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Lesson 5: Translation (Slide)

OBJECTIVES: SWBA to

Describe the effect of a rotation on two-dimensional figures using coordinates. **(8. G.3)**

INTRODUCTION

For the past two meetings we have being talking about how geometric transformations are integral parts of our daily lives. Two meetings ago, we talked about reflection, and during our last meeting, we talk about translations. Today, we will discuss rotations, which are probably the most abstract of the four transformations: reflection, translation, rotation, and dilation. The word "rotation" means "spin" or turning around a center. It is important to realize that when we rotate an object or figure around a given point or center, the image of the object is congruent to the original object. That is, a rotation is isometric—it keeps the same shape (sides and angles) and size as the original object (pre-image). When do we use rotation in our daily lives? At all times! Just think of turning around! We use rotation when using the joy stick in the PlayStation controller, when getting on ferry wheel. And, as we mention before, architects, engineers, and computer programmers and games developers use computer imaging create animations, video games, simulations using the geometrical transformations.

MINI-LESSON/Vocabulary (I DO):

As I mentioned before, a rotation is the movement of a geometric figure about a certain point. The amount of rotation is described in terms of degrees. If the degrees are positive, the rotation is performed counterclockwise; if they are negative, the rotation is clockwise. The figure will not change size or shape, but, unlike a translation, will change direction. The initial figure is always called the **pre-image** while the rotated figure will be called the **image**. Unless, I physically rotate the object, which is not always possible, there are certain notations that we need to use to perform a rotation. The mathematical notation for rotation is usually written as follows:

R (center, rotation) where the center is the point of rotation and the rotation is given in degrees. Often, rotations are written using **coordinate notation**, which means that their coordinates on the coordinate plane are given. There are some general rules for either clockwise (negative degrees) or counter **clock rotation** (positive degrees) of objects using the most common degree measures (90°, 180°, and 270°).

Whether rotating clockwise or counter clockwise, remember these rules:

1. The general rule for rotation of an object **90°** is **(x, y) → (-y, x)**. That is, I swap the coordinates, the take the opposite of y.
2. For **180°**, the rule is **(x, y) → (-x, -y).** That is, I take the opposite of each coordinate.
3. For **270°**, the rule is **(x, y) → (y, -x).** That is, I swap the coordinates, and then take the opposite of x.

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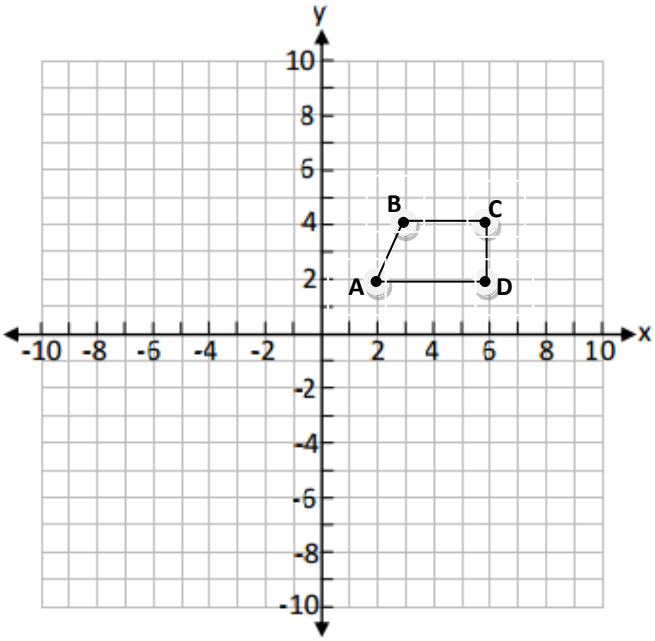
LET ME MODEL FOR YOU:

Example 1:

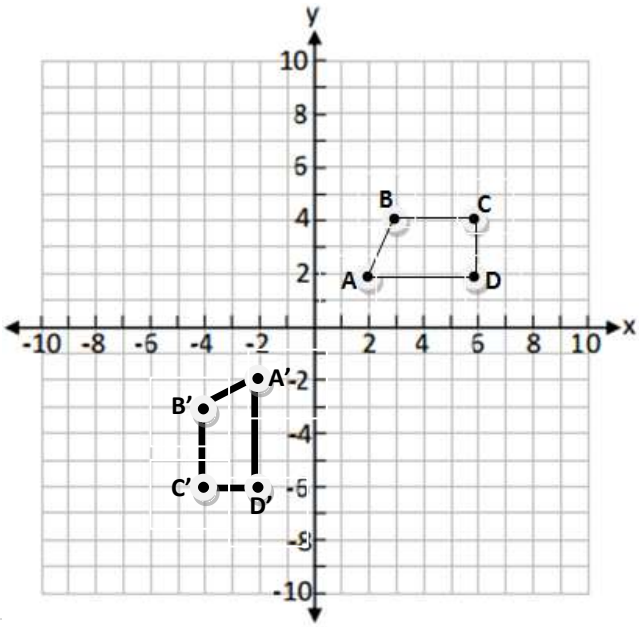
Part A:

Graph and connect these points: (2,2) (3,4) (6,2) (6,4). **Label the quadrilateral ABC.**

Solution:



Part B: Rotate triangle ABC 90° around the origin, (0, 0)



Solution: 90° rotation around (0, 0). This means that

(x, y) of each vertex of the original quadrilateral (pre-image) becomes **(-y, x)** in the image of the quadrilateral**: (x, y)→(-y, x).**

Point A (2, 2) →**Point A'** (-2, 2)

Point B (3, 4) →**Point B'** (-4, 3)

Point C (6, 4) →**Point C'** (-4, 6)

Point D (6, 2) →**Point D'** (-2, 6)

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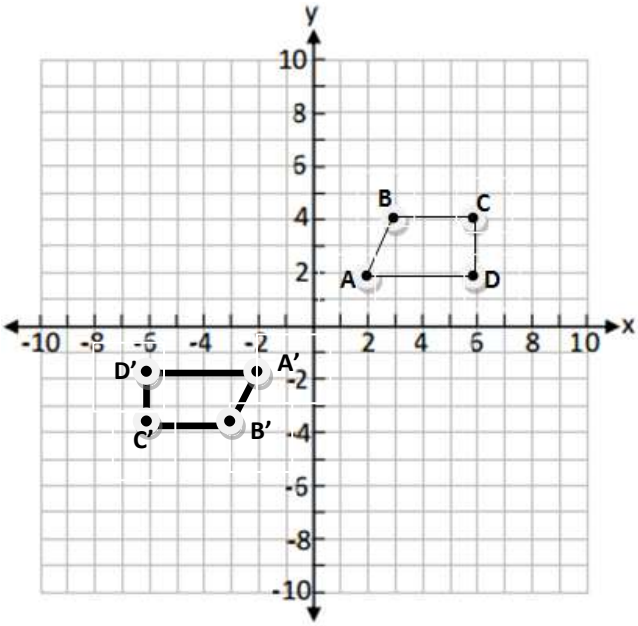
Part C: Rotate triangle ABC 180° around the origin.



Solution: 180° rotation around (0, 0). This means that

(x, y) of each vertex of the original quadrilateral (pre-image) becomes **(-x, -y)** in the image of the quadrilateral**: (x, y)→(-x, -y).**

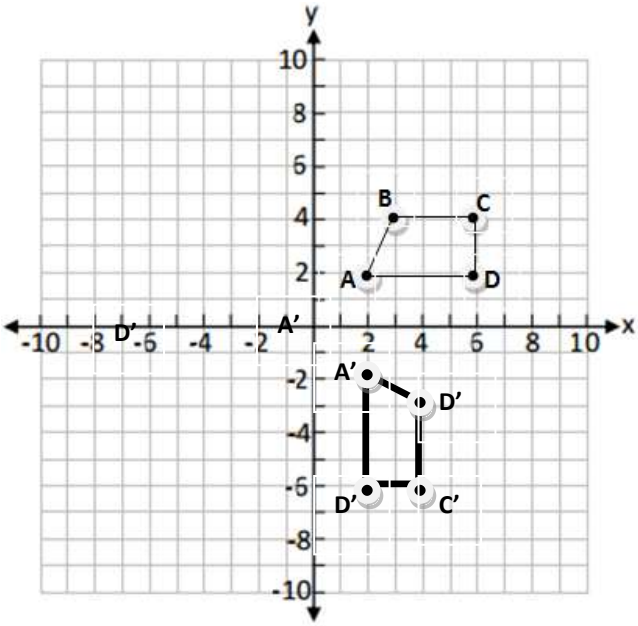
Point A (2, 2) →**Point A'** (-2, -2)

Point B (3, 4) →**Point B'** (-3, -4)

Point C (6, 4) →**Point C'** (-6, -4)

Point D (6, 2) →**Point D'** (-6, -2)

Part D: Rotate triangle ABC 270° around the origin.



Solution: A 270 rotation around the origin means that

(x, y) of each vertex of the original quadrilateral (pre-image) becomes **(y, -x)** in the image of the quadrilateral**: (x, y)→(y, -x).**

Point A (2, 2) →**Point A'** (2, -2)

Point B (3, 4) →**Point B'** (4, -3)

Point C (6, 4) →**Point C'** (4, -6)

Point D (6, 2) →**Point D'** (2, -6)

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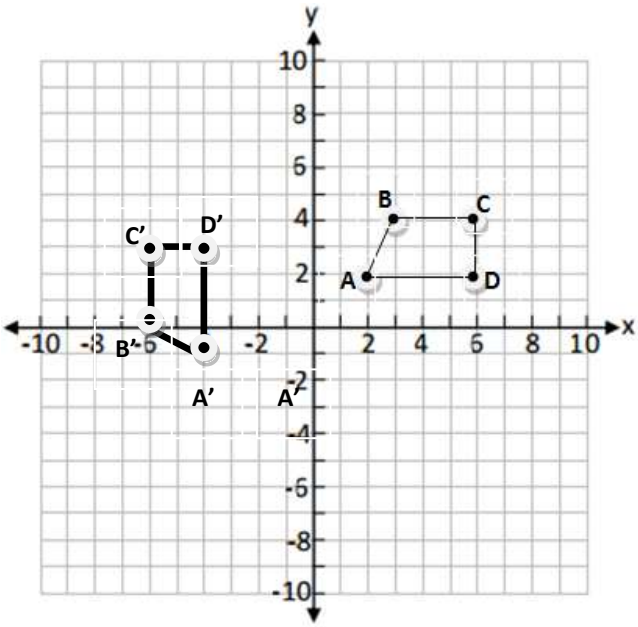
Part E: Rotate triangle ABC 90° around point (-3, 2)



Solution: Rotating around a point other than the origin, (0, 0), is a little be more involved. To accomplish this I translating x coordinate each vertex of the triangle 3 units to the left, and translate the y-coordinate and 2 units up. Then **(x, y) → (-y, x)** each of the coordinates of the new vertices.

Point A (2-3, 2+2) →**Point A** (-1, 4) →**Point A'** (-4, -1)

Point B (3-3, 4+2) →**Point B** (0, 6) →**Point B'** (-6, 0)

Point C (6-3, 4+2) →**Point C** (3, 6) →**Point C'** (-6, 3)

Point D (6-3, 2+2) →**Point D** (3, 4) →**Point D'** (-4, 3)

Initial Summary:

Rotation is a geometric transformation that involves rotating a figure a certain number of degrees about a fixed point.

A positive rotation is counterclockwise and a negative rotation is clockwise. You can use the rotational rules to determine where on the coordinate plane to place the vertices of your image, and then it is easy to draw the image from the pre-image.

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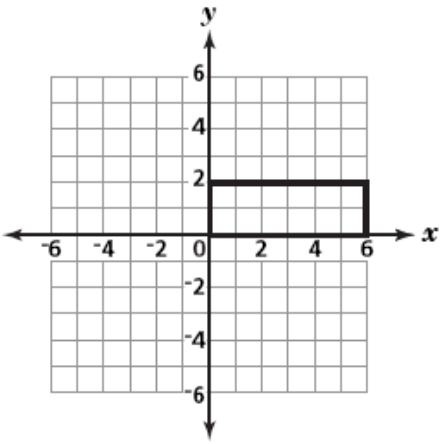
Guide Practice (We do):

A rectangle is plotted on the coordinate plane below.



Solution: Rotating 90° clockwise (negative) is the same as rotating 270° counter clockwise (positive)

270° means that we take the coordinates of vertex of the rectangle, swap the coordinates, and the take the opposite of y.

(x, y) → (y, -x)

The first vertex is (0, 0) →(0, 0)

The second vertex is (0, 2) →(2, 0)

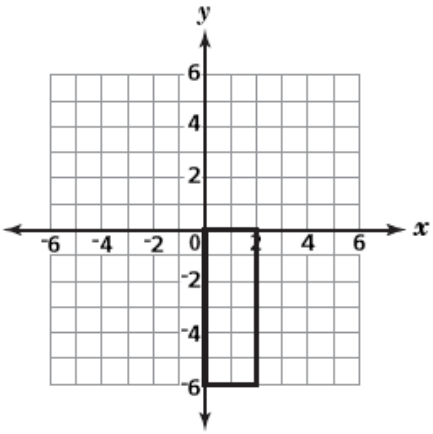
The third vertex is (6, 0) →(0, -6)

The fourth vertex is (6, 2) →(2, -6)

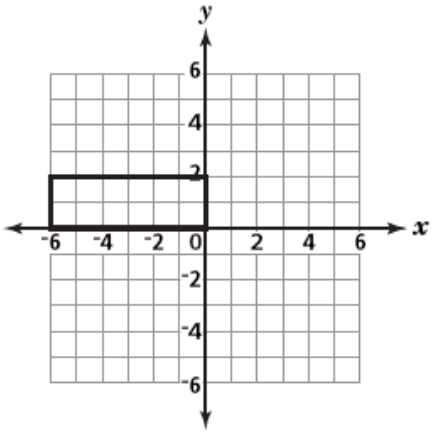
So the **correct answer choice is A**.

Which image shows a 90° clockwise rotation about the origin?

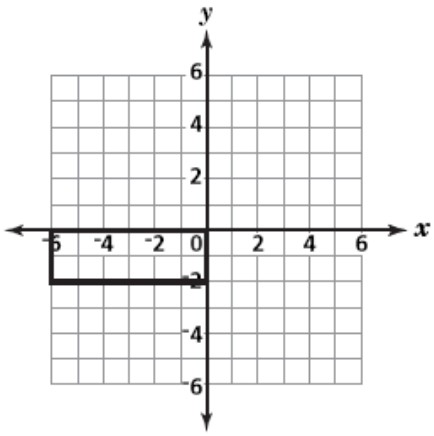
A



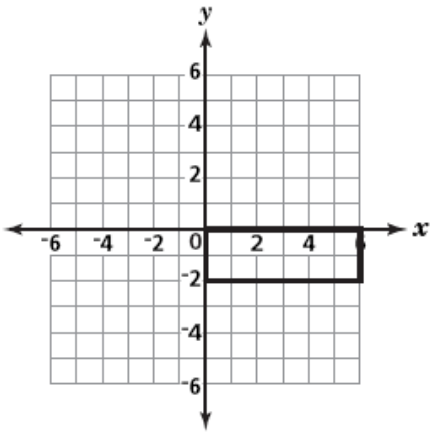
C



B



D



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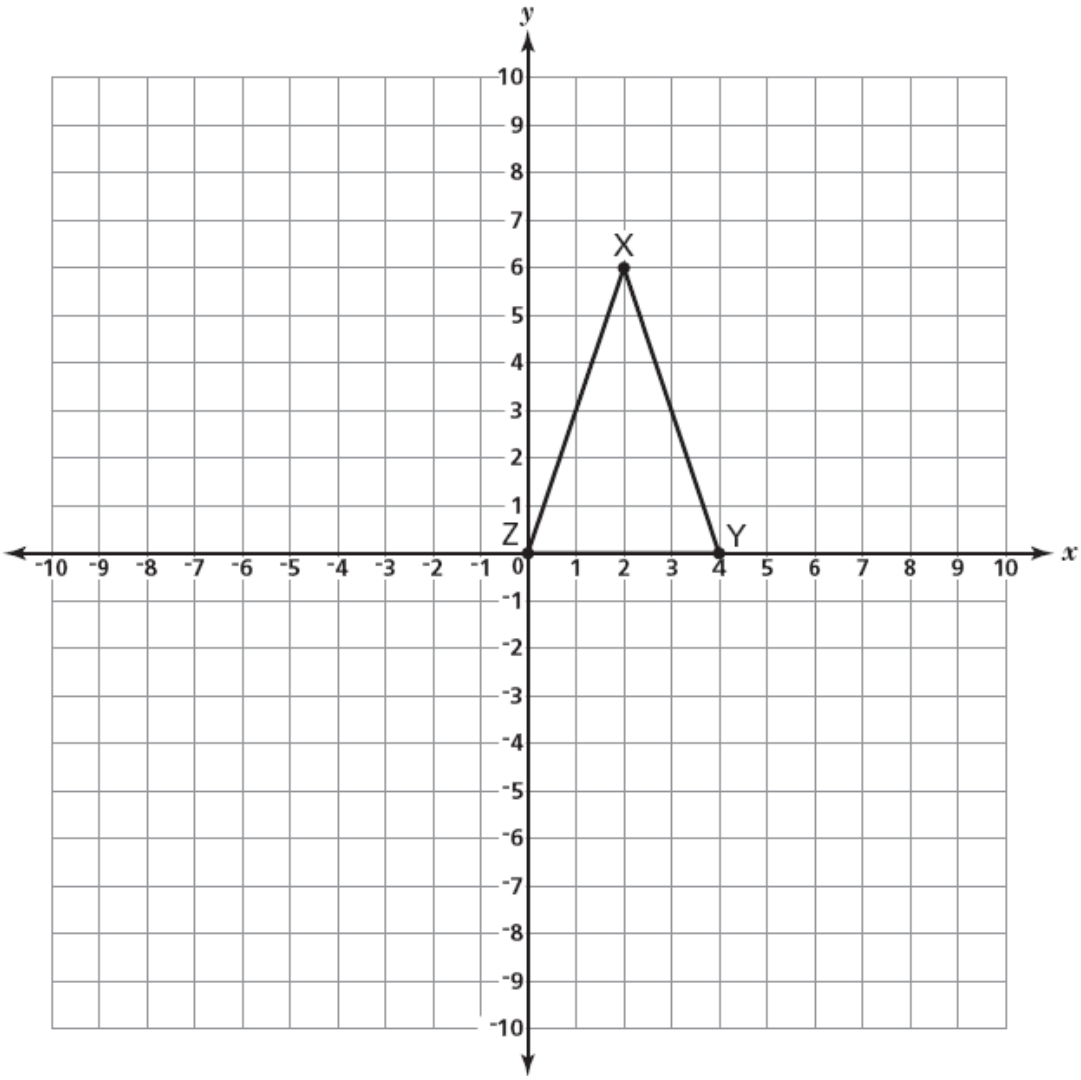
Independent Practice (You Do):

Problem 1:

Triangle XYZ is plotted on the grid below.



Part A

On the grid, draw the image of triangle XYZ after a clockwise rotation of 180° about the origin. Label the new triangle X'Y'Z'.

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Part B

On the lines below, explain how you determined the location of point Y′.

_____

_____

_____

_____

_____

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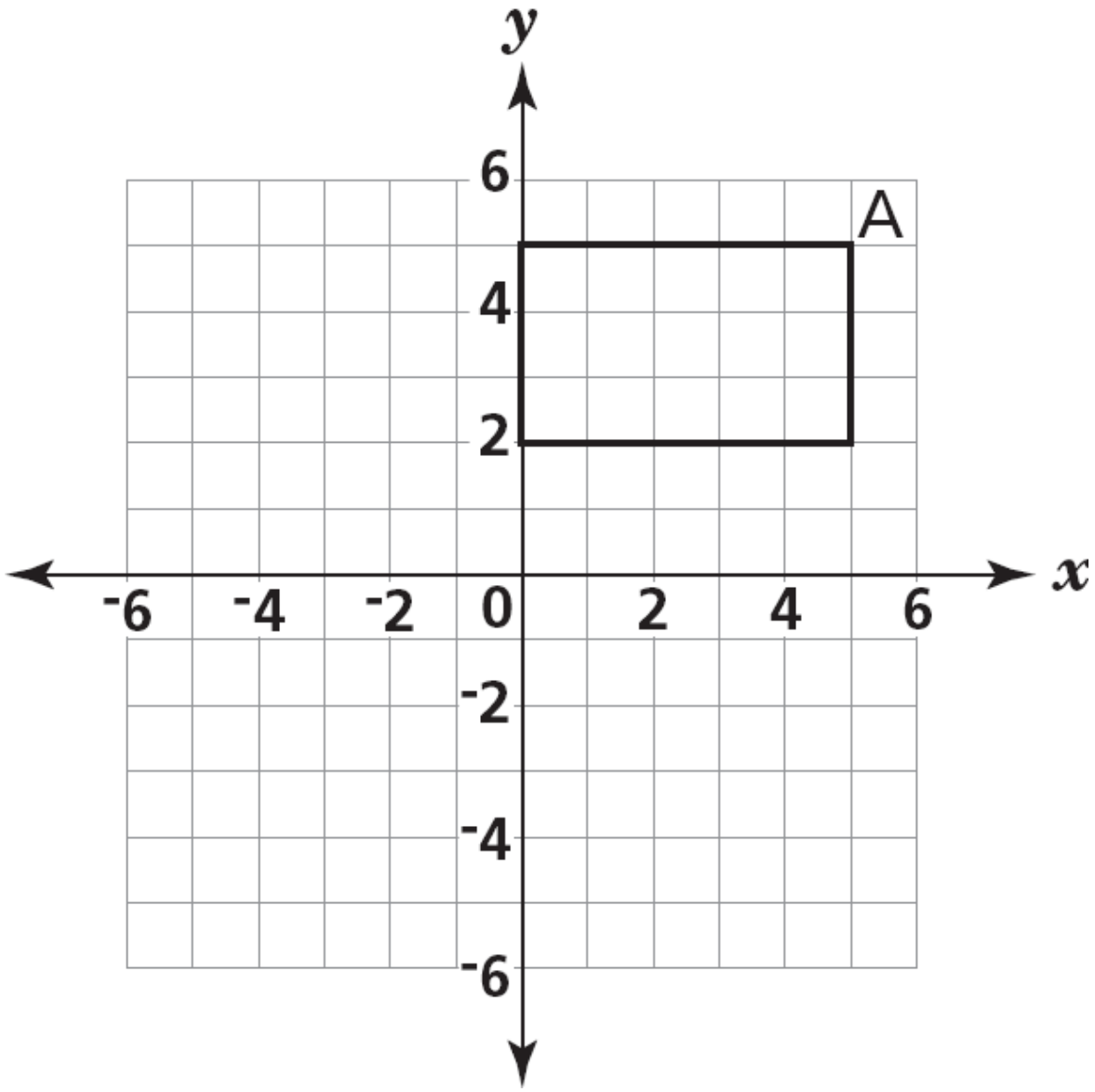
Problem 2:

Brian drew a rectangle on the grid below. On the same grid, rotate the rectangle **both** 90° and 180° clockwise about the origin. Label point A from the rectangle Brian drew as A′ on your 90° rotated figure and as A″ on your 180° rotated figure.



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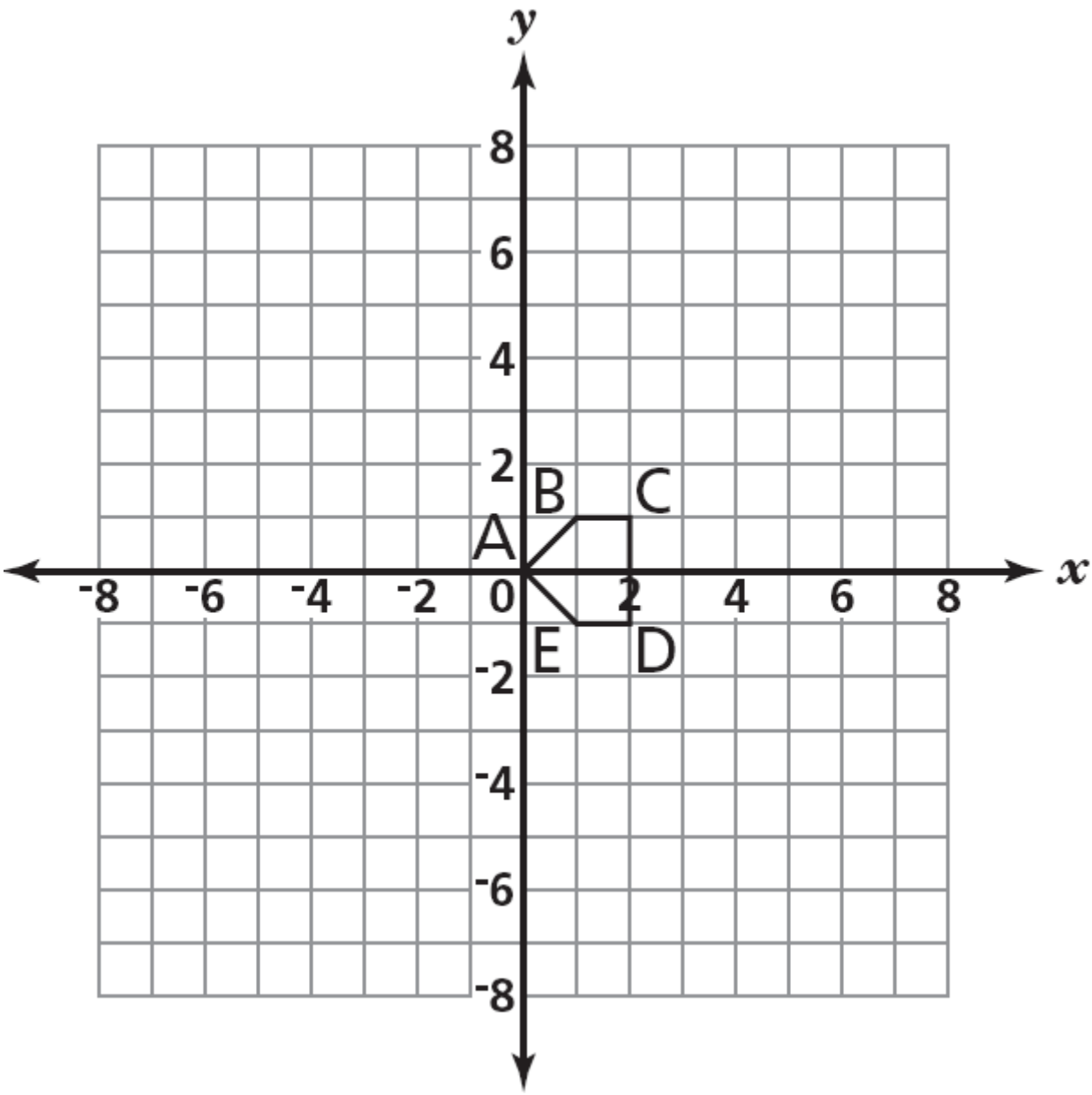
Problem 3:

Rotate pentagon BCDE 90° clockwise (negative) around point (2, 2).



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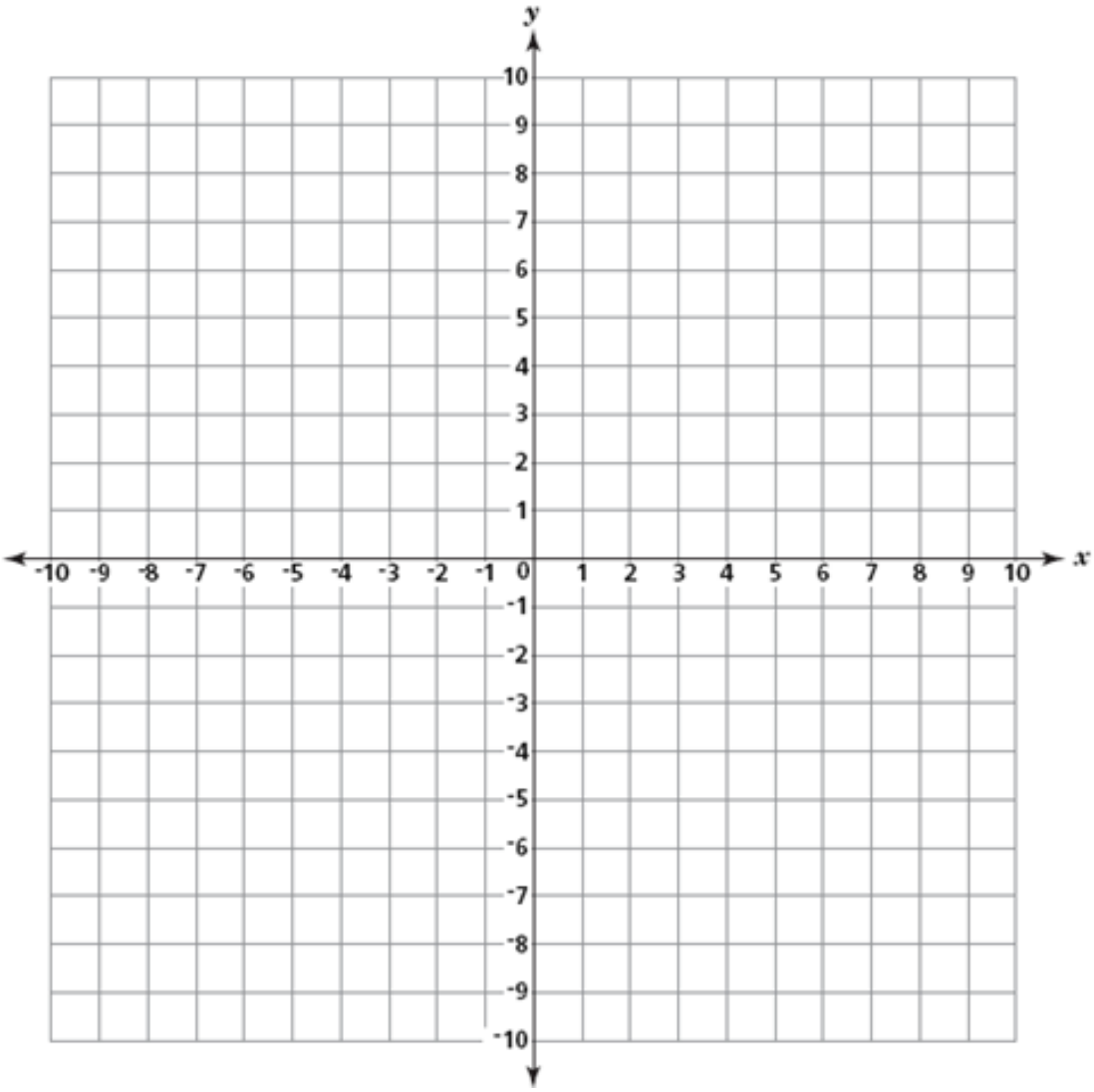
Problem 4: Challenge!

Plot and label triangle ABC if A(-5, -1), B(-3, -2), C(-3, 2). Next, translate triangle ABC by the rule (x, y) →(x +6, y-3), label the image A'B'C'. Then reflect the image or A'B'C' over the y-axis, and label it A''B''C'', finally, rotate A''B''C'' 90° counter clockwise around point (-2, -1).



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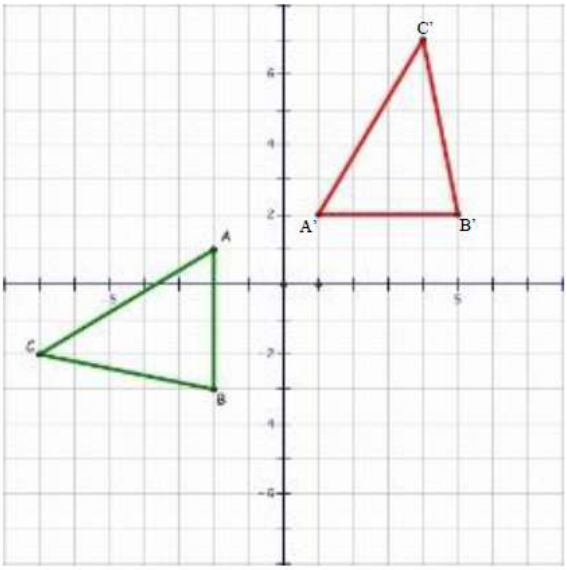
Problem 5: Supper Challenge!

Study the picture to the right. Explain how to transform triangle ABC into triangle A'B'C' in two steps choosing from the options in the list below. Make sure that you give the equation of any line of reflection, the vector of any translation (i.e., the notation of the translation), and the coordinates of any center of rotation.



To solve this problem, you can choose from this limited list of transformations:

- Reflect over a horizontal line.
- Reflect over a vertical line.
- Translate some number of spaces horizontally (right or left).
- Translate some number of spaces vertically (up or down).
- Rotate by 90 degrees, clockwise or counterclockwise, around any point in the plane.
- Rotate by 180 degrees around any point in the plane.

Extra: Find another way to do this (again, in two steps, using the options in the list above).

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Final Summary

In a U-Shape:

1. Re-state the objective to assess if students learn it
2. Elicit from students what they have learned and what they want to learn more about.
3. Tie what they learn to the lesson, and upcoming lessons **(Next Saturday, they will learn about Dilations).**