Rotations on the Coordinate Plane Lesson

- Graph dilations, reflections, and translations on a coordinate plane 8.6(B)

Materials:

- Each group: graph paper with Cartesian plane and axes labeled, patty paper, heavy cardboard (8 inch by 8 inch square), push pin, ruler, tape
- Each student: **Initial Rotations** activity sheet, **Activity 1: Triangle** activity sheet, **Activity 2: Quadrilateral** activity sheet

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Engage

This activity is designed to encourage students to explore their prior knowledge about transformations. Students should be in cooperative groups of two to four where they can engage in conversation about their classification strategies and justify their conjectures about the rules for the transformations.

1. Distribute the **Initial Rotation** activity sheet to each student. Display **Transparency 2** and ask students what they know about rotations. Be sure they understand the concept of rotation. Explain the directions and use the transparency as a model.
2. Allow time for students to complete this procedure and compare their designs with others in their group.
3. Have students discuss any patterns they see in the table and share with the whole class. This should lead to further exploration of rotations.

The teacher should monitor the students to be sure all students understand the process. When every student has had the opportunity to complete the activity, use the Facilitation Questions below to guide the ensuing class discussion.

Facilitation Questions

- How are your figures alike? *They have the same shape, size.*
- What is the difference? *They have different locations and orientations.*
- How were the coordinates changed? *Answers will vary.*
- What patterns do you see in the table? *Answers will vary.*

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Explore

This part of the lesson is designed for small groups of two to four students. Students should be encouraged to interact with each other. The teacher should be moving around the room facilitating the activity. Use the Facilitation Questions below to guide students.

1. Have students attach the graph paper to the cardboard using tape. Ask each group to draw a triangle of their choice in Quadrant I of the coordinate plane and label the vertices A, B, and C. Then, ask students to record the coordinates of the vertices on **Activity 1: Triangle** activity sheet in the column labeled 0° rotation.

2. Ask students to overlay the patty paper onto the graph paper and trace both the axes and the triangle. Then, use the pushpin to attach the patty paper to the graph paper at both origins.

3. Students should work through **Activity 1: Triangle** activity sheet and **Activity 2: Quadrilateral** activity sheet.

Facilitation Questions

- What did you "physically" do with the patty paper? *turned or rotated*
- What pattern do you see in the x-values? *became $-y$*
- What pattern do you see in the y-values? *became x*
- Can you translate what you did with the patty paper to a general statement? $(x, y) \rightarrow (-y, x)$

Activity 1: Triangle

All rotations are counterclockwise about the origin.

- Using a sheet of patty paper, trace your *x*- and *y*-axes and draw a triangle in Quadrant I of the coordinate plane. Record the coordinates of the vertices in the column labeled 0° rotation.
- Rotate the patty paper 90° and record the coordinates of each of the vertices of the rotated triangle.
- Now, rotate the patty paper 180° from the original position and record the coordinates of each of the vertices of the rotated triangle.
- Rotate the patty paper 270° from the original position and record the coordinates of each of the vertices of the rotated triangle.
- Finally, rotate the patty paper 360° from the original position and record the coordinates of each of the vertices of the rotated triangle.

Triangle Vertices	0° Rotation	90° Rotation	180° Rotation	270° Rotation	360° Rotation
A					
B					
C					
P(*x*, *y*)	*(x, y)*	*(-y, x)*	*(-x, -y)*	*(y, -x)*	*(x, y)*

- Find the slopes of the sides of the original triangle and the slopes of the sides of each of the rotated images. Record the slopes in the table.

	0° Rotation	90° Rotation	180° Rotation	270° Rotation	360° Rotation
slope AB					
slope BC					
slope CA					
any	*m*	*-m*	*m*	*-m*	*m*

Activity 2: Quadrilateral

All rotations are counterclockwise about the origin.

Using a new sheet of patty paper, trace your *x*- and *y*-axes and draw a quadrilateral. Repeat the same procedure as in Activity 1 to fill in the table.

Quadrilateral Vertices	0° Rotation	90° Rotation	180° Rotation	270° Rotation	360° Rotation
A					
B					
C					
D					
P(*x*, *y*)	*(x, y)*	*(-y, x)*	*(-x, -y)*	*(y, -x)*	*(x, y)*

- Find the slopes of the sides of the original quadrilateral and the slopes of the sides of each of the rotated images. Record the slopes in the table.

	0° Rotation	90° Rotation	180° Rotation	270° Rotation	360° Rotation
slope AB					
slope BC					
slope CD					
slope DA					
any	*m*	*-m*	*m*	*-m*	*m*

Describe the patterns in slope for each of the rotations. *Answers may vary but should describe the changes as seen in the table above.*

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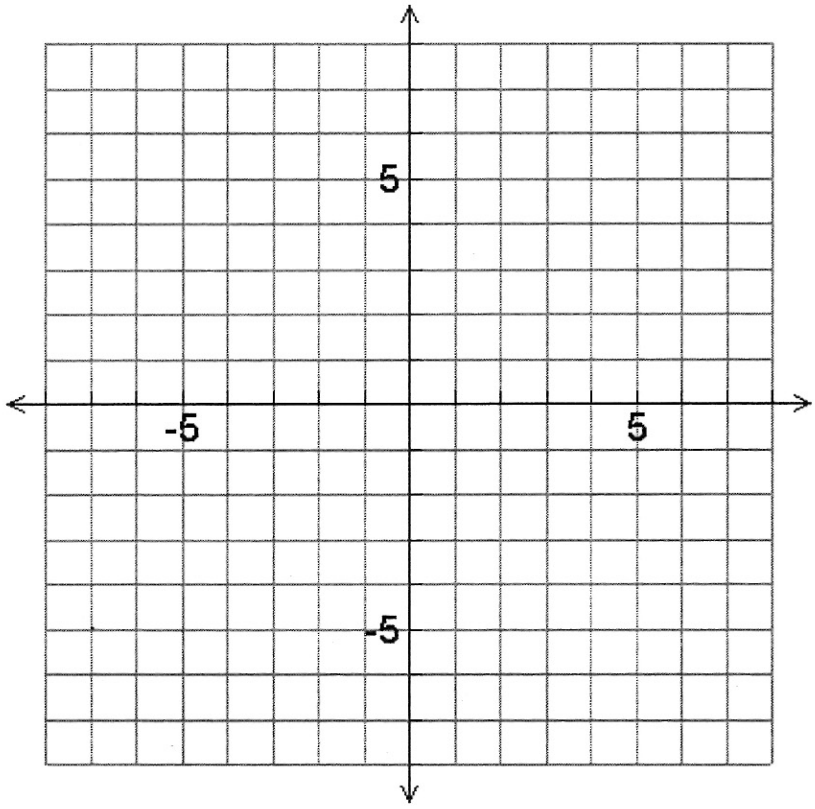
Explain

This part of the lesson is a teacher directed activity of the concepts involved in the lesson. Use the Facilitation Questions below to facilitate the discussion of the exploratory activity.

Facilitation Questions

- What patterns do you notice in the ordered pairs?
  Answers may vary.
- What rule do you see for a 90-degree counterclockwise rotation?
  $(x, y) \rightarrow (-y, x)$
- What rule do you see for a 180-degree counterclockwise rotation?
  $(x, y) \rightarrow (-x, -y)$
- What rule do you see for a 270-degree counterclockwise rotation?
  $(x, y) \rightarrow (y, -x)$
- What rule do you see for a 360-degree counterclockwise rotation?
  $(x, y) \rightarrow (x, y)$
- Will these rules hold for any figure drawn in the coordinate plane?
  Yes.
- What do you think would happen if the triangle were not in Quadrant I?
  The rules will hold true.
- Test your conjecture.
  The rules for rotations hold true.
- What rule do you see for the change in the slope of lince segments fo a 90° counterclockwise rotation?
  $m \rightarrow -m$
- What rule do you see for the change in the slope of line segments for a 150° counterclockwise rotation?
- *No change in slope*
- *What rule do you see for the change in the slope of line segments for a 270° counterclockwise rotation?*
- $m \rightarrow -m$
- What rule do you see for the change in the slope of line segments for a 360° counterclockwise rotation?
- *No change in stage*
- Describe the effect a rotation has on the size, shape, slope and orientation of an object.
  No effect on size, no effect on shape, slope may change, the orientation can vary depending on the angle of rotation.

Sue is designing a logo for her company. She wants to include two triangles, one of which is a rotation of the other. She performed a rotation of 270 degrees to obtain a rotated triangle with coordinates of (3, 1), (4, 4), and (1, 4). Unfortunately, she spilled her coffee on the original triangle and only knows two of the original coordinates, (-4, 1) and (-4, 4). What is the third coordinate? Justify your answer.



Answer: (-1, 3)