3.1 Translations

Learning Target: Translate figures in the coordinate plane.

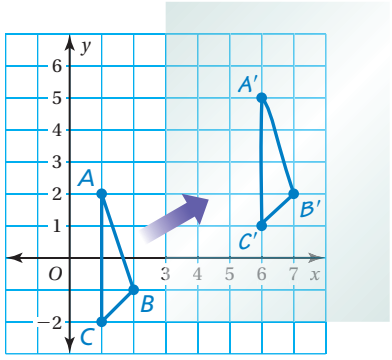
Success Criteria:
- I can identify a translation.
- I can find the coordinates of a translated figure.
- I can use coordinates to translate a figure.

Exploration 1 Sliding Figures

Work with a partner.

a. For each figure below, draw the figure in a coordinate plane. Then copy the figure onto a piece of transparent paper and slide the copy to a new location in the coordinate plane. Describe the location of the copy compared to the location of the original.

- point
- line segment
- line
- triangle
- rectangle



2 MTR MAKE A CONNECTION
How can you use your answer to part (d) to describe what happens to each figure in part (a) when you slide it horizontally a units and vertically b units?

b. When you slide figures, what do you notice about sides, angles, and parallel lines?

c. Describe the location of each point below compared to the point $A(x, y)$.

$B(x + 1, y + 2)$ $C(x - 3, y + 4)$

$D(x - 2, y + 3)$ $E(x + 4, y - 1)$

d. You copy a point with coordinates (x, y) and slide it horizontally a units and vertically b units. What are the coordinates of the copy?

Geometric Reasoning
MA.8.GR.2.3 Describe and apply the effect of a single transformation on two-dimensional figures using coordinates and the coordinate plane.

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3.1 Lesson

Key Vocabulary
transformation, *p. 132*
image, *p. 132*
translation, *p. 132*

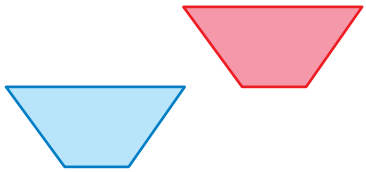
A **transformation** changes a figure into another figure. The new figure is called the **image**.

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

Example 1 Identifying a Translation

Tell whether the blue figure is a translation of the red figure.

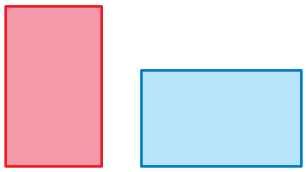
a.



The red figure *slides* to form the blue figure.

▶ So, the blue figure is a translation of the red figure.

b.

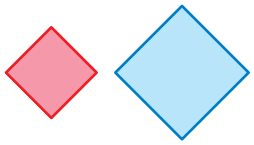


The red figure *turns* to form the blue figure.

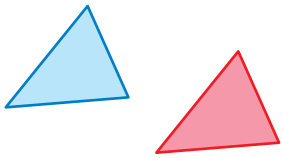
▶ So, the blue figure is *not* a translation of the red figure.

Try It **Tell whether the blue figure is a translation of the red figure.**

1.



2.



Reading

A′ is read "*A* prime." Use *prime* symbols when naming an image.

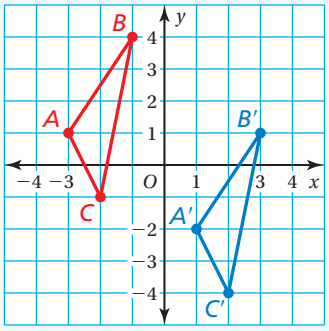
$A \rightarrow A'$
$B \rightarrow B'$
$C \rightarrow C'$

Key Idea

Translations in the Coordinate Plane

Words To translate a figure a units horizontally and b units vertically in a coordinate plane, add a to the x-coordinates and b to the y-coordinates of the vertices.

Positive values of a and b represent translations up and right. Negative values of a and b represent translations down and left.



Algebra $(x, y) \rightarrow (x + a, y + b)$

In a translation, the original figure and its image are identical.

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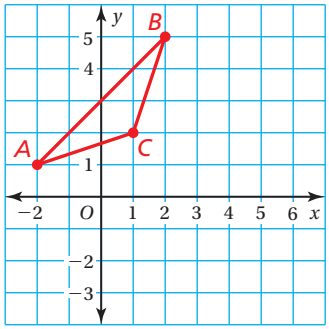
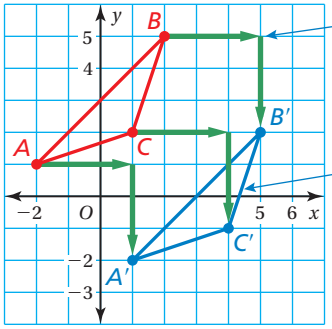
Example 2 Translating a Figure in the Coordinate Plane



Translate the red triangle 3 units right and 3 units down. What are the coordinates of the image?

Method 1: Use a coordinate plane. Move each vertex 3 units right and 3 units down.



▶ The coordinates of the image are $A'(1, -2)$, $B'(5, 2)$, and $C'(4, -1)$.

Method 2: Use coordinates. Add 3 to the x-coordinates of the vertices and add -3, or subtract 3, from the y-coordinates of the vertices.

$$A(-2, 1) \longrightarrow A'(-2 + 3, 1 - 3) \longrightarrow A'(1, -2)$$
$$B(2, 5) \longrightarrow B'(2 + 3, 5 - 3) \longrightarrow B'(5, 2)$$
$$C(1, 2) \longrightarrow C'(1 + 3, 2 - 3) \longrightarrow C'(4, -1)$$

▶ The coordinates of the image are $A'(1, -2)$, $B'(5, 2)$, and $C'(4, -1)$.

Try It

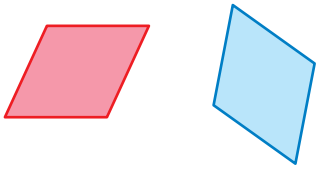
3. WHAT IF? The red triangle is translated 4 units left and 2 units up. What are the coordinates of the image?

In-Class Practice

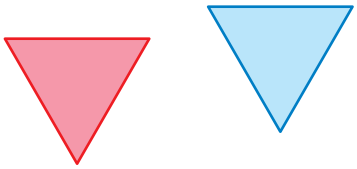
1 I don't understand yet. 2 I can do it with help. 3 I can do it on my own. 4 I can teach someone else.

IDENTIFYING A TRANSLATION Tell whether the blue figure is a translation of the red figure.

4.



5.



6. TRANSLATING A FIGURE The vertices of a triangle are $A(-2, -2)$, $B(0, 2)$, and $C(3, 0)$. Translate the triangle 1 unit left and 2 units up. What are the coordinates of the image?

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Example 3 Modeling Real Life

A landscaper represents a park using a coordinate plane. He draws a square with vertices $A(1, -2)$, $B(3, -2)$, $C(3, -4)$, and $D(1, -4)$ to represent the location of a new fountain. City officials want to move the fountain 4 units left and 6 units up. Find the coordinates of the image. Then draw the original figure and the image in a coordinate plane.

Understand the problem.

You are given the coordinates for the vertices of a fountain. You are asked to find the coordinates after a translation 4 units left and 6 units up, and then graph the original figure and its image in a coordinate plane.

Make a plan.

Use the coordinates of the original figure to calculate the coordinates of the image after the translation. Then graph each figure in a coordinate plane.

Solve and check.

To find the coordinates of the image, subtract 4 from each x-coordinate and add 6 to each y-coordinate.

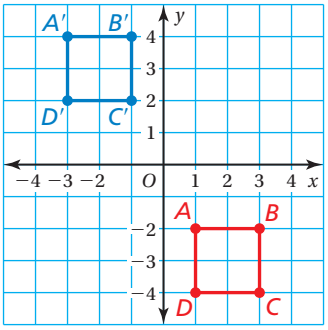
$$(x, y) \longrightarrow (x - 4, y + 6)$$

$A(1, -2) \longrightarrow A'(1 - 4, -2 + 6) \longrightarrow A'(-3, 4)$

$B(3, -2) \longrightarrow B'(3 - 4, -2 + 6) \longrightarrow B'(-1, 4)$

$C(3, -4) \longrightarrow C'(3 - 4, -4 + 6) \longrightarrow C'(-1, 2)$

$D(1, -4) \longrightarrow D'(1 - 4, -4 + 6) \longrightarrow D'(-3, 2)$

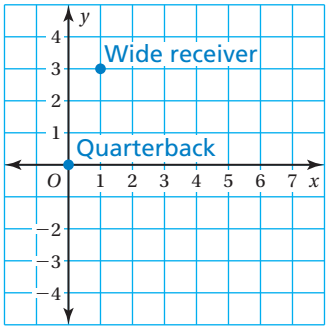


▶ The coordinates of the image are $A'(-3, 4)$, $B'(-1, 4)$, $C'(-1, 2)$, and $D'(-3, 2)$.

Check Counting grid lines in the graph shows that each vertex of the image is translated 4 units left and 6 units up. ✓

In-Class Practice

1 I don't understand yet. 2 I can do it with help. 3 I can do it on my own. 4 I can teach someone else.



7. A neighborhood planner uses a coordinate plane to design a new neighborhood. The coordinates $A(1, -1)$, $B(1, -2)$, and $C(2, -1)$ represent House A, House B, and House C. The planner decides to place a playground centered at the origin, and moves the houses to make space. House A is now located at $A'(3, -4)$. What are the new coordinates of House B and House C when each house is moved using the same translation? Justify your answer.

8. The locations of a quarterback and a wide receiver on a football field are represented in a coordinate plane. The quarterback throws the football to the point $(6, -2)$. Use a translation to describe a path the wide receiver can take to catch the pass.

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3.1 Practice WITH CalcChat® AND CalcView®

Review & Refresh

Solve the inequality.

1. $4x - 2 > 10$

2. $17 \leq \frac{1}{3}z + 5$

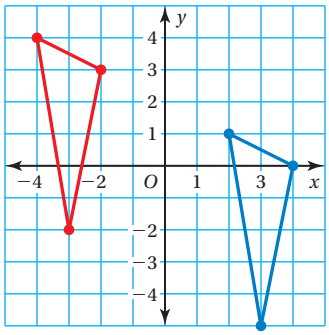
3. $-\frac{2}{5}b - 7 \geq 21$

4. You put $550 in an account that earns 4.4% simple interest per year. How much interest do you earn in 6 months?

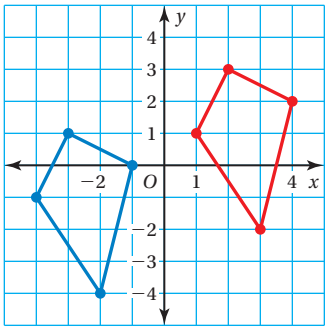
Concepts, Skills, & Problem Solving

DESCRIBING RELATIONSHIPS **For each figure, describe the location of the blue figure relative to the location of the red figure.** (See Exploration 1.)

5.

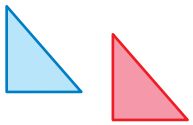


6.

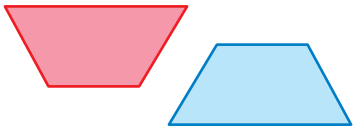


IDENTIFYING A TRANSLATION **Tell whether the blue figure is a translation of the red figure.** (See Example 1.)

7.



8.



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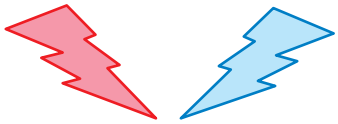

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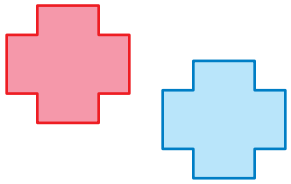
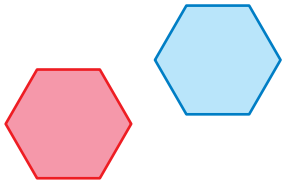
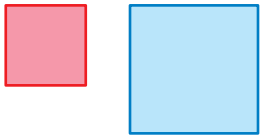


11.



12.



TRANSLATING A FIGURE **The vertices of a triangle are $L(0, 1)$, $M(1, -2)$, and $N(-2, 1)$. Draw the figure and its image after the translation.**

13. 1 unit left and 6 units up

14. 5 units right

15. $(x + 2, y + 3)$

16. $(x - 3, y - 4)$

1 MTR

17. **HELP A CLASSMATE** Your friend wants to translate point A 2 units down and 1 unit right. Explain how your friend can complete the work.

$A(3, 1) \rightarrow A'(3 \quad , 1 \quad) \rightarrow A'(\quad , \quad)$

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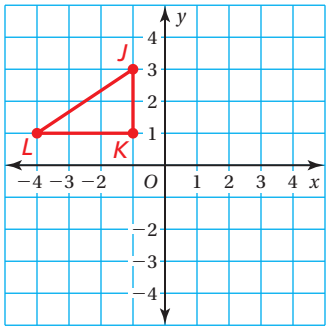
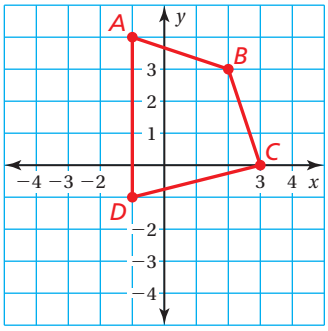
18. TRANSLATING A FIGURE
Translate the triangle 4 units right and 3 units down. What are the coordinates of the image? (See Example 2.)



19. TRANSLATING A FIGURE
Translate the figure 2 units left and 4 units down. What are the coordinates of the image?



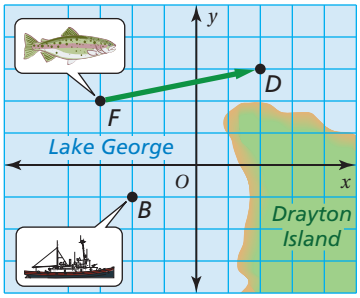
DESCRIBING A TRANSLATION **Describe the translation of the point to its image.**

20. $(3, -2) \rightarrow (1, 0)$

21. $(-8, -4) \rightarrow (-3, 5)$

22. REASONING You can click and drag an icon on a computer's desktop. Is this an example of a translation? Explain.

23. MODELING REAL LIFE The proposed location for a new oil platform is represented in a coordinate plane by a rectangle with vertices $A(1, -3)$, $B(1, 4)$, $C(4, 4)$, and $D(4, -3)$. An inspector recommends moving the oil platform 4 units right and 2 units down. Find the coordinates of the image. Then draw the original figure and the image in the coordinate plane. (See Example 3.)



24. PROBLEM SOLVING A school of fish translates from point F to point D.

a. Describe the translation of the school of fish.

b. Can the fishing boat make the same translation? Explain.

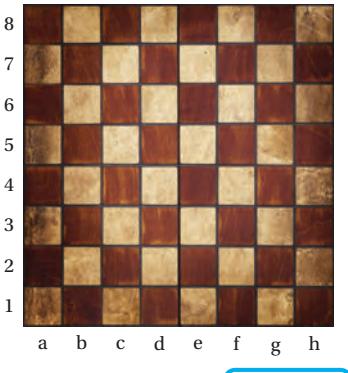
c. Describe a translation the fishing boat could make to get to point D.

25. REASONING The vertices of a triangle are $A(0, -3)$, $B(2, -1)$, and $C(3, -3)$. You translate the triangle 5 units right and 2 units down. Then you translate the image 3 units left and 8 units down. Is the original triangle identical to the final image? Explain your reasoning.

26. Dig Deeper In chess, a knight can move only in an L-shaped pattern:

- *two* vertical squares, then *one* horizontal square;
- *two* horizontal squares, then *one* vertical square;
- *one* vertical square, then *two* horizontal squares; or
- *one* horizontal square, then *two* vertical squares.

Write a series of translations to move the knight from g8 to g5.



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