Essential Question How does a rotation affect the properties of a two-dimensional figure?

VISUAL LEARNING ASSESS

EXAMPLE 1 Understand Rotations

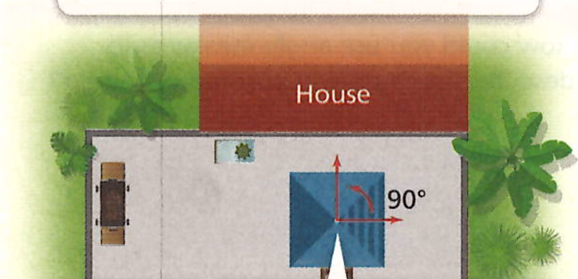
Scan for Multimedia

One feature of the new patio plan is a rectangular umbrella that can easily rotate so that clients can enjoy either the sun or the shade. Where should the architect move the umbrella to highlight this feature for his clients?

Model with Math How can you describe the rotation of the umbrella?

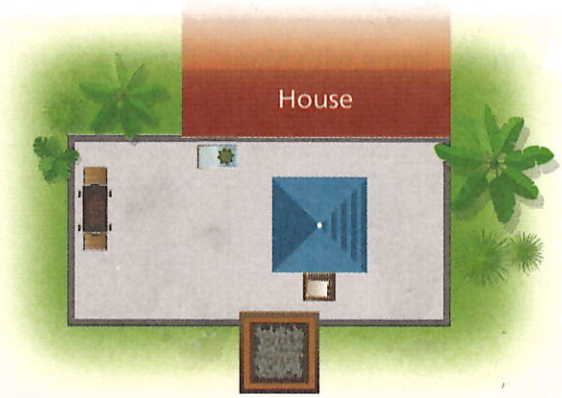
The architect rotates the umbrella 90° counterclockwise.

A **rotation** is a transformation that turns a figure around a fixed point, called the center of rotation.



The **angle of rotation** is the number of degrees the figure rotates. A positive angle of rotation turns the figure counterclockwise.

The umbrella has been rotated about its center. The umbrella has the same size, shape, and orientation.



Try It!

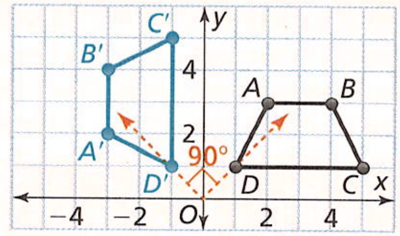
The architect continues to rotate the umbrella in a counterclockwise direction until it is in its original position. What is the angle of this rotation?

Convince Me! How does an image compare to its preimage after a –45° rotation?

EXAMPLE 2 Complete a Rotation

ACTIVITY ASSESS

What are the coordinates of the image of trapezoid *ABCD* after a 90° rotation about the origin?



STEP 1 Draw a ray from the origin to point D. Then use a protractor to draw a 90° angle in the counterclockwise direction.

STEP 2 Plot point D' the same distance from the origin as point D.

STEP 3 Use the same method to map each vertex of trapezoid $ABCD$ to its image. Draw trapezoid $A'B'C'D'$.

$A(2, 3) \rightarrow A'(-3, 2)$

$B(4, 3) \rightarrow B'(-3, 4)$

$C(5, 1) \rightarrow C'(-1, 5)$

$D(1, 1) \rightarrow D'(-1, 1)$

Generalize The x- and y-coordinates of a point change as shown in the table below when rotated in a counterclockwise direction about the origin.

Angle of Rotation	Rule
90°	$(x, y) \rightarrow (-y, x)$
180°	$(x, y) \rightarrow (-x, -y)$
270°	$(x, y) \rightarrow (y, -x)$

Try It!

The coordinates of the vertices of quadrilateral $HIJK$ are $H(1, 4)$, $I(3, 2)$, $J(-1, -4)$, and $K(-3, -2)$. If quadrilateral $HIJK$ is rotated 270° about the origin, what are the vertices of the resulting image, quadrilateral $H'I'J'K'$?

EXAMPLE 3 Describe a Rotation

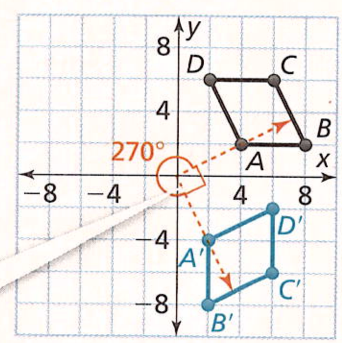
Describe the rotation that maps parallelogram *ABCD* to parallelogram *A'B'C'D'*.

STEP 1 Draw rays from the origin through point A and point A'.

STEP 2 Measure the angle formed by the rays.

A 270° rotation about the origin maps parallelogram $ABCD$ to parallelogram $A'B'C'D'$.

This rotation could also be described as a −90°, or 90° clockwise, rotation.



Try It!

Describe the rotation that maps $\triangle FGH$ to $\triangle F'G'H'$.