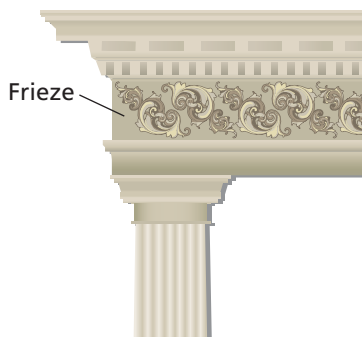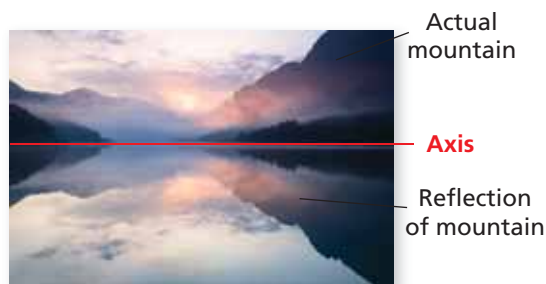**Essential Question** How can you use reflections to classify a frieze pattern?

The Meaning of a Word ● Reflection

When you look at a mountain by a lake, you can see the **reflection**, or mirror image, of the mountain in the lake.

If you fold the photo on its axis, the mountain and its reflection will align.

Actual mountain

Axis

Reflection of mountain

Frieze

A *frieze* is a horizontal band that runs at the top of a building. A frieze is often decorated with a design that repeats.
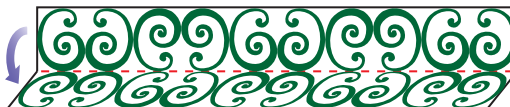
● All frieze patterns are translations of themselves.
● Some frieze patterns are reflections of themselves.
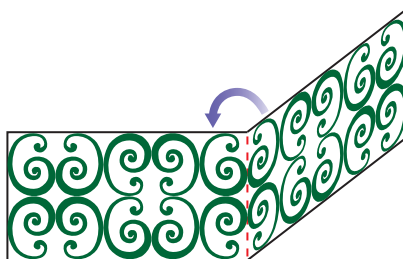
1 ACTIVITY: Frieze Patterns and Reflections

Work with a partner. Consider the frieze pattern shown.
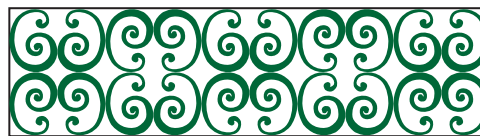
a. Is the frieze pattern a reflection of itself when folded horizontally? Explain.

b. Is the frieze pattern a reflection of itself when folded vertically? Explain.

COMMON CORE

Geometry
In this lesson, you will
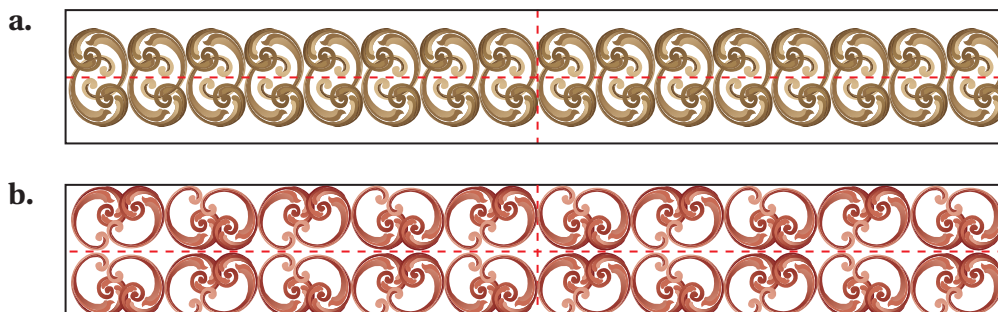● identify reflections.
● reflect figures in the *x*-axis or the *y*-axis of the coordinate plane.
Learning Standards
8.G.1
8.G.2
8.G.3

2 ACTIVITY: Frieze Patterns and Reflections

Work with a partner. Is the frieze pattern a reflection of itself when folded *horizontally*, *vertically*, or *neither*?

a.

b.

3 ACTIVITY: Reflecting in the Coordinate Plane

Work with a partner.

Math Practice 7

Look for Patterns

What do you notice about the vertices of the original figure and the image? How does this help you determine whether the figures are congruent?

a. Draw a rectangle in Quadrant I of a coordinate plane. Find the dimensions of the rectangle.

b. Copy the axes and the rectangle onto a piece of transparent paper.

Flip the transparent paper once so that the rectangle is in Quadrant IV. Then align the origin and the axes with the coordinate plane.

Draw the new figure in the coordinate plane. List the vertices.

c. Compare the dimensions and the angle measures of the new figure to those of the original rectangle.

d. Are the opposite sides of the new figure still parallel? Explain.

e. Can you conclude that the two figures are congruent? Explain.

f. Flip the transparent paper so that the original rectangle is in Quadrant II. Draw the new figure in the coordinate plane. List the vertices. Then repeat parts (c)−(e).

g. Compare your results with those of other students in your class. Do you think the results are true for any type of figure?

What Is Your Answer?

4. **IN YOUR OWN WORDS** How can you use reflections to classify a frieze pattern?
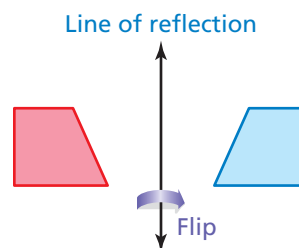
Practice Use what you learned about reflections to complete Exercises 4–6 on page 58.
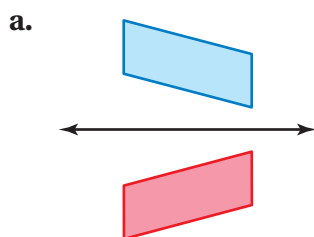
2.3 Lesson

Key Vocabulary 🔊
reflection, *p. 56*
line of reflection,
p. 56

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.
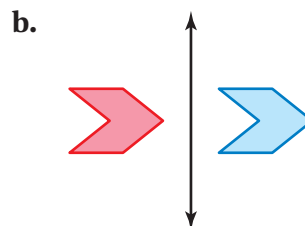
Line of reflection

Flip

EXAMPLE 1 Identifying a Reflection

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

a.

The red figure can be *flipped* to form the blue figure.

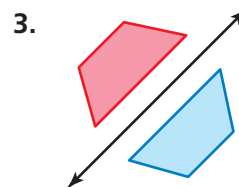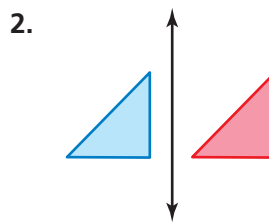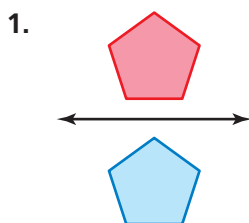⋮ So, the blue figure is a reflection of the red figure.

b.

If the red figure were *flipped*, it would point to the left.

⋮ So, the blue figure is *not* a reflection of the red figure.

On Your Own

Now You're Ready
Exercises 4–9

Tell whether the blue figure is a reflection of the red figure. Explain.
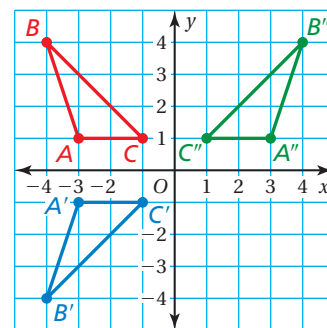
1.

2.

3.

🔑 Key Idea

Reflections in the Coordinate Plane

Words To reflect a figure in the *x*-axis, take the opposite of the *y*-coordinate.

To reflect a figure in the *y*-axis, take the opposite of the *x*-coordinate.

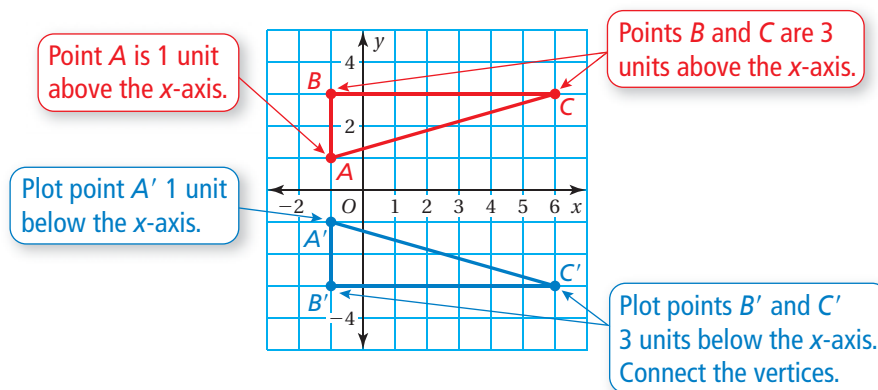**Algebra** Reflection in *x*-axis: $(x, y) \rightarrow (x, -y)$
Reflection in *y*-axis: $(x, y) \rightarrow (-x, y)$

In a reflection, the original figure and its image are congruent.

🔊 Multi-Language Glossary at BigIdeasMath ✓ com
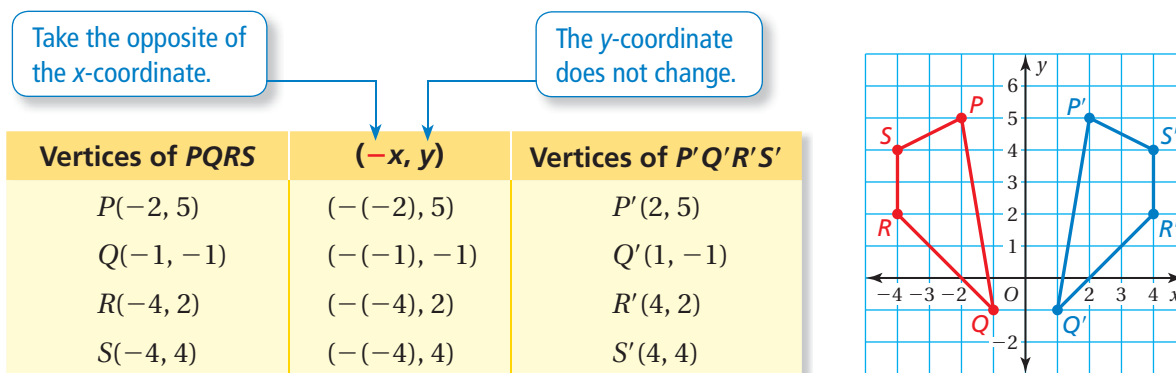
EXAMPLE **2** **Reflecting a Figure in the *x*-axis**

The vertices of a triangle are $A(-1, 1)$, $B(-1, 3)$, and $C(6, 3)$. Draw the figure and its reflection in the *x*-axis. What are the coordinates of the image?

Point *A* is 1 unit above the *x*-axis.

Points *B* and *C* are 3 units above the *x*-axis.

Plot point *A'* 1 unit below the *x*-axis.

Plot points *B'* and *C'* 3 units below the *x*-axis. Connect the vertices.

The coordinates of the image are $A'(-1, -1)$, $B'(-1, -3)$, and $C'(6, -3)$.

EXAMPLE **3** **Reflecting a Figure in the *y*-axis**

The vertices of a quadrilateral are $P(-2, 5)$, $Q(-1, -1)$, $R(-4, 2)$, and $S(-4, 4)$. Draw the figure and its reflection in the *y*-axis.

Take the opposite of the *x*-coordinate.

The *y*-coordinate does not change.

Vertices of *PQRS*	$(-x, y)$	Vertices of *P'Q'R'S'*
$P(-2, 5)$	$(-(-2), 5)$	$P'(2, 5)$
$Q(-1, -1)$	$(-(-1), -1)$	$Q'(1, -1)$
$R(-4, 2)$	$(-(-4), 2)$	$R'(4, 2)$
$S(-4, 4)$	$(-(-4), 4)$	$S'(4, 4)$

The figure and its image are shown at the above right.

On Your Own

Now You're Ready
Exercises 10–17

4. The vertices of a rectangle are $A(-4, -3)$, $B(-4, -1)$, $C(-1, -1)$, and $D(-1, -3)$.

a. Draw the figure and its reflection in the *x*-axis.

b. Draw the figure and its reflection in the *y*-axis.

**c.** Are the images in parts (a) and (b) congruent? Explain.

✓ Vocabulary and Concept Check

1. **WHICH ONE DOESN'T BELONG?** Which transformation does *not* belong with the other three? Explain your reasoning.
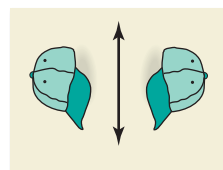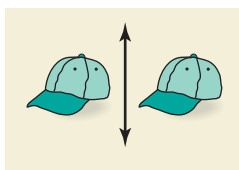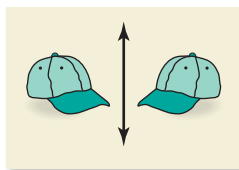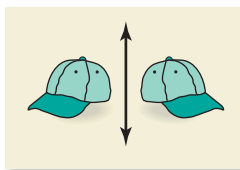
2. **WRITING** How can you tell when one figure is a reflection of another figure?

3. **REASONING** A figure lies entirely in Quadrant I. The figure is reflected in the *x*-axis. In which quadrant is the image?
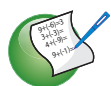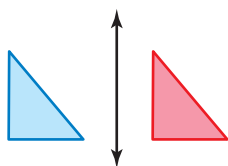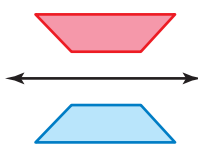
✎ Practice and Problem Solving

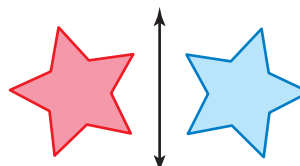**Tell whether the blue figure is a reflection of the red figure.**
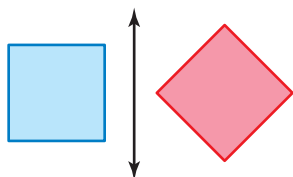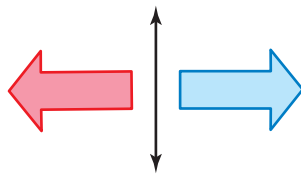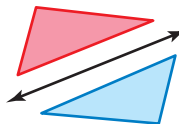
① 4.   5.   6.

7.   8.   9.

Draw the figure and its reflection in the *x*-axis. Identify the coordinates of the image.

② 10. $A(3, 2), B(4, 4), C(1, 3)$ 11. $M(-2, 1), N(0, 3), P(2, 2)$

12. $H(2, -2), J(4, -1), K(6, -3), L(5, -4)$ 13. $D(-2, -1), E(0, -1), F(0, -5), G(-2, -5)$

Draw the figure and its reflection in the *y*-axis. Identify the coordinates of the image.

③ 14. $Q(-4, 2), R(-2, 4), S(-1, 1)$ 15. $T(4, -2), U(4, 2), V(6, -2)$

16. $W(2, -1), X(5, -2), Y(5, -5), Z(2, -4)$ 17. $J(2, 2), K(7, 4), L(9, -2), M(3, -1)$

18. **ALPHABET** Which letters look the same when reflected in the line?

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

The coordinates of a point and its image are given. Is the reflection in the *x*-axis or *y*-axis?
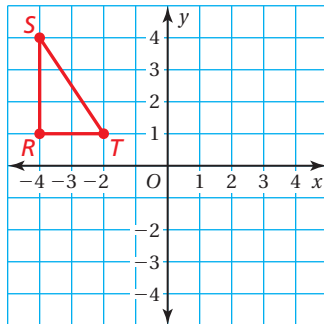
19. $(2, -2) \longrightarrow (2, 2)$

20. $(-4, 1) \longrightarrow (4, 1)$

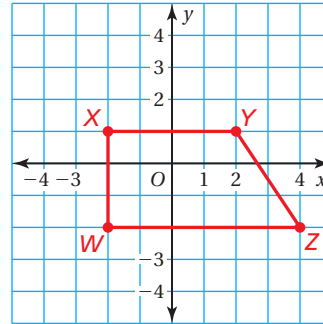**21.** $(-2, -5) \longrightarrow (2, -5)$

22. $(-3, -4) \longrightarrow (-3, 4)$

Find the coordinates of the figure after the transformations.

23. Translate the triangle 1 unit right and 5 units down. Then reflect the image in the *y*-axis.

24. Reflect the trapezoid in the *x*-axis. Then translate the trapezoid 2 units left and 3 units up.

25. **REASONING** In Exercises 23 and 24, is the original figure congruent to the final image? Explain.

26. **NUMBER SENSE** You reflect a point (x, y) in the *x*-axis, and then in the *y*-axis. What are the coordinates of the final image?

27. **EMERGENCY VEHICLE** Hold a mirror to the left side of the photo of the vehicle.

   a. What word do you see in the mirror?

   b. Why do you think it is written that way on the front of the vehicle?

28. **Critical Thinking** Reflect the triangle in the line $y = x$. How are the *x*- and *y*-coordinates of the image related to the *x*- and *y*-coordinates of the original triangle?
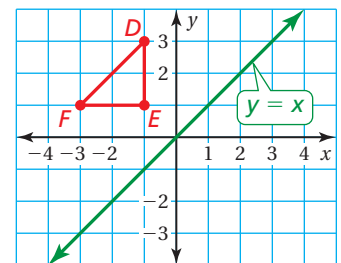
Fair Game Review *What you learned in previous grades & lessons*

Classify the angle as *acute*, *right*, *obtuse*, or *straight*. *(Skills Review Handbook)*

29.

30.

31.

32.

33. **MULTIPLE CHOICE** 36 is 75% of what number? *(Skills Review Handbook)*

   (**A**) 27

   (**B**) 48

   (**C**) 54

   (**D**) 63