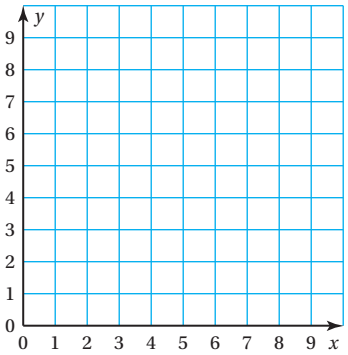
5.5 The Coordinate Plane

Learning Target: Plot and reflect ordered pairs in all four quadrants of a coordinate plane.

Success Criteria:
- I can identify ordered pairs in a coordinate plane.
- I can plot ordered pairs in a coordinate plane and describe their locations.
- I can identify reflections of points in the x-axis or the y-axis.
- I can apply plotting points in all four quadrants to solve real-life problems.

Exploration 1 Extending the Coordinate Plane



Work with a partner. Previously, you plotted points with positive coordinates in a coordinate plane like the one shown. You can also plot points in which one or both of the coordinates are negative numbers.

a. Create ordered pairs with different combinations of positive and negative coordinates, as described below. How can you extend the coordinate plane shown to plot your ordered pairs?

(positive, positive) (negative, positive)

(negative, negative) (positive, negative)

b. How many regions of the coordinate plane are created by the x-axis and y-axis? What do the points in each of these regions have in common?

c. The photo shows the *reflection*, or mirror image, of a mountain in a lake. When you fold the photo on its axis, the mountain and its reflection align.

Plot a point and its *reflection* in one of the axes. Explain your reasoning. What do you notice about the coordinates of the points?

4 MTR COMPARE METHODS

Find a classmate who used a different method to reflect a point. Compare your methods. Which do you prefer?

Geometric Reasoning

MA.6.GR.1.1 Extend previous understanding of the coordinate plane to plot rational number ordered pairs in all four quadrants and on both axes. Identify the x- or y-axis as the line of reflection when two ordered pairs have an opposite x- or y-coordinate.

MA.6.GR.1.3 Solve mathematical and real-world problems by plotting points on a coordinate plane, including finding the perimeter or area of a rectangle.

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5.5 Lesson

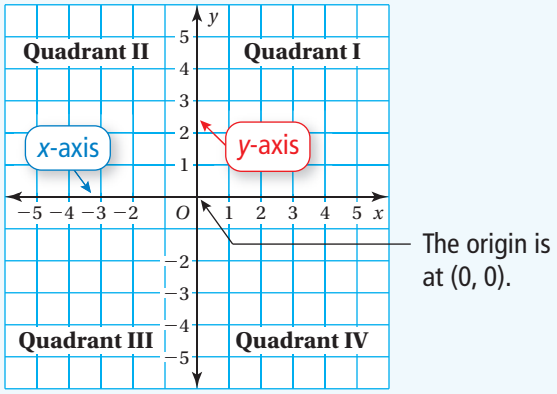
Key Vocabulary
coordinate plane, *p. 224*
origin, *p. 224*
quadrants, *p. 224*

Previously, you plotted points with positive coordinates. Now you will plot points with positive and negative coordinates.

Key Idea

The Coordinate Plane

A **coordinate plane** is formed by the intersection of a horizontal number line and a vertical number line. The number lines intersect at the **origin** and separate the coordinate plane into four regions called **quadrants**.



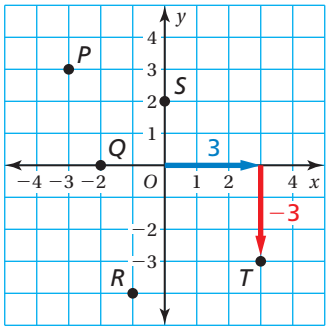
An *ordered pair* is used to locate a point in a coordinate plane.

ordered pair: (4, −2)
x-coordinate
y-coordinate

Example 1 B.E.S.T. Test Prep: Identifying an Ordered Pair

Which ordered pair corresponds to Point *T*?

Ⓐ (−3, −3)
Ⓑ (−3, 3)
Ⓒ (3, −3)
Ⓓ (3, 3)



Point *T* is 3 units to the right of the origin and 3 units down. So, the *x*-coordinate is 3 and the *y*-coordinate is −3.

▶ The ordered pair (3, −3) corresponds to Point *T*. The correct answer is Ⓒ.

Try It **Use the graph in Example 1 to write an ordered pair corresponding to the point.**

1. Point *P* **2.** Point *Q* **3.** Point *R* **4.** Point *S*

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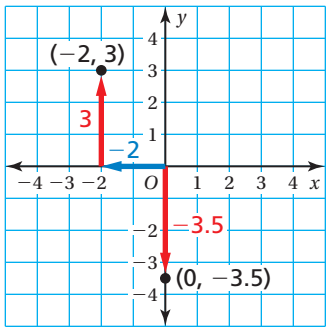
Example 2 Plotting Ordered Pairs



Plot (a) (−2, 3) and (b) (0, −3.5) in a coordinate plane. Describe the location of each point.

a. Start at the origin. Move 2 units left and 3 units up. Then plot the point.

▶ The point is in Quadrant II.

b. Start at the origin. Move 3.5 units down. Then plot the point.

▶ The point is on the *y*-axis.

Try It **Plot the ordered pair in a coordinate plane. Describe the location of the point.**

5. (3, −1) **6.** (−5, 0) **7.** (−2.5, −1) **8.** $\left(-1\frac{1}{2}, \frac{1}{2}\right)$

Key Idea

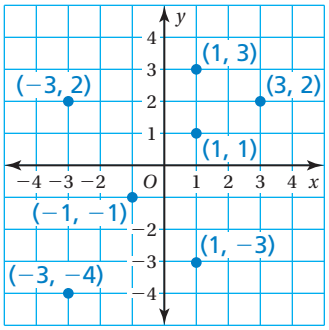
Reflections of Points in Axes

A point can be reflected in a line called the *line of reflection*.

- The reflection of a point in the *x*-axis is a point with the same *x*-coordinate and the opposite *y*-coordinate.
- The reflection of a point in the *y*-axis is a point with the same *y*-coordinate and the opposite *x*-coordinate.

When you reflect a point in an axis, the axis is the line of reflection.

Example 3 Identifying Reflections of Points in Axes



Identify a pair of points that represent a reflection in (a) the *x*-axis and (b) the *y*-axis.

a. The points (1, 3) and (1, −3) have the same *x*-coordinate and opposite *y*-coordinates.

▶ So, (1, 3) and (1, −3) represent a reflection in the *x*-axis.

b. The points (−3, 2) and (3, 2) have the same *y*-coordinate and opposite *x*-coordinates.

▶ So, (−3, 2) and (3, 2) represent a reflection in the *y*-axis.

Try It **Identify a pair of points that represent a reflection in (a) the *x*-axis and (b) the *y*-axis.**

9. (1, 1), (1, −4), (−1, 4), (1, 4), (−2, −4)

10. (−2, 1), (−4, 0), (0, 2), (−2, −1), (0, −4), (4, 0), (3, −1)

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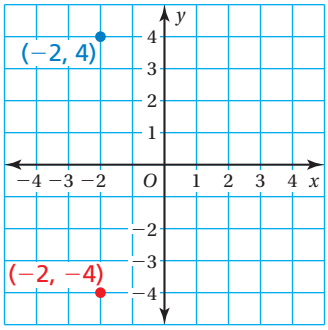
Example 4 Reflecting Points in the *x*-Axis or *y*-Axis

a. Reflect $(-2, 4)$ in the *x*-axis.

Plot $(-2, 4)$.

To reflect $(-2, 4)$ in the *x*-axis, use the same *x*-coordinate, -2, and take the opposite of the *y*-coordinate. The opposite of 4 is -4.

▶ So, the reflection of $(-2, 4)$ in the *x*-axis is $(-2, -4)$.

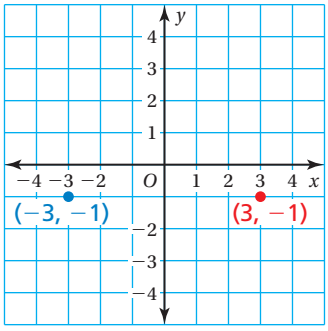


b. Reflect $(-3, -1)$ in the *y*-axis.

Plot $(-3, -1)$.

To reflect $(-3, -1)$ in the *y*-axis, use the same *y*-coordinate, -1, and take the opposite of the *x*-coordinate. The opposite of -3 is 3.

▶ So, the reflection of $(-3, -1)$ in the *y*-axis is $(3, -1)$.

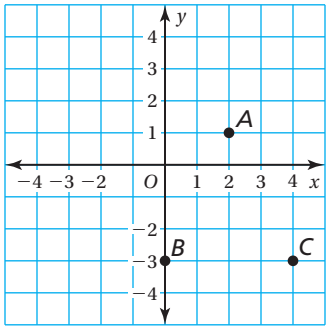


Try It **Reflect the point in (a) the *x*-axis and (b) the *y*-axis.**

11. $(3, -2)$ **12.** $(4, 0)$ **13.** $(-5, 1.5)$

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.



WRITING ORDERED PAIRS **Write an ordered pair corresponding to the point shown in the coordinate plane.**

14. Point *A* **15.** Point *B* **16.** Point *C*

PLOTTING ORDERED PAIRS **Plot the ordered pair in a coordinate plane. Describe the location of the point.**

17. $J(2, 5)$ **18.** $K(4, -6)$ **19.** $L\left(-3, -2\frac{1}{2}\right)$

REFLECTING POINTS **Reflect the point in the given axis.**

20. $(9, 8)$; *x*-axis **21.** $(-7, 3)$; *y*-axis

22. $(0, -4)$; *y*-axis **23.** $(2.5, -4)$; *x*-axis

24. WRITING Explain how to determine whether an axis is a line of reflection for two given points.

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You can use line graphs to display data that are collected over a period of time. Graphing and connecting the ordered pairs can show patterns or trends in the data. This type of line graph is also called a *time series graph*.

Example 5 Modeling Real Life

7 MTR

A blizzard hits a town at midnight. The table shows the hourly temperatures from midnight to 8:00 A.M. Display the data in a line graph. Then describe the change in temperature over time.

Hours after Midnight, x	0	1	2	3	4	5	6	7	8
Temperature, y	7°F	5°F	3°F	0°F	−1°F	−4°F	−5°F	−2°F	2°F

Write the ordered pairs.

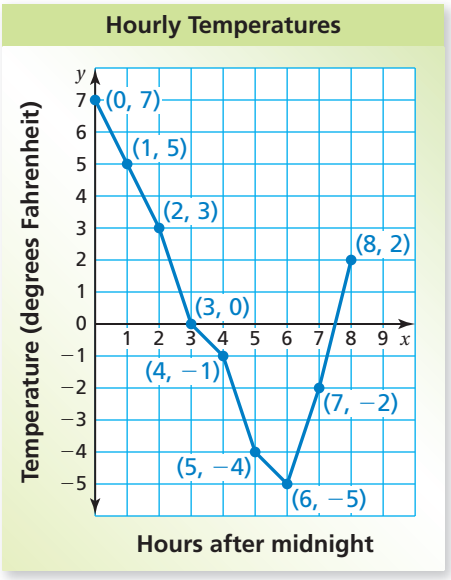
$(0, 7)$ $(1, 5)$ $(2, 3)$

$(3, 0)$ $(4, -1)$ $(5, -4)$

$(6, -5)$ $(7, -2)$ $(8, 2)$

Plot and label the ordered pairs. Then connect the ordered pairs with line segments.

▶ The hourly temperatures decrease from midnight to 6:00 A.M. and then increase from 6:00 A.M. to 8:00 A.M.



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.

25. At a park, the welcome center is located at $(0, 0)$, the theater is located at $(2, 4)$, and the restrooms are located at $(-4.5, 6)$. The snack bar is exactly halfway between the welcome center and the theater. Graph each location in a coordinate plane.

26. The table shows the elevations of a submarine each hour from noon to 5:00 P.M. Display the data in a line graph. Then describe the change in elevation over time.

Hours after Noon, x	0	1	2	3	4	5
Elevation (kilometers), y	−4.5	−3	−2.5	−2	−3.5	−4

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5.5 Practice WITH CalcChat® AND CalcView®

Review & Refresh

Find the absolute value.

1. $|35|$ **2.** $|-18|$ **3.** $|4.7|$ **4.** $\left|-6\frac{7}{12}\right|$

5. What is the ratio of ducks to swans?

Divide.

6. $50.45 \div 5$ **7.** $15.63 \div 0.4$ **8.** $76.3 \div 2.8$

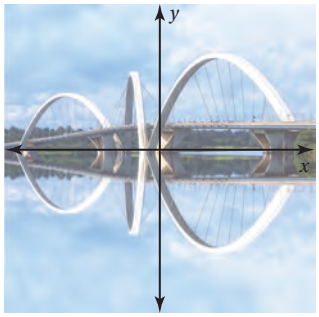
Evaluate the expression. Write the answer in simplest form.

9. $\frac{1}{2} + \frac{3}{8}$ **10.** $\frac{7}{10} - \frac{2}{5}$ **11.** $\frac{4}{7} - \frac{1}{3}$ **12.** $\frac{5}{6} + \frac{3}{4}$

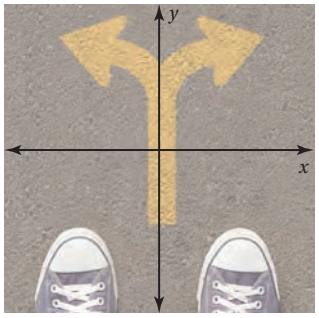
Concepts, Skills, & Problem Solving

DESCRIBING REFLECTIONS Describe the reflection shown in the image.
(See Exploration 1.)

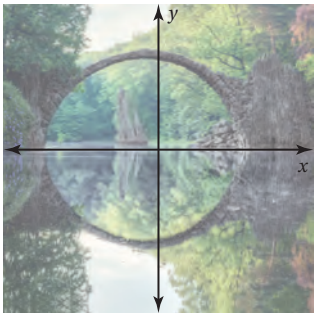
13.



14.



15.



WRITING ORDERED PAIRS Write an ordered pair corresponding to the point. (See Example 1.)

16. Point A

17. Point B

18. Point C

19. Point D

20. Point E

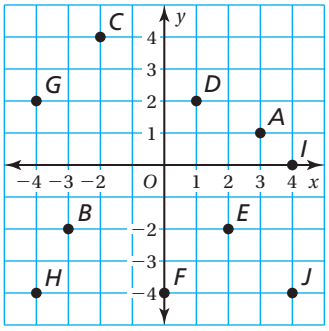
21. Point F

22. Point G

23. Point H

24. Point I

25. Point J



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PLOTTING ORDERED PAIRS **Plot the ordered pair in a coordinate plane. Describe the location of the point.** (See Example 2.)

26. $K(4, 3)$ ▶ **27.** $L(-1, 2)$ **28.** $M(0, -6)$ **29.** $N(3, -7)$

30. $P(-5, -9)$ **31.** $W\left(2\frac{1}{2}, 0\right)$ **32.** $S(-1.5, 0)$ **33.** $T(3.5, -1.5)$

4 MTR **YOU BE THE TEACHER** **Your friend describes how to plot the point. Is your friend correct? Explain your reasoning.**

34.

> To plot (4, 5), start at (0, 0) and move 4 units up and 5 units right.

35.

> To plot (−6, 3), start at (0, 0) and move 6 units left and 3 units up.

7 MTR **MODELING REAL LIFE** **In Exercises 36–40, use the map of the zoo.**

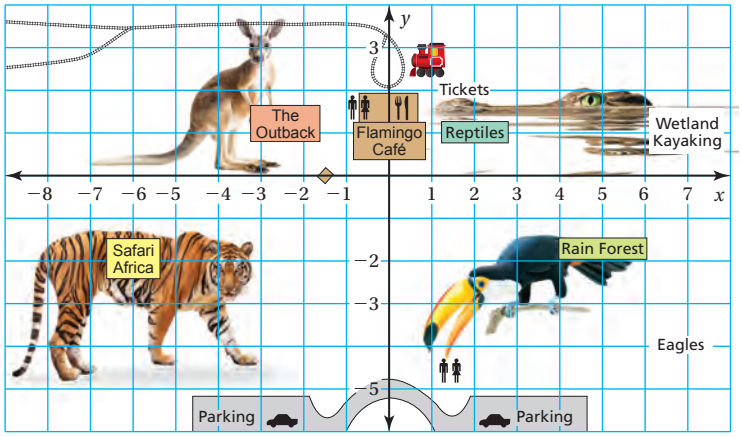
36. Which exhibit is located at (2, 1)?

37. Name an attraction on the positive y-axis.

38. Is parking available in Quadrant II? If not, name a quadrant in which you can park.

39. Write two different ordered pairs that represent the location of the Rain Forest.

40. Which exhibit is closest to (−8, −3)?

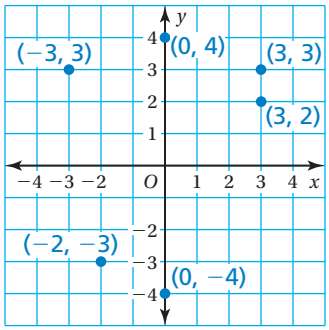


IDENTIFYING REFLECTIONS OF POINTS IN AXES **Identify a pair of points that represent a reflection in (a) the x-axis and (b) the y-axis.** (See Example 3.)

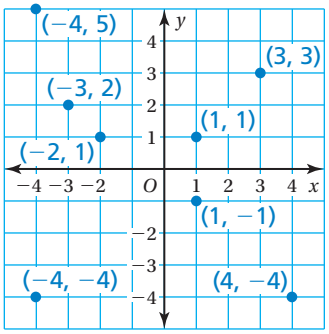
41. (7, 3), (1, 1), (7, −3), (0, 0), (−1, 1) **42.** (2, 3), (1, 1), (1, 3), (1, −3), (−2, 3)

▶ **43.** (0.5, 1), (4, 1), (0.5, −1), (0, 8), (−4, 1) **44.** (3, −2), (1, −7), (−3, −2), (3, 1), (1, 7), (1, 3)

45.



46.



REFLECTING POINTS IN THE X-AXIS OR Y-AXIS **Reflect the point in (a) the x-axis and (b) the y-axis.** (See Example 4.)

47. (3, 2) **48.** (−4, 4) ▶ **49.** (−5, −6) **50.** (4, −7)

51. (−9, 3) **52.** (0, −1) **53.** (2.5, 4.5) **54.** $\left(-5\frac{1}{2}, 3\right)$

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REASONING **Describe the possible location(s) of the point (x, y).**

55. $x > 0, y > 0$ **56.** $x < 0, y < 0$ **57.** $x > 0, y < 0$

58. $x > 0$ **59.** $y < 0$ **60.** $x = 0, y = 0$

4 MTR **DISCUSS MATHEMATICAL THINKING** **Tell whether the statement is *always*, *sometimes*, or *never* true. Explain your reasoning.**

61. The x-coordinate of a point on the x-axis is zero.

62. The y-coordinates of points in Quadrant III are positive.

63. The x-coordinate of a point in Quadrant II has the same sign as the y-coordinate of a point in Quadrant IV.

7 MTR **64.** **MODELING REAL LIFE** The table shows the number of miniature satellites launched from 2010–2019. Display the data in a line graph. Then describe the change in the number of minature satellites launched over time. (See Example 5.)

Years after 2010, x	0	1	2	3	4	5	6	7	8	9
Miniature Satellite Launches, y	19	12	25	88	142	129	88	297	244	188

7 MTR **65.** **MODELING REAL LIFE** The table shows the amount of carbon dioxide emissions of a country, relative to an environmental standard, each year for 7 years. Display the data in a line graph. Then describe the change in carbon dioxide emissions over time.

Year, x	1	2	3	4	5	6	7
Carbon Dioxide Emissions (millions of metric tons), y	0.6	−0.2	−1.2	1.2	0.8	1	−0.6

6 MTR **66.** **ASSESS REASONABLENESS** The table shows the total miles run through each of 17 weeks for a 10K training program.

Week	1	2	3	4	5	6	7	8	9
Total Miles	22	46	72	96	124	151	181	211	244

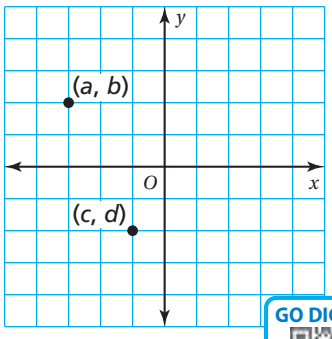
Week	10	11	12	13	14	15	16	17	18
Total Miles	279	317	357	397	437	473	506	530	?

a. Create a table for the distance run during each week of training.

b. Display the data from part (a) in a line graph.

c. Your friend estimates 610 total miles were run through the 18th week. Is your friend's estimate reasonable? Explain.

5 MTR **67.** **STRUCTURE** Two points are plotted in the coordinate plane. Plot each of the following ordered pairs in the same coordinate plane.



a. $P(a, -b)$ **b.** $Q(-a, b)$ **c.** $R(c, -d)$

d. $S(-c, -d)$ **e.** $T(c, -a)$ **f.** $U(-d, -b)$

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