°</td>
<td>25°</td>
<td>180°</td>
<td>acute</td>
</tr>
<tr>
<td>6</td>
<td>37°</td>
<td>97°</td>
<td>46°</td>
<td>180°</td>
<td>obtuse</td>
</tr>
</tbody>
</table>
Name: ____________________________

Reflection

1. To the right are two practice SOL questions. Circle your answers.

2. Explain why you chose that answer to the first question.

3. Explain why you chose that answer to the second question.

4. Can a triangle have more than one right angle? _________ Explain.
Reflection

1. To the right are two practice SOL questions. Circle your answers.

   B, G

2. Explain why you chose that answer to the first question.

   A triangle is classified by its largest angle. A 104° angle is an obtuse angle. Therefore, the triangle is an obtuse triangle.

3. Explain why you chose that answer to the second question.

   All the angles in the triangle are acute. Therefore, the triangle is an acute triangle.

4. Can a triangle have more than one right angle? No Explain.

   Two right angles add up to be 180°, and because the three angles of a triangle must add up to be 180°, there could not be another angle.
**SOL 5.13a**

**Lesson Summary**
Students analyze properties of polygons to develop definitions of square, rectangle, parallelogram, rhombus, and trapezoid, using geoboards. (45 minutes)

**Materials**
- “Quadrilateral Concept Card”
- “Quadrilateral Study Guide” worksheets
- Geoboards and an overhead geoboard
- “Quadrilateral Table” worksheets
- Geoboard dot paper (attached)

**Vocabulary**
- **polygon.** A closed plane geometric figure composed of at least three line segments that do not cross.
- **quadrilateral.** A polygon with four sides.
- **parallelogram.** A quadrilateral with both pairs of opposite sides parallel.
- **rectangle.** A quadrilateral with four right angles.
- **rhombus.** A quadrilateral with 4 congruent sides
- **square.** A quadrilateral with four sides of equal length.
- **trapezoid.** A quadrilateral with exactly one pair of parallel sides.

**Warm-up**
Give each student a “Quadrilateral Concept Card.” Have students follow along as you read and discuss each of the statements. Based on the information given on the concept card and the class discussion, have students draw their own examples of a polygon, non-polygon, quadrilateral, and non-quadrilateral. Have students also write their own definitions, based on their understanding of the words in context.

When students are finished, have them share their card with a partner. Bring the class together, and go over the students' responses. Read the definitions of polygon and quadrilateral (see above) to the class, and allow students to change their definitions to make them more accurate, as necessary.

**Lesson**
1. Display on the overhead geoboard several four-sided figures. Ask students to identify what they all have in common. (The number of sides) Instruct students that all four-sided figures are called quadrilaterals. Focus on the prefix quad, and brainstorm other words to help with meaning.
2. Hand out geoboards and rubber bands, and review class rules about working with these materials. Allow the students to explore shapes with the geoboards for a few minutes.
3. Have students make a shape on their geoboard that is a quadrilateral with both pairs of opposite sides parallel and equal in length. Make this shape on the overhead geoboard. Discuss the properties of this figure: it has four sides, both pairs of opposite sides are parallel, opposite sides are congruent, opposite angles are congruent, a diagonal divides the shape into two congruent triangles. Tell the students that the name for this figure is parallelogram. Hand out dot paper, and have students copy their figure (or yours, if theirs was incorrect) on the dot paper and label it “parallelogram.”
4. Have students make a rectangle on their geoboard. When they finish, make one on the overhead geoboard. Discuss the properties of a rectangle: it is a parallelogram with four right angles. Have students copy their rectangle on dot paper and label it “rectangle.”
5. Ask for a volunteer to make a square on the overhead geoboard. Discuss the properties of a square: it has all of the properties of a parallelogram, and it is also a rectangle with four congruent sides. Have students copy the square on dot paper and label it “square.”
6. Ask students to make a rhombus on their geoboard, and replicate it on the overhead. Guide students to discover that a rhombus has the properties of a parallelogram, which it has four congruent sides, and that opposite angles of a rhombus are congruent. Have the students label their figure “rhombus.”
7. Ask students to make a four-sided shape on their geoboard with only one pair of opposite sides parallel. Ask whether anyone knows the name of this figure. Tell students that it is a **trapezoid**—a four-sided figure with exactly one pair of parallel sides.

8. Have individual students come to the overhead geoboard and create different types of quadrilaterals—rectangle, square, parallelogram, rhombus, and trapezoid—to review the properties and definitions of these quadrilaterals.

9. Have pairs of students complete the “Quadrilateral Study Guide.” Provide assistance as needed.

**Reflection**

Have students complete the “Quadrilateral Table” worksheet.
## Quadrilateral Concept Card

### Polygons

<table>
<thead>
<tr>
<th>These figures are polygons:</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Polygon Examples" /></td>
</tr>
<tr>
<td>These figures are <strong>not</strong> polygons:</td>
</tr>
<tr>
<td><img src="image2.png" alt="Non-Polygon Examples" /></td>
</tr>
</tbody>
</table>

Which of these figures are polygons? (circle)

Draw your own example of a polygon.

Draw your own example of a non-polygon.

What is a polygon?

A polygon is ________________________

### Quadrilaterals

<table>
<thead>
<tr>
<th>These figures are quadrilaterals:</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.png" alt="Quadrilateral Examples" /></td>
</tr>
<tr>
<td>These figures are <strong>not</strong> quadrilaterals:</td>
</tr>
<tr>
<td><img src="image4.png" alt="Non-Quadrilateral Examples" /></td>
</tr>
</tbody>
</table>

Which of these figures are quadrilaterals? (circle)

Draw your own example of a quadrilateral.

Draw your own example of a non-quadrilateral.

What is a quadrilateral?

A quadrilateral is ________________________
Name: ANSWER KEY

Quadrilateral Concept Card

**Polygons**

These figures are polygons:

![Polygons examples]

These figures are **not** polygons:

![Non-polygons examples]

Which of these figures are polygons? (circle)

![Circle indicating selection]

Draw your own example of a polygon.

**Drawing will vary.**

Draw your own example of a non-polygon.

**Drawing will vary.** Sample answer:

![Non-polygon example]

What is a polygon? Sample answer:

A *polygon* is a simple, closed, plane figure formed by three or more straight lines.

**Quadrilaterals**

These figures are quadrilaterals:

![Quadrilaterals examples]

These figures are **not** quadrilaterals:

![Non-quadrilaterals examples]

Which of these figures are quadrilaterals? (circle)

![Circle indicating selection]

Draw your own example of a quadrilateral.

**Drawing will vary.**

Draw your own example of a non-quadrilateral.

**Drawing will vary.** Sample answer:

![Non-quadrilateral example]

What is a quadrilateral? Sample answer:

A *quadrilateral* is a four-sided polygon.
Name: ____________________________

**Quadrilateral Study Guide**

Fill in the blanks, and draw the figures as directed.

1. A _________________ is a polygon with four sides. Draw several examples of this below.

2. A _________________ is a quadrilateral in which both pairs of opposite sides are parallel.

3. Properties of a parallelogram include the following:
   a. A diagonal divides a parallelogram into two congruent _________________.
   b. The opposite sides of a parallelogram are _________________.
   c. The opposite angles of a parallelogram are _________________.

For questions 4–8, refer to the drawings on the right.

4. A _________________ is a parallelogram with four right angles.
   Since a _________________ is a parallelogram, it has the same properties as those of a parallelogram.

5. A _________________ is a rectangle with four congruent sides. Since a _________________ is a rectangle, it has all the properties of a rectangle and of a parallelogram.

6. A _________________ is a parallelogram with four congruent sides. Opposite angles of a _________________ are congruent. Since a _________________ is a parallelogram, it has all the properties of a parallelogram.

7. A _________________ is a quadrilateral with exactly one pair of parallel sides.
Name: ANSWER KEY

Quadrilateral Study Guide

Fill in the blanks, and draw the figures as directed.

1. A quadrilateral is a polygon with four sides. Draw several examples of this below.

   ![Quadrilateral Examples]

2. A parallelogram is a quadrilateral in which both pairs of opposite sides are parallel.

3. Properties of a parallelogram include the following:
   a. A diagonal divides a parallelogram into two congruent triangles.
   b. The opposite sides of a parallelogram are parallel/congruent.
   c. The opposite angles of a parallelogram are congruent.

For questions 4–8, refer to the drawings on the right.

4. A rectangle is a parallelogram with four right angles. Since a rectangle is a parallelogram, it has the same properties as those of a parallelogram. (Discuss with students that square also fits this definition, since a square is a special type of rectangle.)

   ![Rectangle Diagram]

5. A square is a rectangle with four congruent sides. Since a square is a rectangle, it has all the properties of a rectangle and of a parallelogram.

   ![Square Diagram]

6. A rhombus is a parallelogram with four congruent sides. Opposite angles of a rhombus are congruent. Since a rhombus is a parallelogram, it has all the properties of a parallelogram. (Discuss with students that a square is a special rhombus, so it also fits this definition, but a square must have four right angles.)

   ![Rhombus Diagram]

7. A trapezoid is a quadrilateral with exactly one pair of parallel sides.

   ![Trapezoid Diagram]
**Quadrilateral Table**

Place a check mark in the appropriate boxes to show which figures have which properties. Then answer the questions that follow.

<table>
<thead>
<tr>
<th>PROPERTY OF FIGURE</th>
<th>TYPES OF POLYGONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quadrilateral</td>
</tr>
<tr>
<td>Only one set of parallel sides</td>
<td></td>
</tr>
<tr>
<td>Two sets of parallel sides</td>
<td></td>
</tr>
<tr>
<td>Two sides of equal length</td>
<td></td>
</tr>
<tr>
<td>Four sides of equal length</td>
<td></td>
</tr>
<tr>
<td>Four angles of equal measure</td>
<td></td>
</tr>
<tr>
<td>All four angles are right angles</td>
<td></td>
</tr>
<tr>
<td>It may contain a right angle</td>
<td></td>
</tr>
</tbody>
</table>

Is a square a rectangle? _____ How do you know this? ____________________________________________________________

I have four sides and two sets of equal sides, but not all four of my sides are equal, and I have two sets of parallel sides. What shape(s) can I be? ____________________________________________________________
Name: **ANSWER KEY**

**Quadrilateral Table**

Place a check mark in the appropriate boxes to show which figures have which properties. Then answer the questions that follow.

<table>
<thead>
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<td>Quadrilateral</td>
</tr>
<tr>
<td>Only one set of parallel sides</td>
<td>✓</td>
</tr>
<tr>
<td>Two sets of parallel sides</td>
<td>✓</td>
</tr>
<tr>
<td>Two sides of equal length</td>
<td>✓</td>
</tr>
<tr>
<td>Four sides of equal length</td>
<td></td>
</tr>
<tr>
<td>Four angles of equal measure</td>
<td></td>
</tr>
<tr>
<td>All four angles are right angles</td>
<td></td>
</tr>
<tr>
<td>It may contain a right angle</td>
<td>✓</td>
</tr>
</tbody>
</table>

Is a square a rectangle? **Yes** How do you know this? **Because it has 4 sides, 4 right angles, and 2 sets of parallel sides**

I have four sides and two sets of equal sides, but not all four of my sides are equal, and I have two sets of parallel sides. What shape(s) can I be? **quadrilateral, rectangle, or parallelogram**
**SOL 5.13b**

**Lesson Summary**
Students investigate and describe the results of combining and subdividing shapes, using tangram pieces. (30 minutes)

**Materials**
Sets of tangrams
“Tangrams Activity Chart”
“Tangram Puzzles” worksheets
“Assessment Questions” worksheets

**Warm-up**
Pass out the tangram pieces, or have the students cut them out from the “Tangram Template.” Tell the students to write down the names of all seven pieces: A, B, C, D, E are right triangles, F is a square, and G is a parallelogram.

**Lesson**
1. Discuss with students the facts that two or more polygons can be combined to form a new shape and, conversely, that a polygon can be subdivided into two or more shapes.
2. Distribute the “Tangram Activity Chart”. Have students follow the directions and then describe their solutions orally.
3. Pass out the Tangram Puzzle activity sheet. Have students make the figures using all seven tangram pieces and then draw a sketch of their solutions. Participants can work individually or in small groups to solve the tangram puzzles.

**Reflection**
Have students reflect on and write answers to the assessment questions.
Tangram Activity Chart

Use the number of tangram pieces specified in the first column to form each of the geometric figures shown in the top row. As you make each shape, list in the proper box the pieces you use to make it. Some problems may have more than one solution, while others may have no solution.

<table>
<thead>
<tr>
<th>Number of pieces</th>
<th>Square</th>
<th>Rectangle</th>
<th>Triangle</th>
<th>Trapezoid</th>
<th>Parallel -ogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
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<td>4</td>
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<tr>
<td>7</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Name: **ANSWER KEY**

**Tangram Activity Chart**

Use the number of tangram pieces specified in the first column to form each of the geometric figures shown in the top row. As you make each shape, list in the proper box the pieces you use to make it. *Some problems may have more than one solution, while others may have no solution.*

*(Teacher’s Note: For each problem with multiple solutions, only one is included here.)*

<table>
<thead>
<tr>
<th>Number of pieces</th>
<th>Square</th>
<th>Rectangle</th>
<th>Triangle</th>
<th>Trapezoid</th>
<th>Parallel -ogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>D &amp; E</td>
<td>Not possible</td>
<td>D &amp; E</td>
<td>D &amp; F</td>
<td>D &amp; E</td>
</tr>
<tr>
<td>3</td>
<td>D, E, &amp; C</td>
<td>D, C, &amp; E</td>
<td>D, E, &amp; C</td>
<td>A, B, &amp; C</td>
<td>D, E, &amp; C</td>
</tr>
<tr>
<td>4</td>
<td>D, E, C, &amp; B</td>
<td>D, E, C, &amp; B</td>
<td>D, E, C, &amp; B</td>
<td>D, E, A, &amp; B</td>
<td>D, E, C, &amp; B</td>
</tr>
<tr>
<td>6</td>
<td>Not possible</td>
<td>C, E, F, D, G, &amp; A</td>
<td>Not possible</td>
<td>C, E, F, D, G, &amp; A</td>
<td>C, E, F, D, G, &amp; A</td>
</tr>
<tr>
<td>7</td>
<td>All pieces</td>
<td>All pieces</td>
<td>All pieces</td>
<td>All pieces</td>
<td>All pieces</td>
</tr>
</tbody>
</table>
Tangram Puzzles

Can you make these figures, using all seven tangram pieces? Make a sketch of your solutions.

1.  

2.  

3.  

4.  

5.  

6.  

Name: _________________________
**Assessment Questions**

1. What strategy did you use to find the shapes?

2. Is there a basic shape that could be used to make all the figures?

3. Which pieces did you tend to use more than others? Why?

4. What are some other ways to construct each of the shapes?

5. Why is there no six-piece square?
**SOL 6.12, 7.6**

**Lesson Summary**
Students sort a set of triangles into pairs and discover the relationship between the figures that are similar or congruent. Students create similar and congruent figures on geoboards. (40 minutes)

**Materials**
- Sets of “Similar and Congruent Triangle Sorting Pieces”
- Geoboards
- Rubber bands
- “Applying the Lesson” worksheets
- “Similar or Congruent?” worksheets

**Vocabulary**
- **congruent figures.** Two figures that have exactly the same size and the same shape.
- **similar figures.** Two polygons that have the same shape but not the same size. Two figures are similar if corresponding (matching) angles are congruent and the lengths of corresponding sides are proportional.

**Warm-up**
Copy the 12 “Similar and Congruent Triangle Sorting Pieces” onto card stock and cut them out, making enough sets of 12 pieces to give a complete set to each pair of students. Alternatively, have each pair of students cut out their own set. After distributing the sets, ask the partners to pair up the triangles that are related in some way, explaining that for each triangle, there is another that is like it in one way or another. Have students write down the triangle pairs they matched and an explanation of why they paired the triangles the way they did.

**Lesson**
1. Have student partners orally explain how they paired the triangles.
2. Talk about the triangles that are the same shape and same size. Give the students the definition of congruent figures (see above). Show example of congruent triangles.
3. Talk about the triangles that are the same shape but not the same size. Give the students the definition of similar figures (see above). Show example of similar triangles.
4. Pass out geoboards and rubber bands. Have students create similar and congruent figures according to your directions. For example, say, “Show me similar rectangles.” Students should create two rectangles of the same shape but different size. Have students practice making these until they are familiar with the terms similar and congruent.
5. Have the students complete the “Applying the Lesson” worksheet, giving assistance as needed.

**Reflection**
Have students complete the “Similar or Congruent?” worksheet.
Similar and Congruent Triangle Sorting Pieces

F

I

K
Similar and Congruent Triangle Sorting Pieces

G

B

D

E

L
Similar and Congruent Triangle Sorting Pieces

A
J
H
C
A
Name: ________________________

**Applying the Lesson**

In the first box in each row, draw a simple figure. In the second box in that row, draw a figure similar to the original. In the third box, draw a figure congruent to the original figure.

<table>
<thead>
<tr>
<th>Original Figure</th>
<th>Similar Figure</th>
<th>Congruent Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Original Figure" /></td>
<td><img src="image2.png" alt="Similar Figure" /></td>
<td><img src="image3.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image4.png" alt="Original Figure" /></td>
<td><img src="image5.png" alt="Similar Figure" /></td>
<td><img src="image6.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image7.png" alt="Original Figure" /></td>
<td><img src="image8.png" alt="Similar Figure" /></td>
<td><img src="image9.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image10.png" alt="Original Figure" /></td>
<td><img src="image11.png" alt="Similar Figure" /></td>
<td><img src="image12.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image13.png" alt="Original Figure" /></td>
<td><img src="image14.png" alt="Similar Figure" /></td>
<td><img src="image15.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image16.png" alt="Original Figure" /></td>
<td><img src="image17.png" alt="Similar Figure" /></td>
<td><img src="image18.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image19.png" alt="Original Figure" /></td>
<td><img src="image20.png" alt="Similar Figure" /></td>
<td><img src="image21.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image22.png" alt="Original Figure" /></td>
<td><img src="image23.png" alt="Similar Figure" /></td>
<td><img src="image24.png" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="image25.png" alt="Original Figure" /></td>
<td><img src="image26.png" alt="Similar Figure" /></td>
<td><img src="image27.png" alt="Congruent Figure" /></td>
</tr>
</tbody>
</table>
Name: ANSWER KEY

**Applying the Lesson**

In the first box in each row, draw a simple figure. In the second box in that row, draw a figure similar to the original. In the third box, draw a figure congruent to the original figure.

<table>
<thead>
<tr>
<th>Original Figure</th>
<th>Similar Figure</th>
<th>Congruent Figure</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Original Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Similar Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Congruent Figure" /></td>
</tr>
<tr>
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<td><img src="https://via.placeholder.com/150" alt="Similar Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Original Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Similar Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Congruent Figure" /></td>
</tr>
<tr>
<td><img src="https://via.placeholder.com/150" alt="Original Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Similar Figure" /></td>
<td><img src="https://via.placeholder.com/150" alt="Congruent Figure" /></td>
</tr>
</tbody>
</table>
Similar or Congruent?

Label each pair of figures below as similar, congruent, or neither. Then, justify your answer with its mathematical definition.

1. These figures are ____________________ because
   ____________________________________
   ____________________________________

2. These figures are ____________________ because
   ____________________________________
   ____________________________________

3. These figures are ____________________ because
   ____________________________________
   ____________________________________

4. These figures are ____________________ because
   ____________________________________
   ____________________________________

5. These figures are ____________________ because
   ____________________________________
   ____________________________________
**Name: ANSWER KEY**

**Similar or Congruent?**

Label each pair of figures below as *similar*, *congruent*, or *neither*. Then, justify your answer with its mathematical definition.

1. These figures are **neither** because they are neither the same shape nor the same size.

2. These figures are **congruent** because they are exactly the same in shape and size.

3. These figures are **congruent** because they are exactly the same in shape and size.

4. These figures are **similar** because they are exactly the same in shape but different in size.

5. These figures are **neither** because they are neither the same shape nor the same size.
**SOL 6.12, 7.6**

**Lesson Summary**
Students sort triangles and quadrilaterals and discover similar and congruent relationships among the figures. (30–40 minutes)

**Materials**
- “Similar and Congruent Figures Concept Card”
- “Similar or Congruent Figures Chart”
- Sets of “Similar and Congruent Sorting Pieces”
- “Similar or Congruent?” worksheets

**Vocabulary**
- **congruent figures.** Two figures that have exactly the same size and the same shape.
- **similar figures.** Two polygons that have the same shape but not the same size. Two figures are similar if corresponding (matching) angles are congruent and the lengths of corresponding sides are proportional.

**Warm-up**
Give each student a “Similar and Congruent Figures Concept Card.” Based on the information given on the card, have students draw their own pairs of congruent, similar, noncongruent, and nonsimilar figures. Have students write their own definitions of these terms, based on their understanding of the words in context. When they are done, have them share their card with a partner. Bring the class together, and go over the students’ responses.

**Lesson**
1. Copy the “Similar and Congruent Sorting Pieces” onto card stock and cut them out, making enough sets of pieces to give a complete set to each pair of students. After distributing the sets of sorting pieces and the “Similar or Congruent Figures Charts,” ask the partners to sort the shapes into pairs according to whether they are similar or congruent. Instruct them to place (or write) the pairs on the correct side of the chart.
2. Have each group orally explain how they paired the figures.
3. Talk about the figures that are the same shape and same size. Review the definition of congruent figures (see above), stressing that all properties of the two figures are exactly the same and that the two figures would match perfectly if one were laid on top of the other. Show other examples of congruent figures.
4. Talk about the figures that are the same shape but not the same size. Review the definition of similar figures (see above). Ask students to compare two similar figures, noticing what is similar and what is different. They should observe that the angles are congruent but the sides are not. Show other examples of similar figures. Ask: “Are all congruent figures also similar figures?”
5. Have students go back and make any necessary changes to the definitions on their concept cards.

**Reflection**
Have students complete the “Similar or Congruent?” worksheet.
Name: ____________________________

**Similar and Congruent Figures Concept Card**

**Similar Figures**

These pairs of figures are similar.

These pairs of figures are nonsimilar.

Which of these pairs of figures are similar?

Draw your own pair of similar figures.

Draw your own pair of nonsimilar figures.

**Congruent Figures**

These pairs of figures are congruent.

These pairs of figures are noncongruent.

Which of these pairs of figures are congruent?

Draw your own pair of congruent figures.

Draw your own pair of noncongruent figures.

**What are similar figures?**

Similar figures are ____________________________

**What are congruent figures?**

Congruent figures are ____________________________
**Name: ANSWER KEY**

**Similar and Congruent Figures Concept Card**

**Similar Figures**

These pairs of figures are **similar**.

These pairs of figures are **nonsimilar**.

Which of these pairs of figures are similar?

Draw your own pair of similar figures. *Sample answer:*

Draw your own pair of nonsimilar figures. *Sample answer:*

What are similar figures? *Sample answer:*

**Congruent Figures**

These pairs of figures are **congruent**.

These pairs of figures are **noncongruent**.

Which of these pairs of figures are congruent?

Draw your own pair of congruent figures. *Sample answer:*

Draw your own pair of noncongruent figures. *Sample answer:*

What are congruent figures? *Sample answer:*

**Similar figures are two figures that are exactly the same in shape but not necessarily the same in size.**

**Congruent figures are two figures that are exactly same in shape and size.**
Similar and Congruent Figures Sorting Pieces
Similar and Congruent Figures Sorting Pieces

G

B

D

E

L
Similar and Congruent Figures Sorting Pieces

A

H

J

C

A
Similar and Congruent Figures Sorting Pieces

M

O

S

R

T
Similar and Congruent Figures Sorting Pieces

P

N

U

Q
Name: __________________________

**Similar or Congruent Figures Chart**

Sort the figures into pairs according to whether they are similar or congruent. Then, identify the pairs by writing their letters in the chart below.

<table>
<thead>
<tr>
<th>SIMILAR FIGURES</th>
<th>CONGRUENT FIGURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Name: ANSWER KEY**

**Similar or Congruent Figures Chart**

Sort the figures into pairs according to whether they are similar or congruent. Then, identify the pairs by writing their letters in the chart below.

<table>
<thead>
<tr>
<th>SIMILAR FIGURES</th>
<th>CONGRUENT FIGURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>O &amp; S</td>
<td>P &amp; N</td>
</tr>
<tr>
<td>R &amp; T</td>
<td>M &amp; V</td>
</tr>
<tr>
<td>U &amp; Q</td>
<td>C &amp; F</td>
</tr>
<tr>
<td>J &amp; G</td>
<td>H &amp; B</td>
</tr>
<tr>
<td>A &amp; E</td>
<td>I &amp; L</td>
</tr>
<tr>
<td></td>
<td>D &amp; K</td>
</tr>
</tbody>
</table>
Name: __________________________

**Similar or Congruent?**

Determine whether each pair of figures below is similar or congruent, and give a brief explanation of your answer.

1. These figures are ____________________ because
   ____________________________________________________________________________
   ____________________________________________________________________________.

2. These figures are ____________________ because
   ____________________________________________________________________________
   ____________________________________________________________________________.

3. These figures are ____________________ because
   ____________________________________________________________________________
   ____________________________________________________________________________.

4. Draw a pair of quadrilaterals that are similar and another pair that are congruent. Label the pairs.

Answer *True or False* to the following questions. If false, explain why.

5. Congruent figures are always similar. _________________

6. Similar figures are never congruent. ____________________________________________________________________________
   ____________________________________________________________________________
**Name: ANSWER KEY**

**Similar or Congruent?**

Determine whether each pair of figures below is similar or congruent, and give a brief explanation of your answer.

1. These figures are **congruent** because they are exactly the same in shape and size.

2. These figures are **similar** because they are exactly the same in shape but different in size.

3. These figures are **congruent** because they are exactly the same in shape and size.

4. Draw a pair of quadrilaterals that are similar and another pair that are congruent. Label the pairs. **Sample answers:**

   ![Similar and Congruent](image)

Answer **True or False** to the following questions. If false, explain why.

5. Congruent figures are always similar. **True**

6. Similar figures are never congruent. **False. They may be the same in size, and if they are, they are congruent.**
**SOL 6.12**

**Lesson Summary**
Students identify and explore congruent and noncongruent polygons. (40 minutes)

**Materials**
- “Congruent Figures Concept Card”
- Scrap paper
- “Rectangle Templates” worksheets
- “Congruent Figures” worksheets
- Patty paper or tracing paper
- “Reflecting on Congruent Figures” worksheets

**Vocabulary**
congruent figures. Two figures that have exactly the same size and the same shape.

**Warm-up**
Give each student a “Congruent Figures Concept Card.” Based on the information given on the card, have students draw their own examples of congruent and noncongruent figures. Have students write their own definitions of these terms, based on their understanding of the words in context. When they are done, have them share their card with a partner. Bring the class together, and go over the students’ responses.

**Lesson**
1. Give each student a “Rectangle Templates” worksheet, and ask students to cut out one of the rectangles and use it as a template to draw a rectangle on a sheet of scrap paper. Then, ask them to draw another rectangle, using the same template, at another place on the same sheet but to turn the template a different way so that the two rectangles appear to be different. Next, ask them to use another smaller or larger rectangular template to draw a third rectangle on the sheet. Ask students to describe the three rectangles on the sheet. This discussion should lead to an understanding of the word congruent, meaning two figures that are exactly the same in shape and size, as well as the meaning of the word noncongruent, meaning two figures that are not the same in shape and/or size.
2. Based on the discussion for congruent figures, have students make necessary changes to their definitions and examples on their concept cards.
3. Ask students to trace the original rectangle template at the very top of another sheet of scrap paper. Then, ask them to trace another identical rectangle below it but to turn and flip the rectangle template so that it is difficult to tell whether the two rectangles really are congruent. Have students trace a few more identical rectangles in different positions and a few non-identical rectangles on the sheet. When they are done, have them trade papers.
4. After the papers have been traded, give students a minute to determine which rectangles are congruent to the one at the top of the paper. After they have decided, hand out the patty paper or tracing paper, and have them trace the original rectangle at the top. Then have them turn and/or flip their tracing to identify the rectangles that are congruent. Ask the students to circle the congruent rectangles.
5. Have students use the tracing method to prove which figures are congruent on the “Congruent Figures” worksheet.
6. Next, have students use the original rectangle template to trace a rectangle in the center of another sheet of paper and label the drawing “Original.”
7. Have them realign the template with the new drawing, carefully slide the template in any direction without changing its orientation, trace another rectangle, and label this second rectangle “Translation (Slide).”
8. Next, have them execute a translation in another direction from the original but then rotate the template on one point, trace it, and label this third rectangle “Rotation (Turn).”

9. Finally, have the students execute a translation in yet another direction from the original but then flip the template over, trace it, and label this fourth rectangle “Reflection (Flip).”

10. While these figures are being drawn, discuss the reasons for using these terms to label these rectangles.

11. After you have discussed the terms, have students go back to the “Congruent Figures” worksheet. For each figure that they said was congruent with the one at the left, have students label how the second figure was moved, using one of the three terms translation, rotation, or reflection.

**Reflection**

Have students complete the “Reflecting on Congruent Figures” worksheet.
Name: ____________________________

**Congruent Figures Concept Card**

These pairs of figures are congruent.

![Congruent Figures](image1)

These pairs of figures are noncongruent.

![Noncongruent Figures](image2)

Which of these pairs of figures are congruent?

![Congruent Figures](image3)

Draw your own pair of congruent figures.

![Drawing](image4)

Draw your own pair of noncongruent figures.

![Noncongruent Figures](image5)

What are congruent figures?

Congruent figures are ____________________________.
Name: ANSWER KEY

**Congruent Figures Concept Card**

These pairs of figures are **congruent**.

![Figure Examples](image1)

These pairs of figures are **noncongruent**.

![Figure Examples](image2)

Which of these pairs of figures are congruent?

![Figure Examples](image3)

Draw your own pair of congruent figures.
*Sample answer:*

![Figure Examples](image4)

Draw your own pair of noncongruent figures.
*Sample answer:*

![Figure Examples](image5)

What are congruent figures? *Sample answer:*

*Congruent figures are two figures that are exactly the same in shape and size.*
Rectangle Templates
Name: _____________________

**Congruent Figures Worksheet**

Look carefully each row of figures. Circle the figures in that row that are congruent to the first figure in the row, and label them “translation,” “rotation,” or “reflection.” Some figures might be labeled with two terms.

<table>
<thead>
<tr>
<th>1.</th>
<th></th>
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</table>

<table>
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<tr>
<th>2.</th>
<th></th>
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<th>3.</th>
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<table>
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<th>4.</th>
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<table>
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<table>
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</table>

<table>
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<th>7.</th>
<th></th>
<th></th>
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<th></th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>8.</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
</table>
Name: ANSWER KEY

Congruent Figures Worksheet

Look carefully each row of figures. Circle the figures in that row that are congruent to the first figure in the row, and label them “translation,” “rotation,” or “reflection.” Some figures might be labeled with two terms.

1. \[ \text{rotation} \]
2. \[ \text{rotation or reflection} \]
3. \[ \text{translation} \]
4. \[ \text{rotation} \]
5. \[ \text{translation} \]
6. \[ \text{translation} \]
7. \[ \text{reflection and rotation} \]
8. \[ \text{reflection} \]

Virginia Department of Education
Name: __________________________

**Reflecting on Congruent Figures**

In the space below, draw a congruent figure for each figure shown.
Reflecting on Congruent Figures

7. Which 2 shapes below are congruent?

A  L and P
B  M and N
C  N and L
D  P and N

8. Wayne cut this shape out of a piece of paper:

Which of the following is missing a piece exactly the same size and shape as the piece shown above?

A  A and B
B  B and D
C  C and D
D  D and A

Virginia Department of Education
Reflecting on Congruent Figures

In the space below, draw a congruent figure for each figure shown.
Reflecting on Congruent Figures

7. Which 2 shapes below are congruent?

A L and P  
B M and N  
C N and L  
D P and N

8. Wayne cut this shape out of a piece of paper.

Which of the following is missing a piece exactly the same size and shape as the piece shown above?

A A and B  
B B and D  
C C and D  
D D and A
**SOL 6.12**

**Lesson Summary**
Students compare line segments, angles, and polygons for congruence, using tracing and direct measurement. (40 minutes)

**Materials**
Protractors
Centimeter rulers
Permanent markers
Patty paper or tracing paper
“Warm-up” worksheets
“Determining Congruence” worksheets
“Determining Congruence Tables” worksheets
“Reflecting” worksheets

**Vocabulary**
congruent. Congruent figures have exactly the same size and the same shape.

**Warm-up**
Distribute the “Warm-up” worksheets, and if necessary, explain to students or remind them how to measure using a centimeter ruler. After they have completed the worksheet, go over the answers before going on to the lesson.

**Lesson**
1. Explain to students that they are going to compare two geometric images in order to reach one of two conclusions: (1) they are congruent, or (2) they are noncongruent.
2. Distribute the “Determining Congruence” and the “Determining Congruence Tables” worksheets.
3. Part A: Have students measure each pair of line segments, using a centimeter ruler, and record their measurements on the “Determining Congruence Table.” Have them compare the two measurements of the pairs of segments. If the two measurements are the same, the two line segments are congruent; if the two measurements are different, the two line segments are noncongruent. (Note: It is important for students to fully understand that line segments and other shapes may be congruent even if they are oriented differently. If students need reinforcement with this concept, have them practice reorienting pairs of congruent line segments and pairs of congruent figures.
4. Part B: Have students measure each angle in degrees, using a protractor, and record the measures of the angles in the “Determining Congruence Table.” Have students compare the measures of the two angles: if the two angles have the same measure, then the two angles are congruent; if the two angles have different measures, then the two angles are noncongruent.
5. Part C. Distribute patty paper or tracing paper and permanent markers. Have students trace on the paper one of the polygons in each pair, using a permanent marker, and compare the pair of polygons by placing the traced polygon on top of the other polygon in the pair. If they are an exact match in size and shape, then the two polygons are congruent; if the two polygons differ in size and/or shape, then the two polygons are noncongruent.

**Reflection**
Have students answer the questions on the “Reflecting” sheet. Review the responses as you walk around and check the students’ work.
Warm-up

Measure each line segment, using a centimeter ruler, and record each measurement.

1. \( \overline{KM} \) Measure = ________________
2. \( \overline{GT} \) Measure = ________________
3. \( \overline{WR} \) Measure = ________________
4. \( \overline{EL} \) Measure = ________________

Measure each angle in degrees, using a protractor, and record each measure.

5. Measure = _____
6. Measure = _____
7. Measure = _____

8. Define congruent: ________________________________
Name: ANSWER KEY

Warm-up

Measure each line segment, using a centimeter ruler, and record each measurement.

1. Measure = 4 1/2 cm or 4.5 cm

2. Measure = 7 9/10 cm or 7.9 cm

3. Measure = 2 9/10 cm or 2.9 cm

4. Measure = 1 6/10 = 1 3/5 cm or 1.6 cm

Measure each angle in degrees, using a protractor, and record each measure.

5. Measure = 139°

6. Measure = 22°

7. Measure = 44°

8. Define congruent: Answers will vary, e.g., “Having the same size and shape.”
**Determining Congruence**

Part A

Measure each line segment in each pair, using a centimeter ruler, and record each measurement in the table. Then, determine whether the two line segments in each pair are congruent or noncongruent. Record your answers in the table.

1. [Diagram of line segments VJ and D]

2. [Diagram of line segments SQ and CP]

3. [Diagram of line segments UX and OH]
Name: ____________________

**Determining Congruence**

**Part B**

Measure each angle in each pair, using a protractor, and record each measurement in the table. Then, determine whether the two angles in each pair are congruent or noncongruent. Record your answers in the table.

4.

5.

6.
Name: _______________________

**Determining Congruence**

**Part C**

Trace one of the polygons in each pair, using patty paper or tracing paper and a marker. Then, place the tracing over the other polygon in the pair to determine whether the two polygons are congruent or noncongruent. Record your answers in the table.

7. [Insert diagrams]

8. [Insert diagrams]

9. [Insert diagrams]
### Determining Congruence Tables

**Part A**

<table>
<thead>
<tr>
<th>Number</th>
<th>Measure Line Segment 1</th>
<th>Measure Line Segment 2</th>
<th>Congruent or Noncongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Part B**

<table>
<thead>
<tr>
<th>Number</th>
<th>Measure Angle</th>
<th>Measure Angle 2</th>
<th>Congruent or Noncongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Part C**

<table>
<thead>
<tr>
<th>Number</th>
<th>Congruent or Noncongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
**Name: ANSWER KEY**

## Determining Congruence Tables

### Part A

<table>
<thead>
<tr>
<th>Number</th>
<th>Measure Line Segment 1</th>
<th>Measure Line Segment 2</th>
<th>Congruent or Noncongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6 7/10 cm or 6.7 cm</td>
<td>6 7/10 cm or 6.7 cm</td>
<td>Congruent</td>
</tr>
<tr>
<td>2</td>
<td>5 4/10 = 5 2/5 cm or 5.4 cm</td>
<td>5 7/10 cm or 5.7 cm</td>
<td>Noncongruent</td>
</tr>
<tr>
<td>3</td>
<td>4 4/10 = 4 2/5 cm or 4.4 cm</td>
<td>4 1/10 cm or 4.1</td>
<td>Noncongruent</td>
</tr>
</tbody>
</table>

### Part B

<table>
<thead>
<tr>
<th>Number</th>
<th>Measure Angle</th>
<th>Measure Angle 2</th>
<th>Congruent or Noncongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>45°</td>
<td>74°</td>
<td>Noncongruent</td>
</tr>
<tr>
<td>5</td>
<td>134°</td>
<td>134°</td>
<td>Congruent</td>
</tr>
<tr>
<td>6</td>
<td>33°</td>
<td>27°</td>
<td>Noncongruent</td>
</tr>
</tbody>
</table>

### Part C

<table>
<thead>
<tr>
<th>Number</th>
<th>Congruent or Noncongruent</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Congruent</td>
</tr>
<tr>
<td>8</td>
<td>Noncongruent</td>
</tr>
<tr>
<td>9</td>
<td>Congruent</td>
</tr>
</tbody>
</table>
Name: _______________________

Reflecting

1. To the right is a practice SOL question. Circle your answer.

Which figures appear to be congruent?

2. Explain why you chose that answer.

____________________________________
____________________________________
____________________________________
____________________________________

A  A and B
B  B and D
C  C and D
D  D and A

3. Draw two congruent line segments.

4. Draw two congruent angles.
**Name: ANSWER KEY**

**Reflecting**

1. To the right is a practice SOL question. Circle your answer.
   
   D

2. Explain why you chose that answer.
   
   Answers will vary, e.g. “A and D are the same size.” “A and D are made up of the same number of grid boxes.”

3. Draw two congruent line segments.

4. Draw two congruent angles.

**Which figures appear to be congruent?**

A  A and B
B  B and D
C  C and D
D  D and A
**SOL 6.13, 7.7**

**Lesson Summary**
Students construct parallelograms, rectangles, squares, and rhombuses, using D-stix, geo-strips, or toothpicks and marshmallows, and identify the properties of the constructed figures. (approximately 40 minutes)

**Materials**
Sets of D-stix™, Geo-strips™, or toothpicks and miniature marshmallows
“Quadrilateral Concept Card”
“Types of Quadrilaterals” handouts

**Vocabulary**
- **polygon**: A closed plane geometric figure composed of at least three line segments that do not cross. None of the sides are curved.
- **quadrilateral**: A closed plane (two-dimensional) figure with four sides that are line segments.
- **parallelogram**: A quadrilateral whose opposite sides are parallel and opposite angles are congruent.
- **rectangle**: A parallelogram with four right angles.
- **square**: A rectangle with four congruent sides whose diagonals are perpendicular. A square is a rhombus with four right angles.
- **rhombus**: A parallelogram with four congruent sides.
- **trapezoid**: A quadrilateral with exactly one pair of parallel sides.

**Warm-up**
Distribute the “Quadrilateral Concept Cards,” and instruct students to work in pairs to complete them. When students are finished, have a class discussion in which they share their responses. Elicit from the class the essential elements of a polygon:
1. Composed of three or more line segments
2. Simple (the segments do not cross)
3. Closed
4. Lies in a plane (is 2-dimensional)
(Note: You may wish to demonstrate the concept of a plane figure by taking a polygon made of wire, which is 2-dimensional, and twisting it so that it is no longer flat; now it is no longer a polygon because it is no longer a plane [2-dimensional] figure.) Have the class work together to agree on class definitions of the terms **polygon** and **quadrilateral**.

**Lesson**
1. Divide the students into small groups, and give each pair a set of D-stix, geo-strips, or toothpicks with marshmallows.
2. Have the partners pick two pairs of congruent pieces of their materials and connect them as shown at right. Have them flex the figure into different positions. Model constructing the quadrilateral and flexing it, if necessary.
3. Ask the students the following questions:
   - What is another name for this quadrilateral?” (parallelogram) Review the definition of parallelogram with the class.
   - What stays the same when you flex the parallelogram to different positions? (the lengths of the sides; the sum of the measures of the angles; the perimeter; opposite sides stay parallel; opposite angles stay congruent.)
   - What changes when you flex the parallelogram? (size of the angles; the area; the lengths of diagonals; the shape)
   - What do you notice about the opposite sides of the parallelogram? (Opposite sides remain parallel and congruent/equal.)
• What is the sum of the measures of the interior angles of the parallelogram? (360°)
• What do you notice about the opposite angles? (They are congruent—equal in measure.)
• If you make one of the angles a right angle, using the square corner of a book or table to check for accuracy, what happens to the other angles? (They become right angles too.)
• Will this always be true when you make one angle of a parallelogram a right angle? (yes)
• How do you know? (The sum of the measures of the angles in a parallelogram is 360°. If one angle measures 90°, its opposite angle, which is congruent, also measures 90°. Subtracting these two angles from 360° leaves 180° for the combined measure of the two remaining angles. These two angles are also congruent since they are opposite angles in a parallelogram; therefore, each angle must measure 90°.)
• Is it still a parallelogram when every angle is 90°? (yes)
• Is it still a quadrilateral when every angle is 90°? (yes)
• What other name besides polygon, quadrilateral, or parallelogram can be given to it when every angle is 90°? (rectangle) Review the definition of rectangle with the class.

4. Have the partners pick four congruent pieces of their materials and connect them as shown at right. Have them flex the figure into different positions. Model constructing the quadrilateral and flexing it, if necessary.

5. Ask the students the following questions:
   • What is another name for this parallelogram?" (rhombus) Review the definition of rhombus with the class.
   • What stays the same when you flex the rhombus to different positions?" (the lengths of the sides; the sum of the measures of the angles; the perimeter; opposite sides stay parallel; opposite angles stay congruent.)
   • What is the sum of the measures of the interior angles of the rhombus? (360°)
   • What changes when you flex the rhombus? (sizes of the angles; the area; the lengths of diagonals; the shape)
   • What do you notice about the opposite angles of the rhombus? (Opposite angles remain congruent/equal.)
   • Is it still a quadrilateral when flexed? (yes)
   • Is it still a polygon when flexed? (yes)
   • If you make one of the angles of the rhombus a right angle, using the square corner of a book or table to check for accuracy, what happens to the other angles? (They become right angles too.)
   • Is it still a parallelogram? (yes)
   • What other name besides polygon, quadrilateral, parallelogram, and rhombus can be given to it when every angle is 90°? (square) Review the definition of square with the class.
   • Is it a rectangle? (yes)
   • How do you know? (It has four right angles.)

6. Distribute the “Types of Quadrilaterals” handout, and discuss the definitions of quadrilateral, parallelogram, rectangle, rhombus, and square. Discuss the examples of each, making sure the students notice their orientations and how each example fits the definition even though it is not necessarily the typical figure usually seen.

**Reflection**

Have students write a letter to a teacher or someone else, explaining an important concept they learned in class today.
**Quadrilateral Concept Card**

### Polygons

These figures are polygons:

![Polygons examples](image1)

These figures are **not** polygons:

![Non-polygons examples](image2)

Which of these figures are polygons? (circle)

![Circle choices](image3)

Draw your own example of a polygon.

Draw your own example of a non-polygon.

What is a polygon?

**A polygon is** ____________________________

### Quadrilaterals

These figures are quadrilaterals:

![Quadrilaterals examples](image4)

These figures are **not** quadrilaterals:

![Non-quadrilaterals examples](image5)

Which of these figures are quadrilaterals? (circle)

![Circle choices](image6)

Draw your own example of a quadrilateral.

Draw your own example of a non-quadrilateral.

What is a quadrilateral?

**A quadrilateral is** ____________________________
Name: ANSWER KEY

Quadrilateral Concept Card

**Polygons**

These figures are polygons:

These figures are **not** polygons:

Which of these figures are polygons? (circle)

Draw your own example of a polygon.

**Drawing will vary.**

Draw your own example of a non-polygon.

**Drawing will vary. Sample answer:**

What is a polygon? **Sample answer:**

*A polygon is a simple, closed, plane figure formed by three or more straight lines.*

---

**Quadrilaterals**

These figures are quadrilaterals:

These figures are **not** quadrilaterals:

Which of these figures are quadrilaterals? (circle)

Draw your own example of a quadrilateral.

**Drawing will vary.**

Draw your own example of a non-quadrilateral.

**Drawing will vary. Sample answer:**

What is a quadrilateral? **Sample answer:**

*A quadrilateral is a four-sided polygon.*
# Types of Quadrilaterals

<table>
<thead>
<tr>
<th>Quadrilateral</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A quadrilateral</strong></td>
<td>is a closed plane figure with <strong>four sides</strong>.</td>
</tr>
<tr>
<td><strong>A parallelogram</strong></td>
<td>is a quadrilateral whose <strong>opposite sides are parallel</strong>.</td>
</tr>
<tr>
<td><strong>A rectangle</strong></td>
<td>is a parallelogram with <strong>four right angles</strong>.</td>
</tr>
<tr>
<td><strong>A rhombus</strong></td>
<td>is a parallelogram with <strong>four congruent sides</strong>.</td>
</tr>
<tr>
<td><strong>A square</strong></td>
<td>is a rectangle with <strong>four congruent sides</strong> or a rhombus with <strong>four right angles</strong>.</td>
</tr>
<tr>
<td><strong>A trapezoid</strong></td>
<td>is a quadrilateral with exactly one pair of <strong>parallel sides</strong>.</td>
</tr>
</tbody>
</table>
**SOL 6.13, 7.7**

**Lesson Summary**
Students match quadrilaterals with various descriptions listed on an activity sheet and a quadrilateral table, and they determine which sets are identical, attach labels to each category, and create a quadrilateral family tree. (approximately 40 minutes)

**Materials**
- "Warm-up" worksheets
- Sets of "Quadrilateral Sorting Pieces"
- "Quadrilateral Activity" worksheets
- "Quadrilateral Table" worksheets
- "Quadrilateral Family Tree" worksheets
- "Quadrilateral Puzzle" worksheets

**Vocabulary**
- **polygon.** A closed plane geometric figure composed of at least three line segments that do not cross. None of the sides are curved.
- **quadrilateral.** A closed plane (two-dimensional) figure with four sides that are line segments.
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- **rhombus.** A parallelogram with four congruent sides.
- **trapezoid.** A quadrilateral with exactly one pair of parallel sides.

**Warm-up**
Give students 10 minutes to complete the "Warm-up" worksheet. After time is up, have them share their drawings, discussing the shapes as a whole group.

**Lesson**
1. Copy the 12 "Quadrilateral Sorting Pieces" onto card stock and cut them out, making enough sets of 12 pieces to give a complete set to each student. Alternatively, have each student cut out his/her own set.
2. Distribute the sets of sorting pieces and the "Quadrilateral Activity," "Quadrilateral Table," and "Quadrilateral Family Tree" worksheets.
3. Divide the students into small groups, and direct each group to use their sorting pieces to answer the questions on the "Quadrilateral Activity" worksheet and to complete the "Quadrilateral Table."
4. After the students have completed the worksheet and table, have pairs of groups compare their answers and reconcile any discrepancies.
5. For the "Quadrilateral Family Tree," students can work in small groups or, if you feel they need guidance, as a large group.

**Reflection**
For the reflection, have students complete the "Quadrilateral Puzzle."
Name: ____________________________

**Warm-up**

For each question, draw a geometric shape that has all of the properties listed. Write the name of the shape on the line provided.

1. Opposite sides are congruent.  
   Opposite sides are parallel.  
   Opposite angles are congruent.

   ____________________________________________

2. All sides are congruent.  
   Opposite sides are parallel.  
   Opposite angles are equal.  
   No angles are equal to 90°.

   ____________________________________________

3. All angles are right angles.  
   Opposite sides are congruent.  
   Opposite sides are parallel.

   ____________________________________________
Name: ANSWER KEY

Warm-up

For each question, draw a geometric shape that has all of the properties listed. Write the name of the shape on the line provided.

1. Opposite sides are congruent. Opposite sides are parallel. Opposite angles are congruent.
   Sample answers: parallelogram, rectangle, square

2. All sides are congruent. Opposite sides are parallel. Opposite angles are equal. No angles are equal to 90°.
   Sample answers: rhombus, parallelogram

3. All angles are right angles. Opposite sides are congruent. Opposite sides are parallel.
   Sample answers: rectangle, square
Quadrilateral Sorting Pieces

A

B

C

D

E

F
Quadrilateral Sorting Pieces
**Quadrilateral Activity**

Spread out your quadrilateral pieces with the letters facing up so you can see them. Find all of the quadrilaterals that have four right angles, and list them by letter alphabetically on the Question #1 answer line. Then, consider all of the quadrilaterals again. Find all of the quadrilaterals that have exactly one pair of parallel sides, and list them by letter alphabetically in Question #2 answer line. Continue in this manner until you complete all the questions.

1. Has four right angles: ________________________________

2. Has exactly one pair of parallel sides: ________________________________

3. Has two pairs of congruent opposite sides: ________________________________

4. Has four congruent sides: ________________________________

5. Has two pairs of parallel opposite sides: ________________________________

6. Has two pairs of congruent adjacent sides, but not all sides are congruent: __________

7. Has congruent opposite angles: ________________________________

8. Does not have four sides: ________________________________

9. Has four congruent angles: ________________________________

10. Which lists are the same? ________________ What name can be used to describe quadrilaterals with these properties? ________________
Name: **ANSWER KEY**

**Quadrilateral Activity**

Spread out your quadrilateral pieces with the letters facing up so you can see them. Find all of the quadrilaterals that have four right angles, and list them by letter alphabetically on the Question #1 answer line. Then, consider all of the quadrilaterals again. Find all of the quadrilaterals that have exactly one pair of parallel sides, and list them by letter alphabetically in Question #2 answer line. Continue in this manner until you complete all the questions.

1. Has four right angles: A, D, E, K
2. Has exactly one pair of parallel sides: F, H
3. Has two pairs of congruent opposite sides: A, B, D, E, G, K
4. Has four congruent sides: A, B, E
5. Has two pairs of parallel opposite sides: G, K, A, B, D, E
6. Has two pairs of congruent adjacent sides, but not all sides are congruent: L, J
7. Has congruent opposite angles: A, B, D, E, G, K
8. Does not have four sides: no examples
9. Has four congruent angles: A, D, E, K
10. Which lists are the same? #3, 5, and 8  What name can be used to describe quadrilaterals with these properties? parallelograms
### Quadrilateral Table

Using the results of the “Quadrilateral Activity” worksheet, place a check mark in the appropriate spaces to show which figures have which properties.

<table>
<thead>
<tr>
<th>PROPERTY OF FIGURE</th>
<th>TYPES OF POLYGONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Quadrilateral</td>
</tr>
<tr>
<td>All four angles are right angles.</td>
<td></td>
</tr>
<tr>
<td>Opposite sides are parallel.</td>
<td></td>
</tr>
<tr>
<td>Opposite angels are congruent.</td>
<td></td>
</tr>
<tr>
<td>All sides are congruent.</td>
<td></td>
</tr>
<tr>
<td>All angles are congruent.</td>
<td></td>
</tr>
<tr>
<td>May contain a right angle.</td>
<td></td>
</tr>
<tr>
<td>Opposite sides are congruent.</td>
<td></td>
</tr>
<tr>
<td>Has exactly one pair of parallel sides.</td>
<td></td>
</tr>
<tr>
<td>Has two pairs of congruent adjacent sides.</td>
<td></td>
</tr>
</tbody>
</table>
## Quadrilateral Table

Using the results of the “Quadrilateral Activity” worksheet, place a check mark in the appropriate spaces to show which figures have which properties.

<table>
<thead>
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</thead>
<tbody>
<tr>
<td></td>
<td>Quadrilateral</td>
</tr>
<tr>
<td>All four angles are right angles.</td>
<td>√</td>
</tr>
<tr>
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<td>√</td>
</tr>
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<td>√</td>
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</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Has two pairs of congruent adjacent sides.</td>
<td></td>
</tr>
</tbody>
</table>
Name: _______________________

Quadrilateral Family Tree

Fill out the family tree by writing the names quadrilateral, rectangle, square, rhombus, parallelogram, and trapezoid into the appropriate blocks on the diagram.
Name: ANSWER KEY

Quadrilateral Family Tree

Fill out the family tree by writing the names quadrilateral, rectangle, square, rhombus, parallelogram, and trapezoid into the appropriate blocks on the diagram.

- quadrilateral
- parallelogram
- rectangle
- rhombus
- square
- trapezoid
Name: ______________________

Quadrilateral Puzzle

Match the numbered vocabulary word with the block in the puzzle that shows an example of that word. Place the letter or symbol from the puzzle block onto the numbered line below to solve the puzzle. Each block may be used only once even though the shapes in some blocks have more than one name.

1. square
2. rectangle
3. right angle
4. parallel lines
5. rhombus
6. trapezoid
7. parallelogram
8. quadrilateral
9. polygon

1 2 3 4 5 6 7 8 9
Name: **ANSWER KEY**

**Quadrilateral Puzzle**

Match the numbered vocabulary word with the block in the puzzle that shows an example of that word. Place the letter or symbol from the puzzle block onto the numbered line below to solve the puzzle. Each block may be used only once even though the shapes in some blocks have more than one name.

1. square
2. rectangle
3. right angle
4. parallel lines
5. rhombus
6. trapezoid
7. parallelogram
8. quadrilateral
9. polygon

```
G   E   O   M   E   T   R   Y   !
1   2   3   4   5   6   7   8   9
```
SOL 7.6

Lesson Summary
Students sort a set of rectangles into three groups and determine the similarity relationships. (30 minutes)

Materials
Sets of rectangles (see below)
“Alphabet Similarity” worksheets
“Similar Figures Recording Sheet”
Graph paper
“Reflecting on Similar Figures” worksheets

Vocabulary
similar figures. Two polygons are similar if corresponding (matching) angles are congruent and the lengths of corresponding sides are proportional.

Warm-up
Review the meaning of the word congruent—having exactly the same size and shape. Illustrate the definition by writing two congruent capital Qs on the board. Then, write a large Q and a smaller-size Q. Explain to the students that the Qs in this second pair are similar but noncongruent. Once students can give you other examples of similar letters, pictures, etc., have them complete the “Alphabet Similarity” worksheet. Discuss the answers before going on to the lesson.

Lesson
1. In advance of the lesson, make a set of 14 rectangles for each pair of students. Cut them from grid paper in the following sizes: 1 x 1, 1 x 2, 1 x 4, 2 x 4, 2 x 8, 3 x 3, 3 x 6, 3 x 12, 4 x 8, 4 x 16, 5 x 5, 5 x 10, 7 x 7, 10 x 10. Draw all diagonals on the rectangles before photocopying them and cutting them out.
2. Distribute the sets of rectangles. Have student pairs divide the rectangles into three groups with the members of each group having the same shape but differing in size. Students should find that one group consists of five squares of different sizes (1 x 1, 3 x 3, 5 x 5, 7 x 7, and 10 x 10). Another group consists of the 1 x 2, 2 x 4, 3 x 6, 4 x 8, and 5 x 10 rectangles. The third group consists of the 1 x 4, 2 x 8, 3 x 12, and 4 x 16 rectangles.
3. Once students grouped the rectangles, have them arrange each group from smallest to largest and look at the relationships among members of the same group. Suggest to students that they stack the members of each group on top of each other, starting with the largest. This will allow them to line up the diagonals.
4. Once students have them arranged, lead a class discussion based on the following questions:
   - What patterns do you see within each family? (Have them focus on length and width.)
   - What do you notice about the diagonals in each group of rectangles?
   - How could you determine another member of the group?
5. Have students complete the recording sheet with the information from the rectangles in each group.
6. Discuss the following questions:
   - Within a group, what patterns do you notice going down the chart?
   - Within a group, what patterns do you notice going across, from width to length?
7. Have students create ratios of width to length for each group. Ask them what they notice about each of the fractions in each set. (They are equivalent.)
8. Based on this discussion, have students define similar figures.
9. To extend this activity, have students graph the data by graphing the length and width of each rectangle. It works best to use a different color for each set. Students should see that the coordinates associated with a given set form a line.
10. Have students discuss the following questions based on the graphs:
   - How can you use the graph to find another member of a group?
   - Given a rectangle, how can you tell if it is similar to the ones already graphed?

**Reflection**
Have students complete the “Reflecting on Similar Figures” worksheet.
Name: _______________________

**Alphabet Similarity**

Determine whether the pairs of upper and lower case letters are similar or not.

<table>
<thead>
<tr>
<th>Aa</th>
<th>Bb</th>
<th>Cc</th>
<th>Dd</th>
<th>Ee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ff</td>
<td>Gg</td>
<td>Hh</td>
<td>Ii</td>
<td>Jj</td>
</tr>
<tr>
<td>Kk</td>
<td>Ll</td>
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<td>Qq</td>
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<td>Tt</td>
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<td>Uu</td>
<td>Vv</td>
<td>Ww</td>
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<td>Yy</td>
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<td>Zz</td>
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</tbody>
</table>
Name: **ANSWER KEY**

### Alphabet Similarity

Determine whether the pairs of upper and lower case letters are similar or not.

<table>
<thead>
<tr>
<th>Aa</th>
<th>Bb</th>
<th>Cc</th>
<th>Dd</th>
<th>Ee</th>
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</thead>
<tbody>
<tr>
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<td><em>Similar</em></td>
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</table>

<table>
<thead>
<tr>
<th>Ff</th>
<th>Gg</th>
<th>Hh</th>
<th>Ii</th>
<th>Jj</th>
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<td><em>Similar</em></td>
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<table>
<thead>
<tr>
<th>Kk</th>
<th>Ll</th>
<th>Mm</th>
<th>Nn</th>
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<thead>
<tr>
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<th>Qq</th>
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<tr>
<td><em>Similar</em></td>
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<tr>
<th>Uu</th>
<th>Vv</th>
<th>Ww</th>
<th>Xx</th>
<th>Yy</th>
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<tr>
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<table>
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<tr>
<th>Zz</th>
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<tbody>
<tr>
<td><em>Similar</em></td>
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</table>
### Similar Figures Recording Sheet

**GROUP ONE**

<table>
<thead>
<tr>
<th>Rectangle</th>
<th>Width</th>
<th>Length</th>
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</thead>
<tbody>
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</table>

**GROUP TWO**

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<tbody>
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</tbody>
</table>

**GROUP THREE**

<table>
<thead>
<tr>
<th>Rectangle</th>
<th>Width</th>
<th>Length</th>
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<tbody>
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</tr>
</tbody>
</table>
Reflecting on Similar Figures

Four triangles are shown on the grid below.

In the first column below, draw a simple figure. In the second column, draw a figure that is \textit{similar} to the first figure.

Which two triangles appear to be similar?

F  M and S
G  M and N
H  N and S
J  R and N

Virginia Department of Education
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Name: ANSWER KEY

Reflecting on Similar Figures

Four triangles are shown on the grid below.

In the first column below, draw a simple figure. In the second column, draw a figure that is similar to the first figure.

Which two triangles appear to be similar?

- M and S
- M and N
- N and S
- R and N

Virginia Department of Education
SOL 7.8, 8.8

Lesson Summary
Students define and recognize transformations as movement of geometric figures through a translation (slide), reflection (flip), or rotation (turn). (40 minutes)

Materials
- Overhead geoboard and student geoboards
- “Move Those Shapes!” activity sheets
- “Transformation Definitions Chart”
- “Reflecting on Transformations” worksheets
- “Translation, Reflection, Rotation” worksheets
- Patty paper or tracing paper
- Music

Vocabulary
- translation. A transformation in which an image is formed by moving every point on a plane figure the same distance in the same direction (a slide).
- reflection. A transformation in which a plane figure is reflected (flipped) over a line called the line of reflection. All corresponding points in the image and preimage are equidistant from the line of reflections.
- rotation. A transformation in which a plane figure is rotated (turned) around a fixed point. The point may or may not be on the figure. The fixed point is called the center of rotation.
- pre-image. The plane figure before the transformation.
- image. The resulting plane figure after the transformation. A transformation of preimage point $A$ can be denoted as the image $A'$ (read as “A prime”).

Warm-up
Begin by asking students to act out the motion of going down a roller coaster. Ask them whether they still look the same when they reach the bottom. (Their shape and orientation have not changed, but their location has changed.) Now, tell them to pretend they are making lunch, flipping hamburgers. Ask them what has changed for the flipped hamburger. (The shape has not changed, but the orientation has changed: it’s been reversed, as a mirror image). Next, tell students to pretend they are playing basketball and their coach tells them to pivot. Ask them what has changed. (This move is simply a turn. Their shape has not changed, but their orientation has changed.) Emphasize that the shape of objects does not change when the objects are slid from place to place, flipped over, or turned around in place. Explain that there are three types of mathematical movements or transformations: translation (slide), reflection (flip), and rotation (turn).

Lesson
1. Demonstrate a translation on the overhead geoboard. Explain that a translation is a transformation in which an image is formed by moving every point on a pre-image the same distance in the same direction. Instruct students to demonstrate a translation on their geoboard.
2. Demonstrate a reflection on the overhead geoboard, and discuss how a reflection shows a “mirror image.” Explain that a reflection is a transformation in which corresponding points in the image and pre-image are equidistant from the line of reflection. Instruct students to demonstrate a reflection on their geoboard.
3. Demonstrate a rotation on the overhead geoboard. Explain that a rotation is a transformation in which an image is formed by rotating or turning its pre-image around a fixed center point. Instruct students to demonstrate a rotation on their geoboard.
4. Explain to students that each of these focus words indicates a specific movement. Play some music, and ask everyone to stand up and slide to the right with you, and then to slide to the left. Then, ask them to put their hands out in front of them and flip their hands repeatedly. Then, ask them to make quarter turns clockwise or counterclockwise. Have students practice slide steps, hand flips, and quarter turns to the beat of the music. Using the words slide, flip, and turn, call out various transformations for the students to demonstrate and gauge their understanding of these basic terms.
Then, substitute the words *translate*, *reflect*, and *rotate* in your chant. (Note: If some students are strongly opposed to participating in this part of the activity, you may choose to have just a few volunteers demonstrate it. A few may even want to create a “transformation” dance.)

5. Give each student a “Transformation Definitions Chart” illustrating the same types of movements with geometric figures. Connect the actual movements to the geometric movements through discussion.

6. Have students complete the “Translation, Reflection, Rotation” worksheets. If necessary, demonstrate how to use patty paper or tracing paper to copy one of the shapes and perform the transformations.

7. Pair up the students, and have them complete the “Move Those Shapes” activity by following the directions on the sheet.

**Reflection**

Have students complete the “Reflecting on Transformations” worksheet.
**Transformation Definitions Chart**

**Translation (slide)**
A transformation in which an image is formed by moving every point on a figure the same distance in the same direction.

**Rotation (turn)**
A transformation in which an image is formed by turning its pre-image around a fixed point.

**Reflection (flip)**
A transformation in which a figure is flipped over a line, called the line of reflection. All corresponding points in the image and pre-image are equidistant from the line of reflection.
**Translation, Reflection, Rotation**

Trace each original figure. Use the tracing to perform a translation, reflection, and rotation, and draw the result of each in the appropriate box.

<table>
<thead>
<tr>
<th>Original Figure</th>
<th>Translation</th>
<th>Reflection</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Triangle" /></td>
<td></td>
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<tr>
<td><img src="image" alt="Cylinder" /></td>
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<tr>
<td><img src="image" alt="Arrow" /></td>
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<tr>
<td><img src="image" alt="Moon" /></td>
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<td></td>
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<tr>
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<tr>
<td><img src="image" alt="Square" /></td>
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<tr>
<td><img src="image" alt="Square" /></td>
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<td></td>
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</tr>
</tbody>
</table>
**Translation, Reflection, Rotation**

Trace each original figure. Use the tracing to perform a translation, reflection, and rotation, and draw the result of each in the appropriate box.  
**Sample answers:**

<table>
<thead>
<tr>
<th>Original Figure</th>
<th>Translation</th>
<th>Reflection</th>
<th>Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Original Figure" /></td>
<td><img src="image2" alt="Translation" /></td>
<td><img src="image3" alt="Reflection" /></td>
<td><img src="image4" alt="Rotation" /></td>
</tr>
<tr>
<td><img src="image5" alt="Original Figure" /></td>
<td><img src="image6" alt="Translation" /></td>
<td><img src="image7" alt="Reflection" /></td>
<td><img src="image8" alt="Rotation" /></td>
</tr>
<tr>
<td><img src="image9" alt="Original Figure" /></td>
<td><img src="image10" alt="Translation" /></td>
<td><img src="image11" alt="Reflection" /></td>
<td><img src="image12" alt="Rotation" /></td>
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<tr>
<td><img src="image13" alt="Original Figure" /></td>
<td><img src="image14" alt="Translation" /></td>
<td><img src="image15" alt="Reflection" /></td>
<td><img src="image16" alt="Rotation" /></td>
</tr>
<tr>
<td><img src="image17" alt="Original Figure" /></td>
<td><img src="image18" alt="Translation" /></td>
<td><img src="image19" alt="Reflection" /></td>
<td><img src="image20" alt="Rotation" /></td>
</tr>
<tr>
<td><img src="image21" alt="Original Figure" /></td>
<td><img src="image22" alt="Translation" /></td>
<td><img src="image23" alt="Reflection" /></td>
<td><img src="image24" alt="Rotation" /></td>
</tr>
<tr>
<td><img src="image25" alt="Original Figure" /></td>
<td><img src="image26" alt="Translation" /></td>
<td><img src="image27" alt="Reflection" /></td>
<td><img src="image28" alt="Rotation" /></td>
</tr>
<tr>
<td><img src="image29" alt="Original Figure" /></td>
<td><img src="image30" alt="Translation" /></td>
<td><img src="image31" alt="Reflection" /></td>
<td><img src="image32" alt="Rotation" /></td>
</tr>
</tbody>
</table>

*Virginia Department of Education*

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**Move Those Shapes!**

Draw all three transformations discussed in this lesson: **translation, reflection, and rotation.** Draw a figure in the top left portion of the grid paper. The figure should be different from all the others used in this lesson. Perform the first transformation on the original figure, and label the new figure “Figure B.” Perform the second transformation on Figure B, and label the new figure “Figure C.” Perform the final transformation on Figure C, and label the new figure “Figure D.” Draw arrows to show the direction of each transformation.

Transformations: Fig. B. ____________  Fig. C. ____________  Fig. D. ____________
Name: **ANSWER KEY**

**Move Those Shapes!**

Draw all three transformations discussed in this lesson: **translation, reflection, and rotation**. Draw a figure in the top left portion of the grid paper. The figure should be different from all the others used in this lesson. Perform the first transformation on the original figure, and label the new figure “Figure B.” Perform the second transformation on Figure B, and label the new figure “Figure C.” Perform the final transformation on Figure C, and label the new figure “Figure D.” Draw arrows to show the direction of each transformation.

Transformations:  
- Fig. B. **reflection**  
- Fig. C. **rotation**  
- Fig. D. **translation**

![Diagram of transformations](image-url)
Name: ______________________

Reflecting on Transformations

For each change in position of the figures below, determine the type of transformation it is, and write the name of the transformation on the line provided.

1. The example below is an illustration of a _______________________.

2. The example below is an illustration of a _______________________.

3. The example below is an illustration of a _______________________.

4. The example below is an illustration of a _______________________.

5. Write directions about how to go from your bedroom to your kitchen, using the verbs translate, reflect, and rotate.
Name: ANSWER KEY

Reflecting on Transformations

For each change in position of the figures below, determine the type of transformation it is, and write the name of the transformation on the line provided.

1. The example below is an illustration of a rotation.

![Rotation Illustration]

2. The example below is an illustration of a translation.

![Translation Illustration]

3. The example below is an illustration of a reflection.

![Reflection Illustration]

4. The example below is an illustration of a rotation.

![Rotation Illustration]

5. Write directions of how to go from your bedroom to your kitchen, using translations, reflections, and rotations.

Sample Answer:

Rotate to the right out my door, translate past two doors, rotate to the left, translate down the stairs, and reflect into the kitchen.
**SOL 7.8, 8.8a**

**Lesson Summary**
Students draw a polygon on a coordinate plane and perform translations by using patty paper or tracing paper. (45 minutes)

**Materials**
“Warm-up” worksheets
“Translations” worksheets
Pencils
Colored pencils
2 x 2 inch squares of patty paper or tracing paper
Rulers
Scientific calculators
“Reflecting on Translations” worksheets

**Vocabulary**
- **translation.** A transformation in which all points of a geometric figure move the same distance in the same direction.
- **reflection.** A transformation in which all points of a geometric figure move across an axis. Each point of the reflected figure is the same distance from the axis as the corresponding point in the original figure.
- **rotation.** A rotation of a geometric figure is a clockwise or counterclockwise turn of the figure around a fixed point. The point may or may not be on the figure. The fixed point is called the center of rotation.
- **pre-image.** The original polygon before the transformation.
- **image.** The resulting polygon after a transformation. A transformation of preimage point A can be denoted as the image A’ (read as “A prime”).

**Warm-up**
Have the students complete the “Warm-up” worksheet, offering assistance as needed.

**Lesson**
1. Prepare a transparency of the “Translations” worksheet for demonstration purposes.
2. Distribute the “Translations” worksheet, and have students use a regular pencil to draw the pre-image ABCD by graphing the coordinates given and connecting the dots. Make sure they label points A, B, C, and D on the coordinate plane and label the figure “Pre-Image.”
3. Give students patty paper or tracing paper, and ask them to trace the figure ABCD along with the labels.
4. Explain that a translation is a “slide” of a figure along an imaginary “train track.” The figure travels along a straight line in any direction but never rotates as it moves. Demonstrate on the overhead by sliding the patty paper figure across the coordinate plane, and then have the students practice doing the same.
5. Ask students to line up their patty paper figure on top of their pre-image on the coordinate plane. Demonstrate what it means to “translate the figure 4 units to the right.” You might recommend that they focus their eyes on one of the points as they count spaces across the coordinate plane. Then have students practice doing the translation.
6. Have students use a colored pencil to record the new coordinates for A, B, C, and D. Ask if they notice whether the new coordinates give any clue about the translation they just performed. (Some may notice that all x-coordinates increased by 4. If not, just continue with the next step, and encourage students to be on the lookout for any patterns that arise.)
7. Have students use the same colored pencil to connect the new points A, B, C, D on the coordinate plane. Have them label this figure “Image 1” and label the points A', B', C', and D'. (The prime sign is used to indicate that a point belongs to an image.)

8. Have the students use a regular pencil and a ruler to draw arrows from B to B' and from D to D'. Explain that this represents the “train tracks.”

9. Direct students to line up their patty paper figure again on top of their pre-image on the coordinate plane. Demonstrate what it means to “translate the figure 7 units to the left.” Ask students to predict what they think will happen to the coordinates. (The x-coordinates will decrease by 7.) Then have students perform the translation.

10. Have students use a different colored pencil to record the new coordinates for A, B, C, and D. Ask them to compare this new set of coordinates with the original coordinates. Ask whether their prediction was correct. Have them use calculators to verify that the x-coordinates decreased by 7.

11. Have students use the same colored pencil to plot the new coordinates for A, B, C, and D on the coordinate plane. Have them label this figure “Image 2” and again label the points A', B', C', and D'.

12. Have the students use a regular pencil and a ruler to draw again to draw “train tracks” from B to B', and from D to D'.

13. Have students repeat the process, using different colored pencils, for the “up” (Image 3) and “down” (Image 4) translations, and discuss what they notice about the change in coordinates with each translation. (Translations to the left cause the x-coordinates to decrease; translations to the right cause the x-coordinates to increase; translations up cause the y-coordinates to increase; translations down cause the y-coordinates to decrease.)

14. Ask students what they think would happen if a figure translated up and right (both x- and y-coordinates would increase). Have them perform the translation for Image 5.

15. Have students make up their own “double translation” (left or right and up or down) that would cause the figure to move to the third quadrant (lower left corner). Have them record this translation under “Image 6” in the table. Make sure they include the number of units (e.g., 10 units left and 4 units down). Have them write the new coordinates first and then plot the points. Walk around and ask students if the translation turned out the way they planned. If not, have them make adjustments.

**Reflection**

Have students complete the “Reflecting on Translations” worksheet.
Name: __________________________

**Warm-up**

1. Label and number the x-axis and y-axis.

2. Graph the following points, and connect the dots as you go: (−3, −1), (2, −1), (4, 1), (−1, 1)

3. What shape did you just draw? __________________________
Name: ANSWER KEY

Warm-up

1. Label and number the x-axis and y-axis.

2. Graph the following points, and connect the dots as you go: (−3, −1), (2, −1), (4, 1), (−1, 1)

3. What shape did you just draw? parallelogram
Translations

Enter the new coordinates after performing each translation shown below:

<table>
<thead>
<tr>
<th>IMAGE</th>
<th>ORIGINAL COORDINATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image 1: 4 units right</td>
<td>A (2, 3)</td>
</tr>
<tr>
<td>Image 2: 7 units left</td>
<td>B (3, 4)</td>
</tr>
<tr>
<td>Image 3: 5 units up</td>
<td>C (4, 3)</td>
</tr>
<tr>
<td>Image 4: 8 units down</td>
<td>D (3, 1)</td>
</tr>
<tr>
<td>Image 5: 5 units right and 4 units up</td>
<td></td>
</tr>
<tr>
<td>Image 6 (coordinates of choice in the 3rd quadrant):</td>
<td></td>
</tr>
</tbody>
</table>
Enter the new coordinates after performing each translation shown below:

<table>
<thead>
<tr>
<th>IMAGE</th>
<th>ORIGINAL COORDINATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image 1: 4 units right</td>
<td>A (2, 3)</td>
</tr>
<tr>
<td></td>
<td>B (3, 4)</td>
</tr>
<tr>
<td></td>
<td>C (4, 3)</td>
</tr>
<tr>
<td></td>
<td>D (3, 1)</td>
</tr>
<tr>
<td>Image 2: 7 units left</td>
<td>(6, 3)</td>
</tr>
<tr>
<td></td>
<td>(7, 4)</td>
</tr>
<tr>
<td></td>
<td>(8, 3)</td>
</tr>
<tr>
<td></td>
<td>(7, 1)</td>
</tr>
<tr>
<td>Image 3: 5 units up</td>
<td>(-5, 3)</td>
</tr>
<tr>
<td></td>
<td>(-4, 4)</td>
</tr>
<tr>
<td></td>
<td>(-3, 3)</td>
</tr>
<tr>
<td></td>
<td>(-4, 1)</td>
</tr>
<tr>
<td>Image 4: 8 units down</td>
<td>(2, 8)</td>
</tr>
<tr>
<td></td>
<td>(3, 9)</td>
</tr>
<tr>
<td></td>
<td>(4, 8)</td>
</tr>
<tr>
<td></td>
<td>(3, 6)</td>
</tr>
<tr>
<td>Image 5: 5 units right and 4 units up</td>
<td>(2, -5)</td>
</tr>
<tr>
<td></td>
<td>(3, -4)</td>
</tr>
<tr>
<td></td>
<td>(4, -5)</td>
</tr>
<tr>
<td></td>
<td>(3, -7)</td>
</tr>
<tr>
<td>Image 6</td>
<td>(7, 7)</td>
</tr>
<tr>
<td></td>
<td>(8, 8)</td>
</tr>
<tr>
<td></td>
<td>(9, 7)</td>
</tr>
<tr>
<td></td>
<td>(8, 5)</td>
</tr>
</tbody>
</table>

(coordinates of choice in the 3rd quadrant):
Reflecting on Translations

Each figure below shows a transformation. The pre-image is shown with solid lines and the image is shown with dashed lines. Next to each figure, tell whether the transformation shown represents a translation, and then explain why or why not.

1. Is this a translation? _____
   Explain: ____________________________

2. Is this a translation? _____
   Explain: ____________________________

3. Is this a translation? _____
   Explain: ____________________________

4. Is this a translation? _____
   Explain: ____________________________

5. When you translate a figure on the coordinate plane, explain how the x-coordinate and y-coordinate of each point is affected.
   ________________________________

6. What happens to the graph of a figure (in what direction and how far does it move) when...
   - 3 is added to the x-coordinate? ____________________________
   - 10 is added to the y-coordinate? ____________________________
   - 7 is subtracted from the y-coordinate? _______________________
   - 6 is subtracted from the x-coordinate? _______________________
   - 2 is added to the x-coordinate and 3 is subtracted from the y-coordinate? ____________________________
**Name: ANSWER KEY**

**Reflecting on Translations**

Each figure below shows a transformation. The pre-image is shown with solid lines and the image is shown with dashed lines. Next to each figure, tell whether the transformation shown represents a translation, and then explain why or why not.

1. Is this a translation? **No**
   Explain: The points have moved by different amounts.

2. Is this a translation? **No**
   Explain: The figure has rotated. Also, the points have moved by different amounts.

3. Is this a translation? **Yes**
   Explain: All the points have moved right 2 units and up 1 unit. The figure has not rotated.

4. Is this a translation? **No**
   Explain: The figure has changed in size. In a translation, the figure remains the same size.

5. When you translate a figure on the coordinate plane, explain how the x-coordinate and y-coordinate of each point is affected. Moving a figure left or right causes the x-coordinate to change. Moving a figure up or down causes the y-coordinate to change. (Actual responses may vary.)

6. What happens to the graph of a figure (in what direction and how far does it move) when...
   - 3 is added to the x-coordinate? It moves 3 units to the right.
   - 10 is added to the y-coordinate? It moves 10 units up.
   - 7 is subtracted from the y-coordinate? It moves 7 units down.
   - 6 is subtracted from the x-coordinate? It moves 6 units to the left.
   - 2 is added to the x-coordinate and 3 is subtracted from the y-coordinate? It moves 2 units to the right and 3 units down.
**SOL 7.8, 8.8a**

**Lesson Summary**
Students draw a polygon on a coordinate plane and use patty paper and a protractor to perform 90-degree rotations around origin. (45 minutes)

**Materials**
- “Warm-up” worksheets
- “Rotations” worksheets
- Colored pencils
- Protractors
- Tape
- Patty paper or tracing paper, cut into approximately 5 x 5 inch squares
- “Reflecting on Rotations” worksheets

**Vocabulary**
- **rotation.** A rotation of a geometric figure is a clockwise or counterclockwise turn of the figure around a fixed point. The point may or may not be on the figure. The fixed point is called the center of rotation.
- **pre-image.** The original polygon before the transformation.
- **image.** The resulting polygon after a transformation. A transformation of preimage point A can be denoted as the image A' (read as “A prime”).
- **origin.** The point (0, 0) on the coordinate plane.

**Warm-up**
Distribute the “Warm-up” worksheet, and allow students ample time to complete it. Review student responses before proceeding with the lesson.

**Lesson**
1. Distribute the “Rotations” worksheet, protractors, and tape. Have the students tape the worksheet to their desk so that it will not move.
2. Instruct the student to use a colored pencil to graph the original coordinates listed in the table. Then, have them use the straightedge of the protractor to connect the coordinates, thus drawing a triangle. They should label the vertices of the triangle A, B, and C in accordance with the letters of the coordinates. Have them write “Pre-image” inside the triangle.
3. Have students use a different colored pencil to draw a dot on the origin of the coordinate plane and then draw a line connecting the origin to point A.
4. Explain to students that they will now rotate the triangle around the origin. To help them grasp this concept, they may find it helpful to think of the following analogies: (1) The origin is like the axle of a tire in that it stays fixed while the triangle rotates around it. (2) The line connecting the origin to point A is like a kite string, and the origin is like a person’s hand holding the string.
5. Distribute patty paper, and ask students to place the patty paper over the worksheet so that it covers the origin and the triangle.
6. Have students trace their triangle, along with the A, B, and C labels, using the first colored pencil (same color as the triangle). Have them trace the “kite string,” using the other colored pencil.
7. Have students practice rotating by placing their pencil point on the origin and turning the patty paper. Point out that after a rotation, the original kite string and the patty paper kite string form an angle and that this angle represents how “far” the figure has been rotated. Therefore, rotations are measured in degrees. Also, the pre-image can rotate in two directions—clockwise and counterclockwise.
8. Ask students to use estimation to perform a 45° clockwise rotation of the pre-image. You may want them to see how close they got by measuring the angle of rotation with the protractor. In like manner, have them perform a 90° counterclockwise rotation, and a 180° clockwise rotation.
9. Ask students to return their tracing to its original position on top of the original triangle and then to slowly rotate the tracing counterclockwise. Tell them to stop rotating when vertex A is located at point (−3, 3).

10. Ask, “How many degrees has the triangle rotated?” (90°) Have students use the protractor to verify the measure of the angle of rotation formed by the two “kite strings.”

11. Have students record in the table the new coordinates for the three points A, B, and C. Ask, “Do you notice any patterns when comparing the new coordinates with the original coordinates?” (For each pair, the new x-coordinate is the opposite of the original y-coordinate, and the new y-coordinate is the same as the original x-coordinate.)

12. Ask students to set the patty paper aside, graph the new coordinates on the coordinate plane, and connect the dots. Have them add prime marks to the vertex letters (A', B', and C') to indicate these are the vertices of an image. Have them write “90° image” inside the new triangle.

13. Have the students continue in the same manner to perform a 180° rotation [point A at (−3,−3)], a 270° rotation [point A at (3,−3)], and a 360° rotation [point A again at (3, 3)].

**Reflection**

Have students complete the “Reflecting on Rotations” worksheet.
Name: ________________________________

Warm-up

Part I
1. Label and number the x-axis and the y-axis.
2. Graph the following points, and connect them as you go: (2, 0), (−1, −1), (−3, 2) (0, 5), (3, 3).
3. What shape did you just draw? _________________

Part II
4. Stand up, face a wall, and hold your arm straight in front of you. While standing in the same spot, turn your body to the left. How many degrees did you just rotate? _______ Did you rotate clockwise or counterclockwise? __________________
5. Return to your original standing position with your arm straight in front of you. While standing in the same spot, turn your body to right all the way around until you are back in the position where you started. How many degrees did you just rotate? _______ Did you rotate clockwise or counterclockwise? ________________
6. Write a list of things that ordinarily rotate or turn.

________________________________________
________________________________________
________________________________________
Name: **ANSWER KEY**

**Warm-up**

1. Label and number the x-axis and the y-axis.
2. Graph the following points, and connect them as you go: (2, 0), (−1, −1), (−3, 2) (0, 5), (3, 3).
3. What shape did you just draw? __pentagon__

**Part I**

4. Stand up, face a wall, and hold your arm straight in front of you. While standing in the same spot, turn your body to the left. How many degrees did you just rotate? __90°__ Did you rotate clockwise or counterclockwise? __counterclockwise__

5. Return to your original standing position with your arm straight in front of you. While standing in the same spot, turn your body to right all the way around until you are back in the position where you started. How many degrees did you just rotate? __360°__ Did you rotate clockwise or counterclockwise? __clockwise__

6. Write a list of things that ordinarily rotate or turn.
   
   **Possible responses:** tire, merry-go-round, ferris wheel, fan, propeller, a hand on a clock
Rotations

Follow the verbal directions of your teacher to complete this worksheet.

<table>
<thead>
<tr>
<th>Original Coordinates</th>
<th>90° Rotation</th>
<th>180° Rotation</th>
<th>270° Rotation</th>
<th>360° Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (3, 3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B (8, 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C (5, 7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Name: **ANSWER KEY**

# Rotations

Follow the verbal directions of your teacher to complete this worksheet.

<table>
<thead>
<tr>
<th>Original Coordinates</th>
<th>90° Rotation</th>
<th>180° Rotation</th>
<th>270° Rotation</th>
<th>360° Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (3, 3)</td>
<td>(-3, 3)</td>
<td>(-3, -3)</td>
<td>(3, -3)</td>
<td>(3, 3)</td>
</tr>
<tr>
<td>B (8, 4)</td>
<td>(-4, 8)</td>
<td>(-8, -4)</td>
<td>(4, -8)</td>
<td>(8, 4)</td>
</tr>
<tr>
<td>C (5, 7)</td>
<td>(-7, 5)</td>
<td>(-5, -7)</td>
<td>(7, -5)</td>
<td>(5, 7)</td>
</tr>
</tbody>
</table>
Reflecting on Rotations

1. When a figure is rotated on the coordinate plane, does its shape change? ______

2. At right is a sample SOL test question related to rotations. How could you use patty paper to help answer the question?

3. Which answer is correct? ______

The diagram below shows a geometric figure on a coordinate plane.

Which of the diagrams below shows a rotation of this geometric figure?

- F
- G
- H
- J
**Name: ANSWER KEY**

**Reflecting on Rotations**

1. **When a figure is rotated on the coordinate plane, does its shape change?** 
   ___no____

2. **At right is a sample SOL test question related to rotations. How could you use patty paper to help answer the question?**

   You could trace the original pre-image on the patty paper and then put the patty paper over each answer image, rotating the tracing to see if the answer image is a rotation.

3. **Which answer is correct?** 
   ___J____

The diagram below shows a geometric figure on a coordinate plane.

Which of the diagrams below shows a rotation of this geometric figure?

- [Diagram F]
- [Diagram G]
- [Diagram H]
- [Diagram J]
**SOL 8.8a**

**Lesson Summary**
Students perform dilations of polygons on the coordinate plane. (30 minutes)

**Materials**
- “Warm-up” worksheets
- “Dilations” worksheets
- Pencils
- Calculators
- “Reflecting on Dilations” worksheets

**Vocabulary**

dilation. A transformation that changes the size of a figure by a scale factor to create a similar figure.

**Warm-up**
Have students complete the “Warm-up” worksheet. Give assistance as needed.

**Lesson**
1. Distribute the “Dilations, Part 1” worksheet. Have students graph the given coordinates A, B, C, and D and connect the dots. Ask, “What shape did you draw?” (rectangle) Have them determine how long sides AB and AD are in grid units and record these lengths in the chart.
2. Ask students to fill in the second row of coordinates by multiplying both coordinates of each point in the first row by 2.
3. Have students predict what they think this new shape will look like. Then, have them plot the new coordinates and label the new coordinates A’, B’, C’, and D’. (The prime sign is used to indicate that a point belongs to an image.) Ask them to describe the new shape. (It is the same shape but larger.) Prompt them to describe exactly how much larger it is (twice as large) by comparing the length of the new side A’B’ to the original side AB, and comparing the length of the new side A’D’ to the original side AD. Explain that they have just performed a dilation, using a scale factor of 2. This means that the figure gets twice as large.
4. Ask students how they think they will perform a dilation of the original figure, using a scale factor of 3. (Multiply both coordinates of each point by 3.) Have them perform the dilation in the same manner, labeling the points A”, B”, C”, and D”.
5. Have students complete the questions on the worksheet.
6. Distribute the “Dilations, Part 2” worksheet. Have students graph the given coordinates and connect the dots. Ask, “What shape did you draw?” (pentagon)
7. Explain that this time they will perform a dilation using a scale factor of ½. Ask them how they think they will accomplish this task. (Multiply both coordinates of each point by ½ or 0.5.) Have them perform the dilation in the same manner and complete the questions on the worksheet.

**Reflection**
Have students complete the “Reflecting on Dilations” worksheet.
Warm-up

1. Make a list of real-life situations in which you see “scaled up” or “scaled down” versions of objects.

2. Practice multiplying a fraction by a whole number:
   a. \( \frac{1}{2} \cdot 6 = \)
   b. \( \frac{1}{3} \cdot 12 = \)
   c. \( \frac{3}{5} \cdot 10 = \)
   d. \( \frac{1}{4} \cdot 0 = \)
Name: ANSWER KEY

Warm-up

1. Make a list of real-life situations in which you see “scaled up” or “scaled down” versions of objects.

   Answers will vary. Possible responses: maps, blueprints, model airplanes, architectural models, toys that are scaled down versions of real objects, images taken from a microscope, photocopies that are enlargements or reductions of the original.

2. Practice multiplying a fraction by a whole number:

   a. \( \frac{1}{2} \cdot 6 = 3 \)

   b. \( \frac{1}{3} \cdot 12 = 4 \)

   c. \( \frac{3}{5} \cdot 10 = 6 \)

   d. \( \frac{1}{4} \cdot 0 = 0 \)
Name: ______________________

**Dilations, Part 1**

<table>
<thead>
<tr>
<th>SCALE FACTOR</th>
<th>COORDINATES</th>
<th>Length of AB</th>
<th>Length of AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>original</td>
<td>A (−1, −1)</td>
<td>B (2, −1)</td>
<td>C (2, 3)</td>
</tr>
<tr>
<td>2</td>
<td>A’ ( )</td>
<td>B’ ( )</td>
<td>C’ ( )</td>
</tr>
<tr>
<td>3</td>
<td>A” ( )</td>
<td>B” ( )</td>
<td>C” ( )</td>
</tr>
</tbody>
</table>

1. What happens to the size of the figure after dilating it, using a scale factor of 2?

2. What happens to the size of the figure after dilating it, using a scale factor of 3?

3. Does a dilation cause the shape to change? ___________________________________
Dilations, Part 2

1. What happens to the size of the figure after dilating it, using a scale factor of $\frac{1}{2}$?

2. Did the shape change?
**Dilations, Part 1**

<table>
<thead>
<tr>
<th>SCALE FACTOR</th>
<th>COORDINATES</th>
<th>Length of AB</th>
<th>Length of AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>(original)</td>
<td>A (-1, -1)</td>
<td>B (2, -1)</td>
<td>C (2, 3)</td>
</tr>
<tr>
<td>2</td>
<td>A’ (-2, -2)</td>
<td>B’ (4, -2)</td>
<td>C’ (4, 6)</td>
</tr>
<tr>
<td>3</td>
<td>A” (-3, -3)</td>
<td>B” (6, 3)</td>
<td>C” (6, 9)</td>
</tr>
</tbody>
</table>

1. What happens to the size of the figure after dilating it, using a scale factor of 2?
   
   It gets twice as large.

2. What happens to the size of the figure after dilating it, using a scale factor of 3?
   
   It gets three times as large.

3. Does a dilation cause the shape to change? **No, only the size changes.**
**Dilations, Part 2**

<table>
<thead>
<tr>
<th>SCALE FACTOR</th>
<th>COORDINATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>(original)</td>
<td>A (0, 4)</td>
</tr>
<tr>
<td>½</td>
<td>A' (0, 2)</td>
</tr>
</tbody>
</table>

1. What happens to the size of the figure after dilating it, using a scale factor of ½?
   - It gets half as large.

2. Did the shape change? No, only the size changes.
Reflecting on Dilations

1. How would you describe a dilation?

2. If you dilate a figure using a scale factor greater than 1, what happens to the figure?

3. If you dilate a figure using a scale factor less than 1, what happens to the figure?

4. If you were to dilate a figure using a scale factor of 1, what do you think would happen to the figure?
Name: ANSWER KEY

Reflecting on Dilations

1. How would you describe a dilation?  
   It causes a figure to change in size, but its shape stays the same.

2. If you dilate a figure using a scale factor greater than 1, what happens to the figure?  
   It gets bigger.

3. If you dilate a figure using a scale factor less than 1, what happens to the figure?  
   It gets smaller.

4. If you were to dilate a figure using a scale factor of 1, what do you think would happen to the figure?  
   It would stay the same size.
**SOL 8.8a**

**Lesson Summary**
Students draw a polygon on a coordinate plane and use patty paper or tracing paper to perform reflections across the x-axis and y-axis. (45 minutes)

**Materials**
- 5 x 5 inch squares of patty or tracing paper
- “Reflections” worksheets
- Pencils
- Rulers
- Tape
- “Reflecting on Reflections” worksheets

**Vocabulary**
- **reflection.** A transformation in which all points of a geometric figure move across an axis. Each point of the reflected figure is the same distance from the axis as the corresponding point in the original figure.
- **line of reflection.** The line (axis) across which a figure is reflected.

**Warm-up**
Distribute patty paper or tracing paper, and instruct students to fold it in half and draw a picture or write their name on one side of the folded paper. Then, have them flip the paper over and trace what they drew. Finally, have them unfold the paper. Lead students in describing what happened to their picture. (The second picture is a “backwards” or “flipped” version of the first. It “mirrors” the first on the fold line.

**Lesson**
1. Distribute the “Reflections” worksheet. Ask students to enter the coordinates of the figure, as directed in step 1.
2. Explain the procedure for reflecting the image across the x-axis—that the x-axis will be the line of reflection or mirror line. Ask students to predict what the image will look like.
3. Distribute patty paper. Ask students to trace the x-axis, the y-axis, and the figure, including the points and the letters.
4. Have students perform a reflection across the x-axis by flipping the patty paper over in a downward direction, making sure to keep the x-axis and y-axis aligned. Have them tape the patty paper in place.
5. Tell students to enter in the second row of the table the coordinates of the reflected image and then to write down what they notice about the these coordinates. (They should see that the x-coordinates stay the same, but the y-coordinates change signs. Discourage them from saying the y-coordinates “go negative,” because if the coordinates had been negative to begin with, they would change to positive.)
6. Have students complete steps 3 and 4 of Part 1.
7. Have the students complete Part 2, this time reflecting the figure across the y-axis; the patty paper will flip to the left.

**Reflection**
Have students complete the “Reflecting on Reflections” worksheet.
Name: _______________________

Reflections, Part 1

1. In the table below, write the coordinates of the figure above and its image after reflecting it across the x-axis.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>A'</td>
<td>B'</td>
<td>C'</td>
<td>D'</td>
<td>E'</td>
<td>F'</td>
</tr>
</tbody>
</table>

2. Compare the sets of coordinates. What do you notice about these pairs?

3. Count how many blocks each point is from the x-axis, and list them below:

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>A'</td>
<td>B'</td>
<td>C'</td>
<td>D'</td>
<td>E'</td>
<td>F'</td>
</tr>
</tbody>
</table>

4. The distance from the mirror line to any point on the figure is ________ the distance from the mirror line to its reflected image. (greater than, less than, or equal to)
Reflections, Part 2

1. In the table below, write the coordinates of the figure above and its image after reflecting it across the y-axis.

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>A'</td>
<td>B'</td>
<td>C'</td>
<td>D'</td>
<td>E'</td>
<td>F'</td>
</tr>
</tbody>
</table>

2. Compare the sets of coordinates. What do you notice about these pairs?

3. Count how many blocks each point is from the y-axis, and list them below:

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>A'</td>
<td>B'</td>
<td>C'</td>
<td>D'</td>
<td>E'</td>
<td>F'</td>
</tr>
</tbody>
</table>

4. The distance from the mirror line to any point on the figure is ___________________ the distance from the mirror line to its reflected image.

(greater than, less than, or equal to)
Name: ANSWER KEY

Reflections, Part 1

1. In the table below, write the coordinates of the figure above and its image after reflecting it across the x-axis.

<table>
<thead>
<tr>
<th>Original</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (5, 5)</td>
<td>A' (5, -5)</td>
</tr>
<tr>
<td>B (4, 3)</td>
<td>B' (4, -3)</td>
</tr>
<tr>
<td>C (5, 2)</td>
<td>C' (5, -2)</td>
</tr>
<tr>
<td>D (6, 2)</td>
<td>D' (6, -2)</td>
</tr>
<tr>
<td>E (7, 3)</td>
<td>E' (7, -3)</td>
</tr>
<tr>
<td>F (6, 5)</td>
<td>F' (6, -5)</td>
</tr>
</tbody>
</table>

2. Compare the sets of coordinates. What do you notice about these pairs?

The x-coordinates stay the same, but the y-coordinates change signs.

3. Count how many blocks each point is from the x-axis, and list them below:

<table>
<thead>
<tr>
<th>Original</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 5</td>
<td>A' 5</td>
</tr>
<tr>
<td>B 3</td>
<td>B' 3</td>
</tr>
<tr>
<td>C 2</td>
<td>C' 2</td>
</tr>
<tr>
<td>D 2</td>
<td>D' 2</td>
</tr>
<tr>
<td>E 3</td>
<td>E' 3</td>
</tr>
<tr>
<td>F 5</td>
<td>F' 5</td>
</tr>
</tbody>
</table>

4. The distance from the mirror line to any point on the figure is equal to the distance from the mirror line to its reflected image. (greater than, less than, or equal to)
1. In the table below, write the coordinates of the figure above and its image after reflecting it across the y-axis.

<table>
<thead>
<tr>
<th>Original</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (2, 4)</td>
<td>A' (-2, 4)</td>
</tr>
<tr>
<td>B (3, 5)</td>
<td>B' (-3, 5)</td>
</tr>
<tr>
<td>C (5, 4)</td>
<td>C' (-5, 4)</td>
</tr>
<tr>
<td>D (6, 5)</td>
<td>D' (-6, 5)</td>
</tr>
<tr>
<td>E (6, 3)</td>
<td>E' (-6, 3)</td>
</tr>
<tr>
<td>F (3, 3)</td>
<td>F' (-3, 3)</td>
</tr>
</tbody>
</table>

2. Compare the sets of coordinates. What do you notice about these pairs?

The x-coordinates change signs, but the y-coordinates stay the same.

3. Count how many blocks each point is from the y-axis, and list them below:

<table>
<thead>
<tr>
<th>Original</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>D</td>
<td>6</td>
</tr>
<tr>
<td>E</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>3</td>
</tr>
<tr>
<td>A'</td>
<td>2</td>
</tr>
<tr>
<td>B'</td>
<td>3</td>
</tr>
<tr>
<td>C'</td>
<td>5</td>
</tr>
<tr>
<td>D'</td>
<td>6</td>
</tr>
<tr>
<td>E'</td>
<td>6</td>
</tr>
<tr>
<td>F'</td>
<td>3</td>
</tr>
</tbody>
</table>

4. The distance from the mirror line to any point on the figure is equal to the distance from the mirror line to its reflected image.
Name: ________________________

**Reflecting on Reflections**

1. How do the coordinates change when an object is reflected across the *x*-axis?

2. How do the coordinates change when an object is reflected across the *y*-axis?

Use your conclusions above to find the new coordinates for each point:

3. (4, 3) reflected across the *x*-axis _________

4. (−2, 1) reflected across the *y*-axis _________

5. (0, 0) reflected across the *y*-axis _________

6. (−5, −6) reflected across the *x*-axis _________

7. (0, 9) reflected across the *y*-axis _________

8. (0, 9) reflected across the *x*-axis _________

9. (7, 0) reflected across the *y*-axis _________

10. (7, 0) reflected across the *x*-axis _________

11. Reflect the figures below across the *x*-axis.

12. Reflect the figures below across the *y*-axis.
**Name: ANSWER KEY**

**Reflecting on Reflections**

1. How do the coordinates change when an object is reflected across the x-axis?
   
The x-coordinate stays the same, but the y-coordinate changes sign.

2. How do the coordinates change when an object is reflected across the y-axis?
   
The x-coordinate changes sign, but the y-coordinate stays the same.

Use your conclusions above to find the new coordinates for each point:

3. (4, 3) reflected across the x-axis (4, -3)
4. (-2, 1) reflected across the y-axis (2, 1)
5. (0, 0) reflected across the y-axis (0, 0)
6. (-5, -6) reflected across the x-axis (-5, 6)
7. (0, 9) reflected across the y-axis (0, 9)
8. (0, 9) reflected across the x-axis (0, -9)
9. (7, 0) reflected across the y-axis (-7, 0)
10. (7, 0) reflected across the x-axis (7, 0)
11. Reflect the figures below across the x-axis.

12. Reflect the figures below across the y-axis.