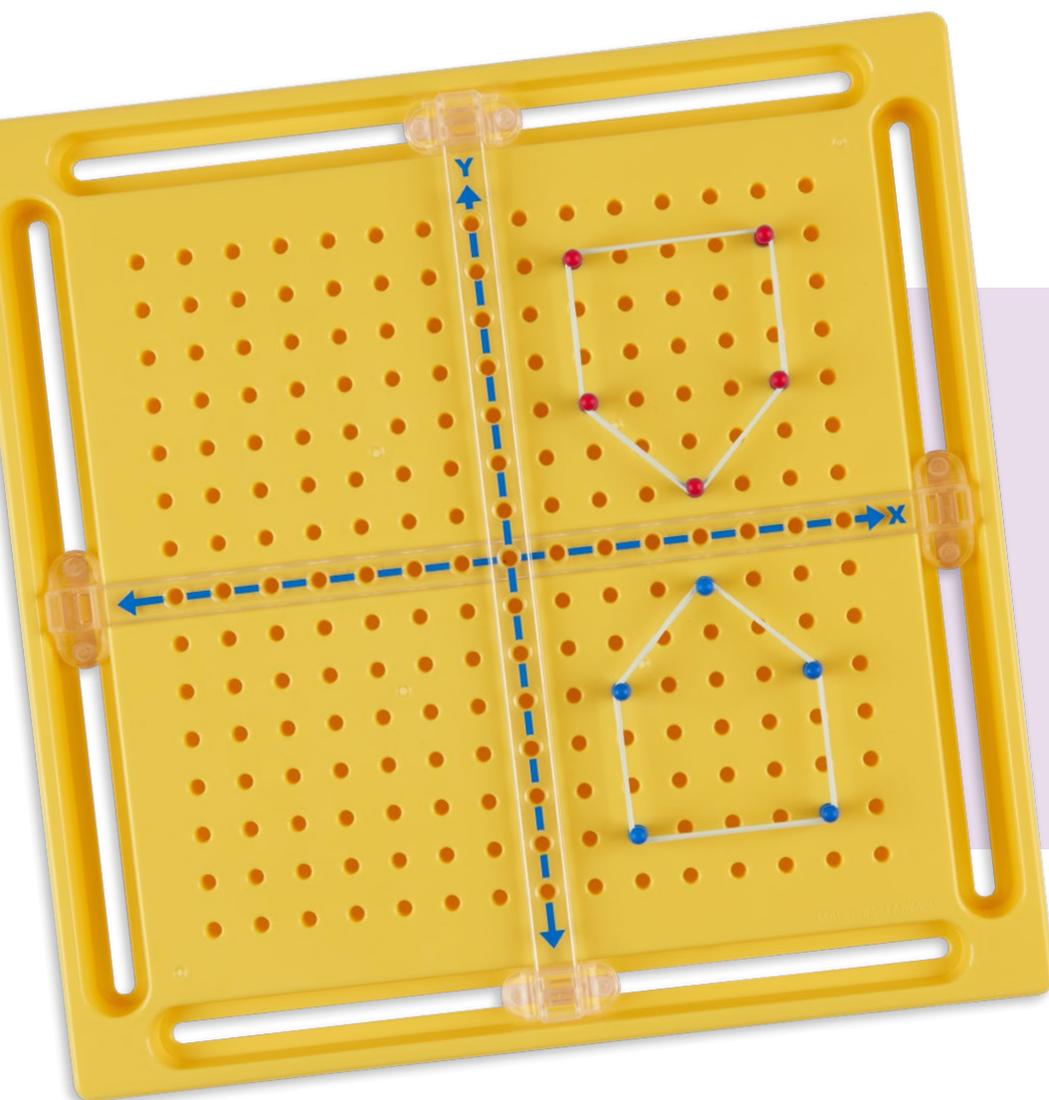Developed with Kristin Hotter

Translations and reflections

Volume 25 | Gr. 6-8
Time: 45-60 mins.

Content
Students will use the X-Y Coordinate Geoboard to create translations and reflections of specific shapes. They will need to have prior knowledge and experience with the four quadrants of the coordinate plane as well as an understanding of both the x and y axes. During this lesson, they will be introduced to the meaning of translation and reflection. They will have a chance to practice the concepts using a variety of problems across all quadrants of the coordinate plane. The lesson is meant as a basic introduction to the concept of transformations.

Objectives
Students will...
- Analyze how (*x, y*) coordinates change when performing translations and reflections
- Identify the differences/similarities between translations and reflections
- Conclude that each type follows a given set of rules

Materials
- X-Y Coordinate Geoboard (**TB24598**) or X-Y Coordinate Geoboard Set of 30 (**TB25306**) NOTE: Each board includes pegs and rubber bands.
- Student worksheet and answer key (attached with lesson plan download)

Common core state standards
CCSS.Math.Content.6.G.A.3—Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.
CCSS.Math.Content.8.G.A.1—Verify experimentally the properties of rotations, reflections, and translations.

Introduction

1. Today, students will be using their knowledge of the coordinate plane and applying it to geometric transformations. Tell students that a transformation is exactly as it sounds: it's a change that is made to a given shape. There are three types of transformations — translations, reflections, and rotations. This lesson will focus on translations and reflections. Provide students with the following definitions:

   Translation: a transformation where every point in an object is moved the same distance in the same direction.

   Reflection: a transformation where a mirror image of a geometric figure is created across a line.

2. Before performing any transformations, students will need to make a series of shapes on their coordinate planes. They should be sure that their x-axis and y-axis are centered on their geoboard. They should also be sure that their x-axis is pointing to the right and the y-axis is pointing up.

3. Students will begin by building two geometric figures in the coordinate plane. They should start in Quadrant I by placing a blue peg at each of the following points: (2, 2), (2, 5), (5, 4), and (5, 2). They should then place a small rubber band around the four pegs to create a geometric shape **(See Figure 1)**. Ask students how the shape could be named *(as a quadrilateral and a trapezoid)*.

4. Have students make a second geometric shape in Quadrant II of the coordinate plane. Place a blue peg at each of the following points: (–5, 1), (–5, 4), (–3, 1), and (–1, 3). Place a small rubber band around the four new pegs to create a second geometric shape **(See Figure 2).** Ask how this shape can be named *(as a quadrilateral)*.
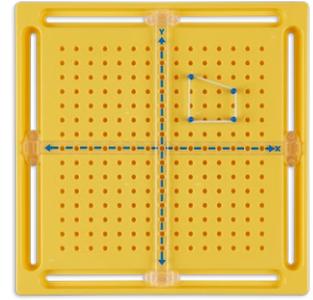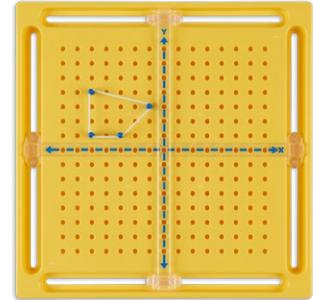

Figure 1

Figure 2

Translation activity

1. Now that two different quadrilaterals have been built on the geoboards, it's time to work on the first transformation. The first kind of transformation students will be looking at is a translation. Tell students that just like the definition they discussed earlier told them, a translation happens when they move their object. They will need to move each point on the object they've made in the exact same direction and the exact same distance.

2. Tell students that they are going to translate the shape in Quadrant I across the *x*-axis. Ask students in what new quadrant will the shape be located *(**Quadrant IV).***

3. In this exercise, the top of the translated shape needs to be the same distance from the x-axis as the bottom of the current shape. Ask what the distance of the bottom of the current shape is from the *x*-axis *(two rows or points above the x-axis).* This means that the top of the translated shape needs to be two rows or points below the *x*-axis, indicating that students will need to ask themselves which point on the current shape is the top point. They should say that the point at *(2, 5)* is the highest point. Ask how many points they need to move that point down to be two rows below the *x*-axis *(7)*, then what the coordinates of that new spot would be *(2, –2)*. Have students put a red peg at that point.

Figure 3

4. Reiterate that a translation means that all points on the shape need to move the exact same distance and direction, then ask how many points students will need to move the three other points *(7)*. Also ask in which direction they need to be moved *(down)*.

5. Have students look at the peg located at (2, 2). Ask what its translated position will be *(2, –5)* and how they know this *(the peg needs to be moved down 7 points)*. Follow the same procedure for peg (5, 2), which moves to translated position (5, –5), and peg (5, 4), which moves to translated position (5, –3).

6. Have students place a rubber band around the translated shape to make sure they have created the exact same shape in a new location. Students should be able to see that the same shape has been translated seven points across the *x*-axis **(See Figure 3).**

7. Tell students that now they will perform a translation across the *y*-axis; but before they can do that, they need to remove the original shape from Quadrant I. Once that shape is removed, they will be able to move the shape from Quadrant II across the *y*-axis to Quadrant I. Ask the following questions:

   What direction will the shape move? *(to the right)*

   Which point on the shape is closest to the *y*-axis? *(–1, 3)*

   How many points is it from the *y*-axis? *(1)*

   How many points do the current furthest points from the *y*-axis need to be in the translated shape? *(3 points)*

   Which points are furthest from the *y*-axis in the current shape? *(–5, 1) and (–5, 4)*

8. Have students start with (–5, 1). They will need to determine how many points to the right it needs to be moved so that it is located 1 point from the *y*-axis in Quadrant I. As it moves, have students count each point so they can see that the peg needs to move 6 points to the right. Ask students in which coordinate should they place a red peg *(1, 1)*.
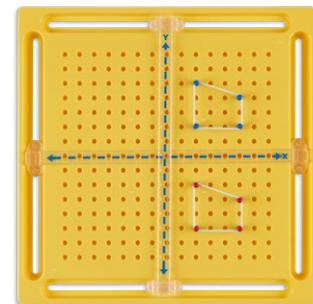
Translation activity (continued)

9. Next, have students move the peg at (–5, 4). Ask if the peg is moved in the same direction, to the right, and the same distance, 6 points, what its translated coordinates will be **(1, 4)**. Follow the same procedure for the peg at (–3, 1), which moves to (3, 1), and for (–1, 3), which moves to (5, 3). Note that the blue peg shouldn't actually be moved, but a red peg should be placed in each new spot. Have students put a rubber band around the translated shape. The two shapes should look exactly the same, and each peg should be exactly 6 points to the right of the original shape's point. Ask students if these things are true for them, which they should be **(See Figure 4)**.

10. Ask students which coordinate changed when they translated across the *x*-axis, the *x*-coordinate or the *y*-coordinate **(the y-coordinate)**. Also ask them which coordinate changed when they translated across the *y*-axis **(the x-coordinate)**. Finally, ask them what statement about translations can be made from these answers **(the coordinate that changes in a translation is the opposite of the axis that the translation crosses)**.
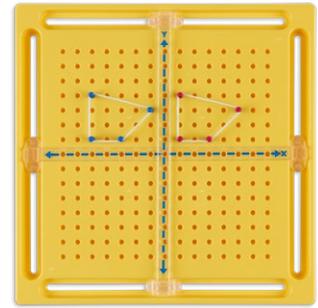

Figure 4

Translation check for understanding

Have students make a quadrilateral in Quadrant III by placing a blue peg at (–2, –3), (–1, –5), (–2, –7), and (–3, –5). Students will translate that shape across the *y*-axis into Quadrant IV of the coordinate plane **(See Figure 5)**. They should use red pegs to indicate the translation. Informally assess students as they work through the problem independently. Once students have had a chance to tackle the problem, ask the following questions:

1. Which peg in the original shape is closest to the *y*-axis? *(–1, –5)*
2. How far from the *y*-axis does the furthest peg need to be in our translated shape? **(1 point)**
3. How were you able to determine it should be 1 point? **(The closest point in the original shape is 1 point from the y-axis.)**
4. What is the furthest point in the original shape? **(–3, –5)**
5. How far to the right does it need to be moved? **(4 points)**
6. What is its translated location? **(1, –5)**
7. What is the translated location of (–2, –7)? **(2, –7)**
8. What is the translated location of (–1, –5)? **(3, –5)**
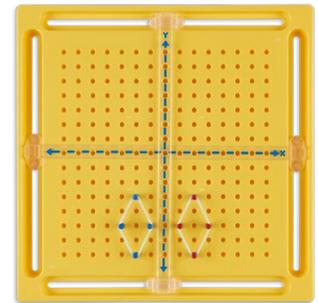9. What is the translated location of (–2, –3)? **(2, –3)**

Figure 5

Reflection activity

1. Tell students that now they will be examining reflections. To do this, they will need to create two more shapes on their geoboards. In Quadrant I, they should use three blue pegs to create a triangle at (3, 2), (6, 2), and (3, 5). In Quadrant IV, they should use five blue pegs to create a shape at (4, –1), (2, –3), (2, –6), (6, –6), and (6, –3). Students should connect the triangle with a rubber band, then use another rubber band to connect the second shape **(See Figure 6)**.

2. Remind students of the definition of reflection, that a reflection happens when a mirror image of an object is created over a line. The lines that they will be reflecting across are the x- and y-axes.

3. Students will begin by reflecting the triangle in Quadrant I across the y-axis. See if students can tell you in what new quadrant the shape will be located *(Quadrant II)*. Tell students that when they reflect over the y-axis, they find the opposite of the x-coordinate in their coordinate pair. Remind them that the same was true when they did translations.

4. Direct students' attention to their point at (3, 2). Ask what the x-coordinate in the coordinate pair is **(3)** and what the opposite of 3 is **(–3)**. Tell them that the y-coordinate is going to stay exactly the same at 2. They should plot the new point at (–3, 2) and place a red peg at that point.
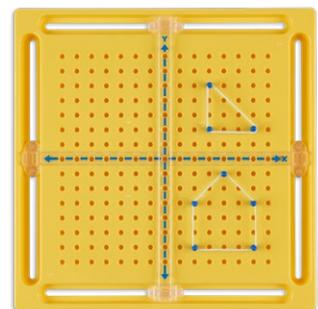

Figure 6

Reflection activity (continued)

5. For point (6, 2), ask what the opposite of the x-coordinate in that pair is *(–6)* and what will happen to the y-coordinate (it will stay the same). See if they can determine the reflected point for (6, 2). It should be (–6, 2). Have students place a red peg at the new point.

6. The last point on the original shape is at (3, 5). As before, ask what the opposite of the x-coordinate in that pair is *(–3)* and what will happen to the y-coordinate *(it will stay the same)*. Students should be able to tell you that the third reflected point should be plotted at (–3, 5). Have them plot the point and place a red peg there. Students should now place a small rubber band around the three new points in Quadrant II **(see Figure 7)**.

7. Ask students what they notice about the shape *(it's an exact copy of the original shape, but it looks backwards)*. Tell students that when they find the mirror image of a shape, the image appears to flip.

Figure 7

8. Have students remove the original triangle from Quadrant I so they can reflect the shape in Quadrant IV. Ask students which axis they will be reflecting over if they reflect the shape from Quadrant IV into Quadrant I *(the x-axis)*. Remind students that when they reflected across the y-axis in their last reflection, the only coordinate that changed was the x-coordinate. See if they can conclude that since they are reflecting across the x-axis this time, the y-coordinate will be the one that changes, making this type of reflection similar to the previous one, except that this time the x-coordinate will remain the same and the y-coordinate will change.

9. Have students start with the point at (4, –1). Ask them which coordinate is the y-coordinate in the pair *(–1)* and what the opposite of –1 is *(1)*. See if they remember what will happen to the x-coordinate *(it will stay the same)*. Have them plot the reflected point for (4, –1). They should plot it at (4, 1) and place a red peg there.

10. Move on to the peg located at (2, –3). Ask what is the opposite of the y-coordinate in the pair *(3)* and what will happen to the x-coordinate *(it will stay the same)*. Students should determine that they need to plot a reflected point for (2, –3) at point (2, 3) and place a red peg there.
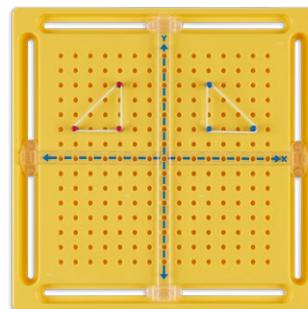
Reflection check for understanding

Give students a few minutes to determine the reflected points for the other three points on the shape in Quadrant IV. They should place a rubber band around the new shape when it is completed **(see Figure 8)**. When this task is completed, ask students the following questions:

1. At what point did you place a peg to show the reflection of (2, –6)? *(2, 6)*
2. How did you decide on that point? *(The x-coordinate needs to remain the same. The new y-coordinate is the opposite of the original coordinate. Since the original was –6, its opposite is 6.)*
3. At what point did you place a peg to show the reflection of (6, –3)? *(6, 3)*
4. At what point did you place a peg to show the reflection of (6, –6)? *(6, 6)*
5. When you place a rubber band around your reflected shapes, what do you notice about the reflected image? *(It looks like an upside down version of the original shape.)*

At this time, you may distribute the student worksheet.
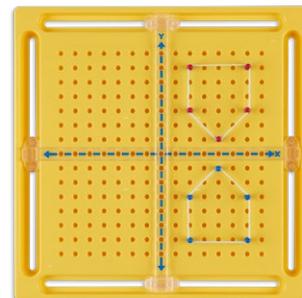

Figure 8

Intervention

Being able to make the connection for how many points need to be moved in a translation can make the process a bit confusing. Simply give students the number of points that need to be moved. It will help them understand the concept of translating without having to figure out the extra step independently.

Extension

Students can combine translations and reflections in the same problem. EXAMPLE: Original shape has coordinates of (–1, 1), (–1, 3), (–3, 4), and (–4, 2). Reflect the shape to Quadrant III, then translate the new shape to Quadrant IV.

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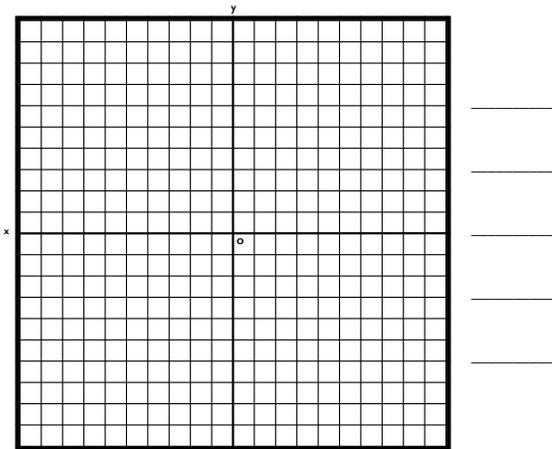
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Name: _____   Date: _____

Directions: Plot each set of given points on your *X-Y* Coordinate Geoboard. Complete the requested transformation. Draw the original and transformed points on the corresponding coordinate plane below. Be sure to record the coordinates of your transformed shape.
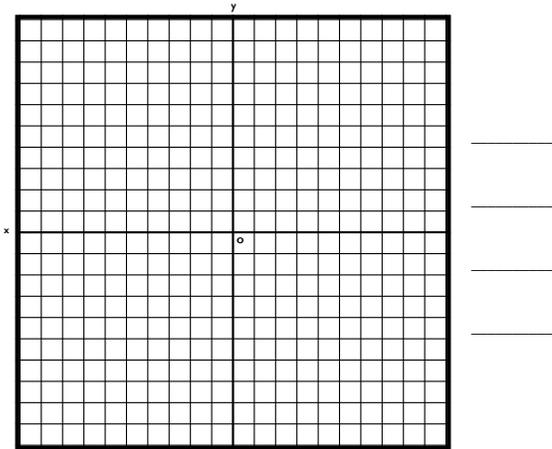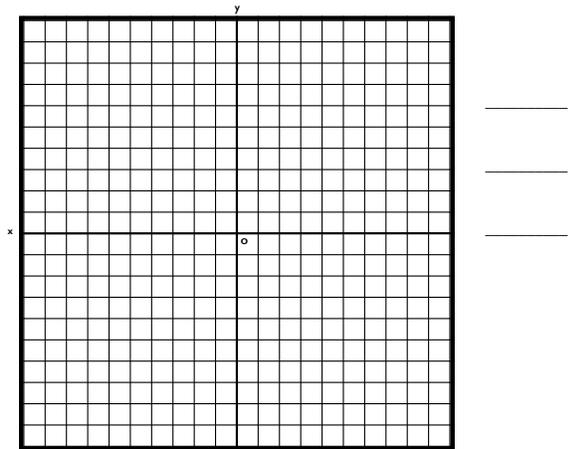
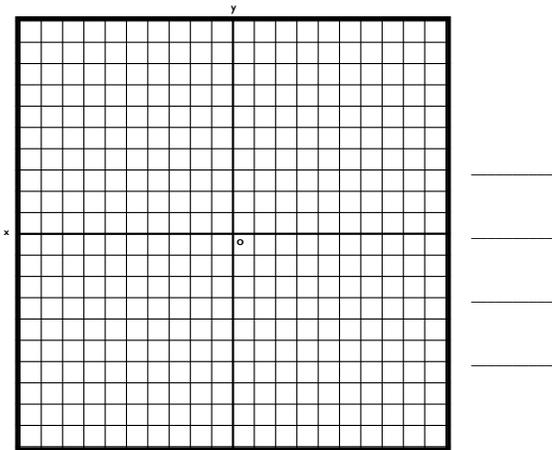**1.** Plot the points (2, 2), (7, 4), (7, 7), and (4, 6). Translate those points across the *y*-axis.
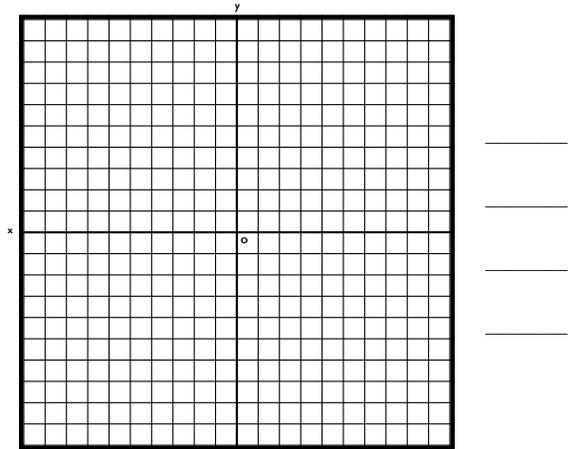
2. Plot the points (–2, 1), (–5, 2), (–5, 6), and (–3, 5). Reflect those points across the *x*-axis.

3. Plot the points (–4, –2), (–6, –4), (–5, –6), (–3, –7), and (–2, –4). Reflect those points across the *y*-axis.

4. Plot the points (3, –3), (5, –6), and (7, –3). Translate those points across the *x*-axis.
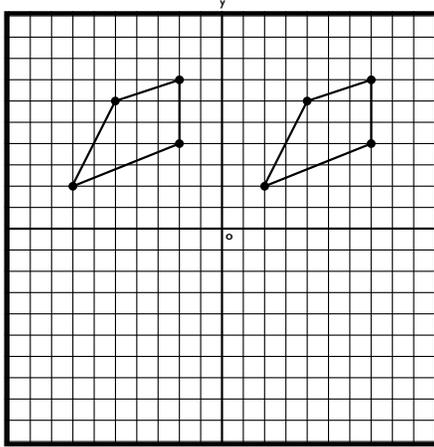
5. Create a quadrilateral of your own in Quadrant III. Translate those points into Quadrant II.

6. Create a triangle of your own in Quadrant I. Reflect those points into Quadrant II.

Translations and reflections — **answer key**
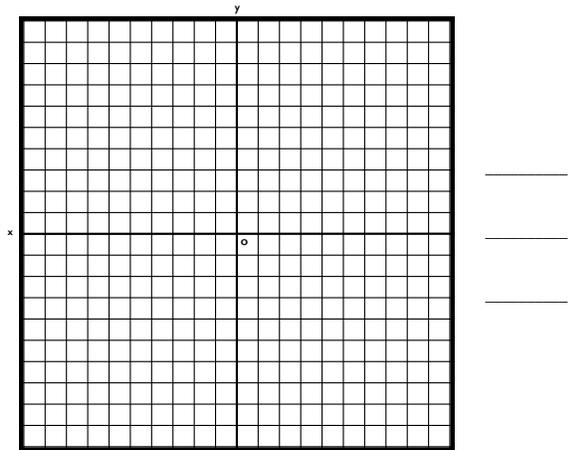
Directions: Plot each set of given points on your *X-Y* Coordinate Geoboard. Complete the requested transformation. Draw the original and transformed points on the corresponding coordinate plane below. Be sure to record the coordinates of your transformed shape.
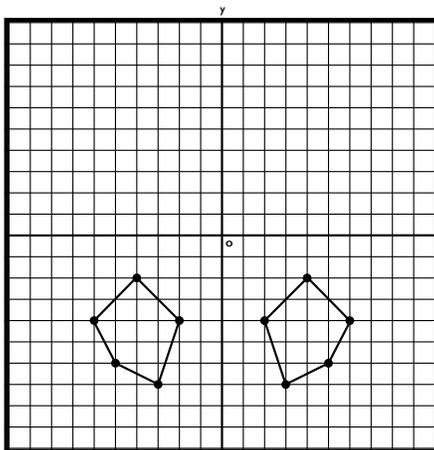

(–7, 2)

(–2, 4)

(–2, 7)

(–5, 6)

1. Plot the points (2, 2), (7, 4), (7, 7), and (4, 6). Translate those points across the *y*-axis.
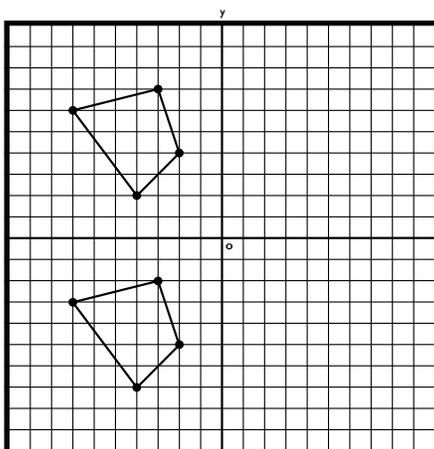

(–2, –1)

(–5, –2)

(–5, –6)

(–3, –5)

2. Plot the points (–2, 1), (–5, 2), (–5, 6), and (–3, 5). Reflect those points across the *x*-axis.

(4, –2)

(6, –4)

(5, –6)

(3, –7)

(2, –4)

3. Plot the points (–4, –2), (–6, –4), (–5, –6), (–3, –7), and (–2, –4). Reflect those points across the *y*-axis.

(3, 6)

(5, 3)

(7, 6)

4. Plot the points (3, –3), (5, –6), and (7, –3). Translate those points across the *x*-axis.

Sample Answer

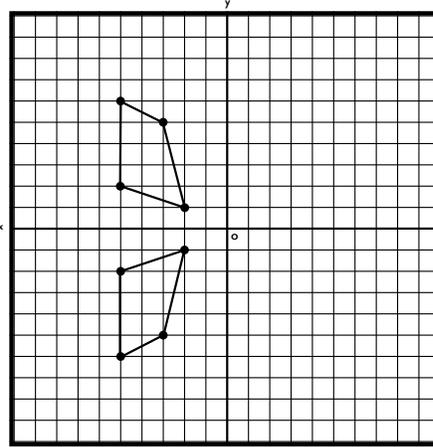(–2, 4)

(–3, 7)

(–4, 2)

(–7, 6)

5. Create a quadrilateral of your own in Quadrant III. Translate those points into Quadrant II.
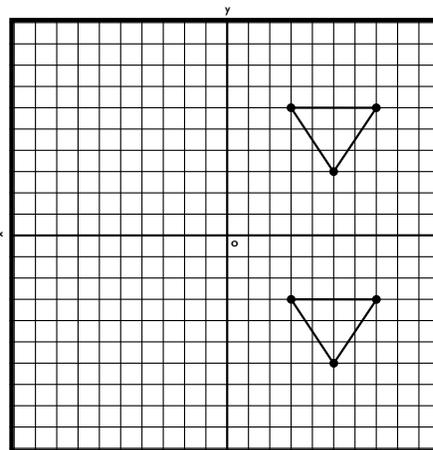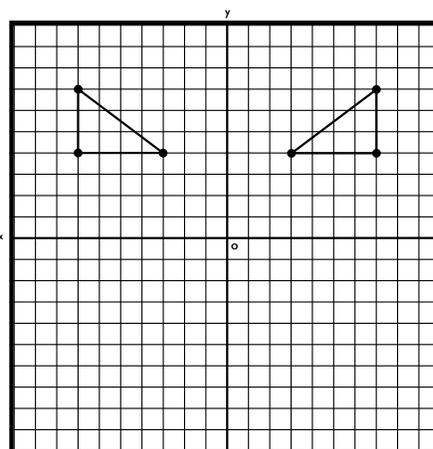

Sample Answer

(–3, 4)

(–7, 4)

(–7, 7)

6. Create a triangle of your own in Quadrant I. Reflect those points into Quadrant II.