English Spanish

Topic 1 Transformations

Check It Out
Lesson Tutorials
BigIdeasMath.com

Key Idea

Translations

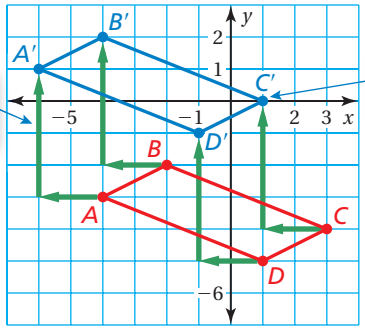
A **translation**, or *slide*, is a transformation in which a figure moves but does not turn. Every point of the figure moves the same distance and in the same direction.

For translations, the original figure and its image have the same size and shape. Figures with the same size and shape are called **congruent figures**.

EXAMPLE 1 Translating a Figure

The vertices of a parallelogram are $A(-4, -3)$, $B(-2, -2)$, $C(3, -4)$, and $D(1, -5)$. Translate the parallelogram 2 units left and 4 units up. What are the coordinates of the image?

Move each vertex 2 units left and 4 units up.



Connect the vertices. Label as A', B', C', and D'.

∴ The coordinates of the image are $A'(-6, 1)$, $B'(-4, 2)$, $C'(1, 0)$, and $D'(-1, -1)$.

Practice

The vertices of a triangle are $P(-2, 2)$, $Q(1, 4)$, and $R(1, 1)$. Draw the triangle and its image after the translation. Find the coordinates of the image.

1. 6 units up
2. 2 units right
3. 1 unit left and 4 units up
4. 3 units right and 5 units down
5. **OPEN-ENDED** Draw a parallelogram $ABCD$ in a coordinate plane.
   - **a.** Name the parallel sides.
   - **b.** Translate the parallelogram to a different location in the coordinate plane.
   - **c.** Do the sides in part (a) remain parallel after the translation? Explain your reasoning.

Multi-Language Glossary at BigIdeasMath.com

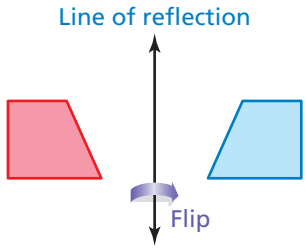
English Spanish

Key Idea

Reflections

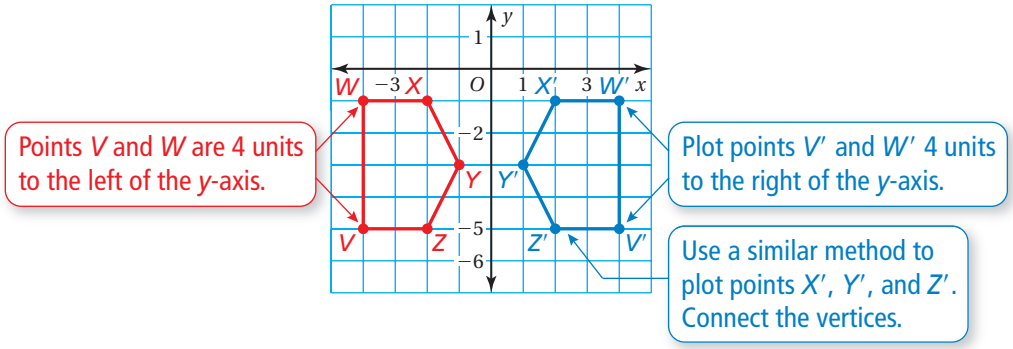
A **reflection**, or *flip*, is a transformation in which a figure is reflected in a line called the *line of reflection*. A reflection creates a mirror image of the original figure.

For reflections, the original figure and its image are congruent.



EXAMPLE 2 Reflecting a Figure

The vertices of a pentagon are $V(-4, -5)$, $W(-4, -1)$, $X(-2, -1)$, $Y(-1, -3)$, and $Z(-2, -5)$. Reflect the pentagon in the y-axis. What are the coordinates of the image?



∴ The coordinates of the image are $V'(4, -5)$, $W'(4, -1)$, $X'(2, -1)$, $Y'(1, -3)$, and $Z'(2, -5)$.

Practice

Find the coordinates of the figure after reflecting in the x-axis.

6. $A(-8, 1)$, $B(-3, 4)$, $C(-3, 1)$

7. $L(3, 1)$, $M(3, 4)$, $N(7, 4)$, $P(7, 1)$

Find the coordinates of the figure after reflecting in the y-axis.

8. $W(2, -5)$, $X(3, -3)$, $Y(6, -3)$, $Z(7, -5)$

9. $H(-6, -7)$, $I(-6, -2)$, $J(-3, -3)$, $K(-3, -8)$

10. REASONING The coordinates of a figure and its image are given. Is the reflection in the *x-axis* or the *y-axis*?

$W(2, -3), X(2, -1), Y(4, -1), Z(4, -3) \longrightarrow W'(2, 3), X'(2, 1), Y'(4, 1), Z'(4, 3)$

11. OPEN-ENDED Draw a rectangle $ABCD$ in a coordinate plane. Reflect rectangle $ABCD$ in the x-axis or y-axis.

a. Is angle B congruent to angle B'? Explain your reasoning.

b. Is side CD congruent to side $C'D'$? Explain your reasoning.

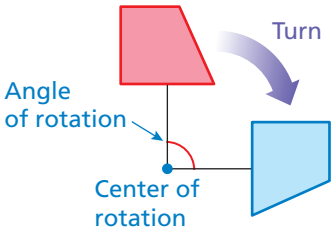
English Spanish

Key Idea

Rotations

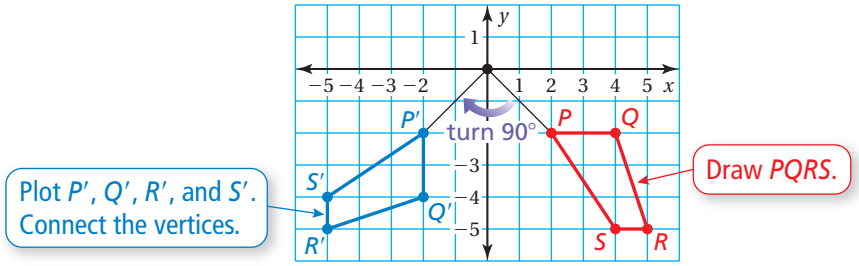
A **rotation**, or *turn*, is a transformation in which a figure is rotated about a point called the *center of rotation*. The number of degrees a figure rotates is the *angle of rotation*.

For rotations, the original figure and its image are congruent.



EXAMPLE 3 Rotating a Figure

The vertices of a trapezoid are $P(2, -2)$, $Q(4, -2)$, $R(5, -5)$, and $S(4, -5)$. Rotate the trapezoid 90° clockwise about the origin. What are the coordinates of the image?



∴ The coordinates of the image are $P'(-2, -2)$, $Q'(-2, -4)$, $R'(-5, -5)$, and $S'(-5, -4)$.

Practice

The vertices of a trapezoid are $L(1, 1)$, $M(2, 4)$, $N(4, 4)$, and $P(5, 1)$. Rotate the trapezoid as described. Find the coordinates of the image.

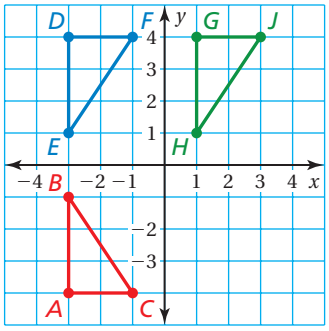
12. 90° clockwise about the origin

13. 180° counterclockwise about the origin

14. **REASONING** A figure is congruent to another figure if you can create the second figure from the first by a sequence of translations, reflections, and rotations.

a. Is triangle ABC congruent to triangle DEF? Explain your reasoning.

b. Is triangle ABC congruent to triangle GHJ? Explain your reasoning.



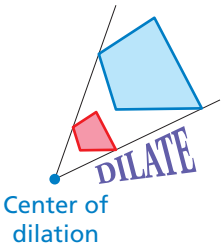
English Spanish

Key Idea

Dilations

A **dilation** is a transformation in which a figure is made larger or smaller with respect to a fixed point called the *center of dilation*.

For dilations, the original figure and its image are similar.



Study Tip

You can check your answer by drawing a line from the origin through each vertex of the original figure. The vertices of the image should lie on these lines.

The ratio of the side lengths of the image to the corresponding side lengths of the original figure is the *scale factor* of the dilation. To dilate a figure in the coordinate plane with respect to the origin, multiply the coordinates of each vertex by the scale factor k.

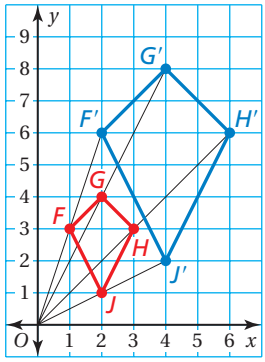
- When $k > 1$, the dilation is called an *enlargement*.
- When $k > 0$ and $k < 1$, the dilation is called a *reduction*.

EXAMPLE 4 Dilating a Figure

Draw the image of quadrilateral *FGHJ* after a dilation with a scale factor of 2. Identify the type of dilation.

Multiply each x- and y-coordinate by the scale factor 2.

Vertices of *FGHJ*	$(x \cdot 2, y \cdot 2)$	Vertices of $F'G'H'J'$
$F(1, 3)$	$(1 \cdot 2, 3 \cdot 2)$	$F'(2, 6)$
$G(2, 4)$	$(2 \cdot 2, 4 \cdot 2)$	$G'(4, 8)$
$H(3, 3)$	$(3 \cdot 2, 3 \cdot 2)$	$H'(6, 6)$
$J(2, 1)$	$(2 \cdot 2, 1 \cdot 2)$	$J'(4, 2)$



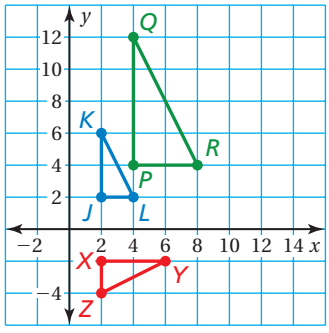
∴ The dilation is an *enlargement* because the scale factor is greater than 1.

Practice

The vertices of a rectangle are $E(2, -4)$, $F(2, -1)$, $G(6, -1)$, and $H(6, -4)$. Dilate the rectangle using the given scale factor. Find the coordinates of the image. Identify the type of dilation.

15. scale factor $= \frac{1}{2}$

16. scale factor $= 3$



17. **REASONING** A figure is similar to another figure if you can create the second figure from the first by a sequence of translations, reflections, rotations, and dilations.

a. Is triangle *XYZ* congruent to triangle *JKL*? Explain your reasoning.

b. Is triangle *XYZ* similar to triangle *PQR*? Explain your reasoning.