

4.3 Start Thinking

On a computer with a word processor, use 18-point Arial font to type the capital letters of the alphabet, putting a space between each letter.

Which letter is symmetric when you rotate the paper 90 degrees? Which letters are symmetric when you rotate the paper 180 degrees? Are any letters not symmetric when you rotate the paper 360 degrees?

4.3 Warm Up

Rotate point P counterclockwise about the origin by the given angle. State the coordinates of P' .

1. $P(4, 2); 90^\circ$
2. $P(3, 0); 90^\circ$
3. $P(6, 0); 180^\circ$
4. $P(2, 6); 180^\circ$
5. $P(-2, 0); 270^\circ$
6. $P(4, 0); 270^\circ$

4.3 Cumulative Review Warm Up

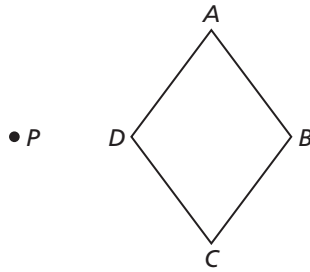
State the name of the property.

1. For any segment AB , $\overline{AB} \cong \overline{AB}$.
2. If $\angle A \cong \angle B$, then $\angle B \cong \angle A$.

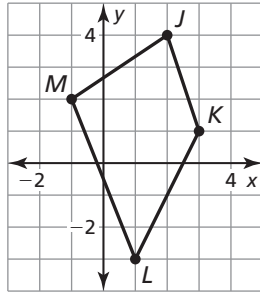
4.3

Practice A

- Trace the polygon and point P . Then draw a 60° rotation of the polygon about point P .



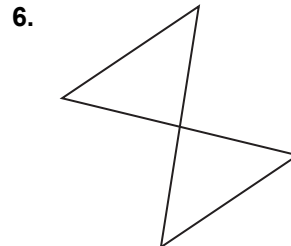
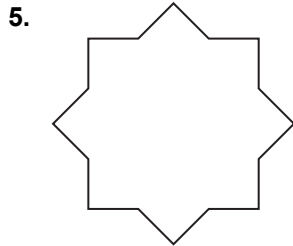
- Graph the polygon and its image after a 270° rotation about the origin.



In Exercises 3 and 4, graph $\triangle RST$ with vertices $R(2, 3)$, $S(-2, 1)$, and $T(-1, 5)$ and its image after the composition.

- | | |
|--|--|
| <ol style="list-style-type: none"> Translation: $(x, y) \rightarrow (x - 2, y - 1)$
Rotation: 90° about the origin | <ol style="list-style-type: none"> Reflection: in the line $x = y$
Rotation: 180° about the origin |
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In Exercises 5 and 6, determine whether the figure has rotational symmetry. If so, describe any rotations that map the figure onto itself.

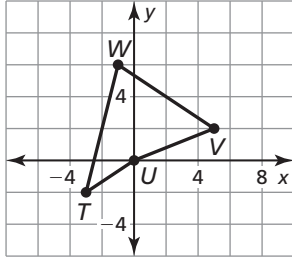


- Draw \overline{AB} with points $A(2, 0)$ and $B(0, 2)$. Rotate the segment 90° counterclockwise about point A . Then rotate the two segments 180° about the origin. What geometric figure did you create using the original segment and its images?
- List the uppercase letters of the alphabet that have rotational symmetry, and state the angle of the symmetry.

4.3

Practice B

- Graph the polygon and its image after a 90° rotation about the origin.

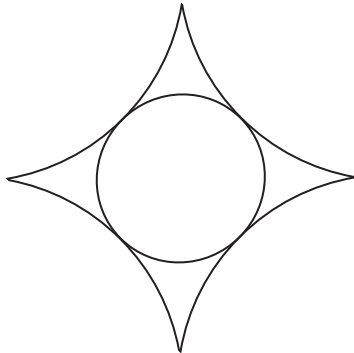


In Exercises 2 and 3, graph $\triangle CDE$ with vertices $C(-1, -3)$, $D(4, 2)$, and $E(-5, -1)$ and its image after the composition.

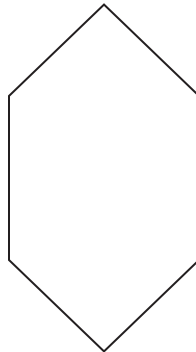
- | | |
|---|--|
| <ol style="list-style-type: none"> Rotation: 180° about the origin
Translation: $(x, y) \rightarrow (x + 3, y + 1)$ | <ol style="list-style-type: none"> Reflection: in the line $x = y$
Rotation: 270° about the origin |
|---|--|

In Exercises 4 and 5, determine whether the figure has rotational symmetry. If so, describe any rotations that map the figure onto itself.

4.



5.



- Is it possible to have an object that does not have 360° of rotational symmetry? Explain your reasoning.
- A figure that is rotated 60° is mapped back onto itself. Does the figure have rotational symmetry? Explain. How many times can you rotate the figure before it is back where it started?
- Your friend claims that he can do a series of translations on any geometric object and get the same result as a rotation. Is your friend correct?
- Your friend claims that she can do a series of reflections on any geometric object and get the same result as a rotation. Is your friend correct?
- List the digits from 0–9 that have rotational symmetry, and state the angle of the symmetry.

4.3 Enrichment and Extension

Rotations

In Exercises 1–4, rotate the line the given number of degrees about the given point. Write the equation of the image.

1. $y = \frac{3}{2}x - 3$; 90° ; x -intercept

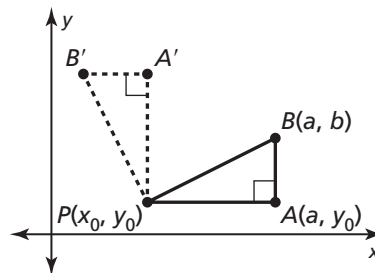
2. $y = -x + 8$; 180° ; x -intercept

3. $3x + 2y = 6$; 90° ; y -intercept

4. $y = 2x + 5$; 180° ; y -intercept

5. In the diagram, A' and B' are the images of A and B after a 90° rotation about point P .

- Find the coordinates of A' .
- Find the coordinates of B' .
- The point $(-6, 1)$ is rotated 90° about $(2, 1)$. What are the coordinates of the image point?
- The point $(2, -5)$ is rotated 90° about $(-3, 7)$. What are the coordinates of the image of the point?



6. The endpoints of \overline{FG} are $F(1, 2)$ and $G(3, 4)$. Graph $\overline{F'G'}$ and $\overline{F''G''}$ after the given rotations.
- Rotation:** 90° about the origin; **Rotation:** 180° about $(0, 4)$
 - Rotation:** 270° about the origin; **Rotation:** 90° about $(-2, 0)$



Puzzle Time

What Did One Parallel Line Say To The Other Parallel Line?

A	B	C	D	E	F
G					

Complete each exercise. Find the answer in the answer column. Write the word under the answer in the box containing the exercise letter.

(1,1) MEET
symmetric AND
rotation WHAT
(a, b) DOWN
(3, -5) SKINNY
(3, -4) NEVER
(b, -a) WE

Complete the sentence.

- A. A _____ is a transformation in which a figure is turned about a fixed point.
- B. When a point (a, b) is rotated counterclockwise about the origin for a rotation of 90° , $(a, b) \rightarrow (\underline{\hspace{1cm}})$.
- C. When a point (a, b) is rotated counterclockwise about the origin for a rotation of 180° , $(a, b) \rightarrow (\underline{\hspace{1cm}})$.
- D. When a point (a, b) is rotated counterclockwise about the origin for a rotation of 270° , $(a, b) \rightarrow (\underline{\hspace{1cm}})$.

Triangle ABC has vertices $A(-3, 5)$, $B(4, 3)$, and $C(-1, 1)$.

Find the vertex of the image after a 270° rotation about the origin.

- E. A'
- F. B'
- G. C'

$(-a, -a)$ STRAIGHT
$(-a, -b)$ SHAME
(5, 3) WILL
$(-1, -1)$ NAMED
$(-b, a)$ A
(0, 0) DEEP
(3, 4) LONG