Lesson 1-6
Ordered Pairs and Relations

Interactive Study Guide

See pages 17–18 for:
- Getting Started
- Vocabulary Start-Up
- Notes

Essential Question

How can you use numbers and symbols to represent mathematical ideas?

Common Core State Standards

Content Standards
Preparation for 7.RP.2a, 7.RP.2b, 7.RP.2d, 8.EE.5

Mathematical Practices
1, 3, 4

Vocabulary

coordinate system
coordinate plane
y-axis
origin
x-axis
ordered pair
x-coordinate
y-coordinate
graph
relation
domain
range

What You'll Learn

- Use ordered pairs to locate points.
- Use graphs to represent relations.

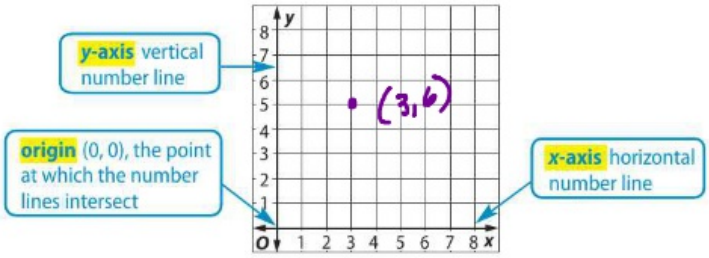
Real-World Link

Bungee Jumping People bungee jump from bridges, from cliffs, and even into volcanoes! The table describes four bungee jumping sites and the approximate heights and times of the jumps. There are different ways to represent this information.

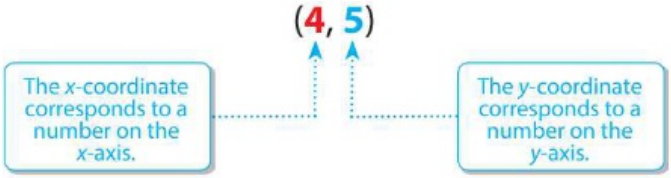
Location	Height (ft)	Time of Fall (s)
Europabrücke, Austria	630	6
Glenns Ferry Bridge, Idaho	170	3
Macau Tower, China	764	7
Navajo Bridge, Arizona	452	5

Ordered Pairs

In mathematics, a **coordinate system** or **coordinate plane** is used to locate points. The coordinate system is formed by the intersection of two number lines that meet at right angles at their zero points.



An **ordered pair** of numbers is used to locate any point on a coordinate plane. The first number is called the ***x*-coordinate**, and the second number is called the ***y*-coordinate**.



Purestock/SuperStock

To **graph** an ordered pair, draw a dot at the point that corresponds to the ordered pair. The coordinates are your directions to locate the point.

Example 1

Tools Tutor

Coordinate Planes
Unless the units are marked otherwise, you can assume that each unit on the *x*-axis and *y*-axis represents 1 unit.

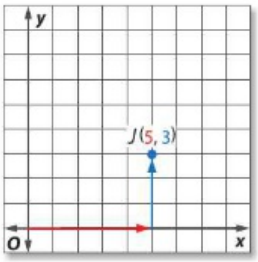
Graph each ordered pair on a coordinate plane.

a. $J(5, 3)$

Step 1 Start at the origin.

Step 2 Since the *x*-coordinate is 5, move 5 units to the right.

Step 3 Since the *y*-coordinate is 3, move 3 units up. Draw a dot.

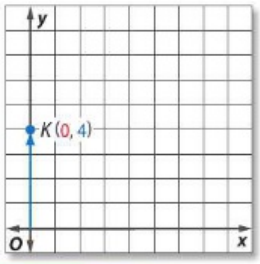


b. $K(0, 4)$

Step 1 Start at the origin.

Step 2 Since the *x*-coordinate is 0, you do not need to move right.

Step 3 Since the *y*-coordinate is 4, move 4 units up. Draw the dot on the axis.



Got It? Do these problems to find out.

1a. $Q(2, 3)$ **1b.** $R(5, 0)$ **1c.** $S\left(3, 1\frac{1}{2}\right)$ **1d.** $T\left(6\frac{1}{2}, 5\frac{1}{2}\right)$

Sometimes a point on a graph is named by using a capital letter. To identify its location, you can write the ordered pair that represents the point.

Example 2

Tutor

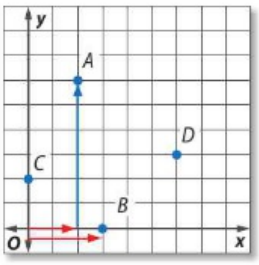
Write the ordered pair that names each point.

a. A

Step 1 Start at the origin.

Step 2 Move right on the *x*-axis to find the *x*-coordinate of point *A*, which is 2.

Step 3 Move up the *y*-axis to find the *y*-coordinate, which is 6.



The ordered pair for point *A* is (2, 6).

b. B

The *x*-coordinate of point *B* is 3, and the *y*-coordinate is 0.

The ordered pair for point *B* is (3, 0).

Got It? Do these problems to find out.

2a. C **2b.** D

Relations

Domain and Range
The domain of a relation is also called the *input*. The range of a relation is also called the *output*.

A set of ordered pairs such as {(2, 3), (3, 5), (4, 1)} is a **relation**. A relation can also be shown in a table or a graph. The **domain** of the relation is the set of *x*-coordinates. The **range** of the relation is the set of *y*-coordinates.

Ordered Pairs

(2, 3)
(3, 5)
(4, 1)

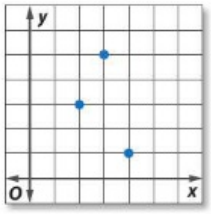
The domain is {2, 3, 4}.

The range is {3, 5, 1}.

Table

x	*y*
2	3
3	5
4	1

Graph



Example 3

Watch Tutor

Express the relation {(0, 2), (1, 4), (2, 5), (3, 8)} as a table. Then determine the domain and range.

x	0	1	2	3
y	2	4	5	8

The domain is {0, 1, 2, 3}, and the range is {2, 4, 5, 8}.

Got It? Do this problem to find out.

3. Express the relation {(2, 4), (0, 3), (1, 4), (1, 1)} as a table. Then determine the domain and range.

Example 4

Real World

Tools Tutor

A seahorse swims at a rate of about 5 feet per hour.

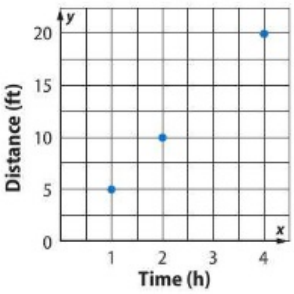
a. Make a table of ordered pairs in which the *x*-coordinate represents the hours and the *y*-coordinate represents the number of feet for 1, 2, and 4 hours.

x	*y*
1	5
2	10
4	20

The points appear to lie in a line.

b. Graph the ordered pairs and describe the graph.

Seahorses



Got It? Do these problems to find out.

4. One square mile is equal to six hundred forty acres.

a. Make a table of ordered pairs in which the *x*-coordinate represents the number of square miles and the *y*-coordinate represents the number of acres in 1, 2, and 3 square miles.

b. Graph the ordered pairs. Then describe the graph.

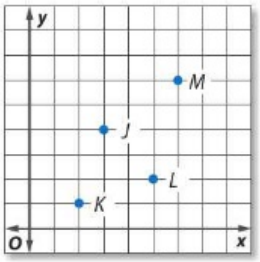
Guided Practice

Check

Graph each ordered pair on a coordinate plane. (Example 1)

1. $F(6, 0)$ **2.** $A(2, 5)$ **3.** $W(4, 1)$ **4.** $Z(0, 1)$

Refer to the coordinate plane shown at the right. Write the ordered pair that names each point. (Example 2)



5. J **6.** K

7. L **8.** M

Express each relation as a table. Then determine the domain and range. (Example 3)

9. $\{(3, 4), (1, 5), (4, 2)\}$

10. $\{(1, 3), (2, 6), (3, 3), (4, 7)\}$

11. One quart is equal to two pints. (Example 4)

a. Make a table of ordered pairs in which the x-coordinate represents the number of quarts and the y-coordinate represents the number of pints in 1, 2, 3, and 4 quarts.

b. Graph the ordered pairs. Then describe the graph.

Independent Practice

Go online for Step-by-Step Solutions

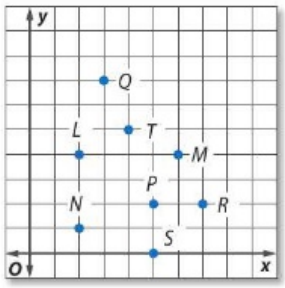
eHelp

Graph each ordered pair on a coordinate plane. (Example 1)

12. $A(4, 7)$ **13.** $B(0, 4)$ **14.** $C(7, 3)$ **15.** $D(3, 4)$

16. $F(6, 1)$ **17.** $G(6, 5)$ **18.** $H(3, 0)$ **19.** $J(2, 2)$

Refer to the coordinate plane shown at the right. Write the ordered pair that names each point. (Example 2)



20. L **21.** M

22. N **23.** P

24. Q **25.** R

26. S **27.** T

Express each relation as a table. Then determine the domain and range. (Example 3)

28. $\{(4, 5), (2, 1), (5, 0), (3, 2)\}$ **29** $\{(0, 2), (2, 2), (4, 1), (3, 5)\}$

30. $\{(6, 0), (4, 5), (2, 1), (3, 1)\}$ **31.** $\{(5, 1), (3, 7), (4, 8), (5, 7)\}$

32. The cost of a mini pizza is \$7 at Pizza Pizza. (Example 4)

a. Make a table of ordered pairs in which the x-coordinate represents the number of mini pizzas and the y-coordinate represents the cost of 1, 3, 5, and 7 mini pizzas at Pizza Pizza.

PIZZAS	1	3	5	7
COST	7	21	35	49

b. Graph the ordered pairs. Then describe the graph.

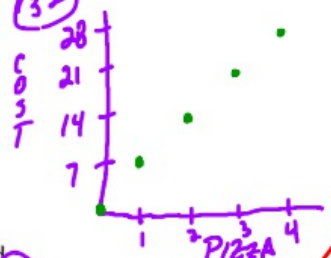
33. Aaron is hiking in a state park. He averages 3 miles per hour. (Example 4)

a. Make a table of ordered pairs in which the x-coordinate represents the number hours and the y-coordinate represents the number of miles hiked in 1, 2, 4, and 6 hours.

TIME	1	2	4	6
DISTANCE	3	6	12	18

b. Graph the ordered pairs.

(32)



34. CCSS **Multiple Representations** In this problem, you will explore more about relations. Suppose Jamal has only 30 minutes to practice the piano and study for a science test.

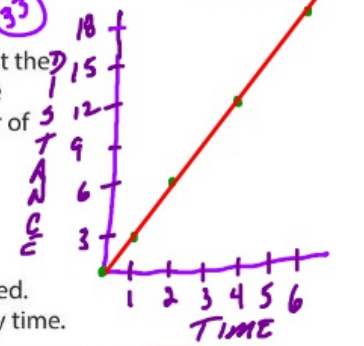
a. Table Make a table of ordered pairs showing at least 6 ways Jamal can split the time between the two activities. Let the x-coordinate and the y-coordinate represent the number of minutes spent playing the piano and the number of minutes spent studying, respectively.

b. Graph Graph the ordered pairs.

c. Words Describe the general pattern of points of your graph.

d. Graph Choose a point on the graph that is *not* one of the points you plotted. Use the coordinates to predict a pair of values for the piano time and study time.

(33)



35 Six students in Mr. Maloney's class made a table of ordered pairs for their height in inches x and their shoe size y.

Height (in.)	58	56	62	60	59	61
Shoe Size	6	$5\frac{1}{2}$	$8\frac{1}{2}$	8	7	$7\frac{1}{2}$

a. Graph the ordered pairs.

b. Compare this graph to the graph in Example 4.

59	60	61
7	$7\frac{1}{2}$	8

36. CCSS **Multiple Representations** The numbers 4, 7, 10, 13, … form an *arithmetic sequence* because each term can be found by adding the same number to the previous term.

Term Number	1	2	3	4
Term	4	7	10	13

a. Numbers Write the set of ordered pairs (term number, term).

b. Graph Graph the ordered pairs.

c. Words Describe the shape of the graph.

d. Words If possible, write a rule to find the twentieth term. Explain how you found the rule or why you cannot write a rule.

H.O.T. Problems Higher Order Thinking

37. CCSS **Reason Abstractly** Write a vocabulary term that completes the following.

A point is to a number line as a(n) ___?___ is to a coordinate grid.

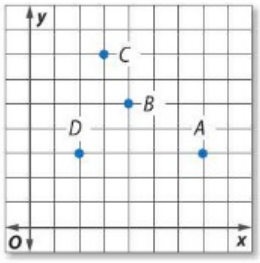
38. CCSS **Persevere with Problems** Describe all of the possible locations for the graph of (x, y) if $x = 2$.

39. CCSS **Justify Conclusions** Refer to Exercises 32 and 33. For which graph would it make more sense to connect the points with line segments? Explain.

40. **Building on the Essential Question** Explain why the point $M(4, 3)$ is different from the point $N(3, 4)$.

Standardized Test Practice

41. On the map of a campsite shown below, the tent is located at (3, 7). Which point represents the location of the tent?



A point *A*
B point *B*
C point *C*
D point *D*

42. Rectangle *ABCD* has vertices *A*(1, 3), B(1, 6), and *C*(5, 6). What are the coordinates of point *D*?

F (6, 5)
G (5, 1)
H (5, 3)
J (6, 1)

43. What is the domain of the relation below?

x	y
1	3
2	4
4	8
6	1
7	4

A {1, 2, 4, 6, 7}
B {1, 3}
C {1, 3, 4, 8}
D {(1, 3), (2, 4), (4, 8), (6, 1), (7, 4)}

44. **Short Response** Point *Z* is located at (4, 7) on a coordinate plane. Point *T* is located 3 units to the right and 4 units down from point *Z*. What is the *x*-coordinate of point *T*?

Common Core Review

Name the property shown by each statement. 7.EE.1

45. $5 \cdot 3 = 3 \cdot 5$

46. $6 \cdot 2 \cdot 0 = 0$

47. $0 + 13 = 13$

48. $(5 + x) + 6 = 5 + (x + 6)$

State whether each conjecture is true. If not, give a counterexample. 7.EE.1

49. Division of whole numbers is associative.

50. Subtraction of whole numbers is commutative.

51. Melinda purchased the items shown in the table. 7.EE.3

a. Write an expression to show the total cost of the items.

b. Suppose the cost of the sweater is $25. How much did she spend in all?

Item	Price ($)
sweater	s
purse	$s + 12$
belt	$s + 4$

a. $s + s + 12 + s + 4 = 3s + 16$

b. $3(25) + 16$
$75 + 16$
$91

Find the value of each expression. 6.EE.2c

52. $x + 7$ if $x = 8$

53. $d - 5$ if $d = 12$

54. $18 + m$ if $m = 4$

55. $f - 12$ if $f = 28$

56. $s + 14$ if $s = 32$

57. $19 - b$ if $b = 5$

Find the value of each expression. 5.OA.1

58. $8 + 12 \times 4 \div 8$

59. $13 - 6 \times 2 + 1$

60. $14 - 2 \times 7 + 0$

61. $30 - 14 \times 2 + 8$

62. $11 + 4 \times (12 - 7)$

63. $(11 - 7) \times 3 - 5$

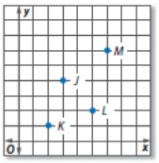
Guided Practice

Check

Graph each ordered pair on a coordinate plane. (Example 1) **1–4. See Answer Appendix.**

1. $F(6, 0)$ **2.** $A(2, 5)$ **3.** $W(4, 1)$ **4.** $Z(0, 1)$

Refer to the coordinate plane shown at the right. Write the ordered pair that names each point. (Example 2)



5. J **(3, 4)** **6.** K **(2, 1)**

7. L **(5, 2)** **8.** M **(6, 6)**

Express each relation as a table. Then determine the domain and range. (Example 3) **9–11. See Answer Appendix.**

9. {(3, 4), (1, 5), (4, 2)}

10. {(1, 3), (2, 6), (3, 3), (4, 7)}

11. One quart is equal to two pints. (Example 4)

a. Make a table of ordered pairs in which the x-coordinate represents the number of quarts and the y-coordinate represents the number of pints in 1, 2, 3, and 4 quarts.

b. Graph the ordered pairs. Then describe the graph.

Independent Practice

Go online for Step-by-Step Solutions

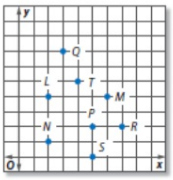
eHelp

Graph each ordered pair on a coordinate plane. (Example 1) **12–19. See Answer Appendix.**

12. $A(4, 7)$ **13.** $B(0, 4)$ **14.** $C(7, 3)$ **15.** $D(3, 4)$

16. $F(6, 1)$ **17.** $G(6, 5)$ **18.** $H(3, 0)$ **19.** $J(2, 2)$

Refer to the coordinate plane shown at the right. Write the ordered pair that names each point. (Example 2)



20. L **(2, 4)** **21.** M **(6, 4)**

22. N **(2, 1)** **23.** P **(5, 2)**

24. Q **(3, 7)** **25.** R **(7, 2)**

26. S **(5, 0)** **27.** T **(4, 5)**

Express each relation as a table. Then determine the domain and range. (Example 3) **28–32. See Answer Appendix.**

28. {(4, 5), (2, 1), (5, 0), (3, 2)} **29.** {(0, 2), (2, 2), (4, 1), (3, 5)}

30. {(6, 0), (4, 5), (2, 1), (3, 1)} **31.** {(5, 1), (3, 7), (4, 8), (5, 7)}

32. The cost of a mini pizza is $7 at Pizza Pizza. (Example 4)

a. Make a table of ordered pairs in which the x-coordinate represents the number of mini pizzas and the y-coordinate represents the cost of 1, 3, 5, and 7 mini pizzas at Pizza Pizza.

b. Graph the ordered pairs. Then describe the graph.

PG 35

33. Aaron is hiking in a state park. He averages 3 miles per hour. (Example 4)

a. Make a table of ordered pairs in which the x-coordinate represents the number hours and the y-coordinate represents the number of miles hiked in 1, 2, 4, and 6 hours. **33–35a. See Answer Appendix.**

b. Graph the ordered pairs.

B 34. **Multiple Representations** In this problem, you will explore more about relations. Suppose Jamal has only 30 minutes to practice the piano and study for a science test.

a. **Table** Make a table of ordered pairs showing at least 6 ways Jamal can split the time between the two activities. Let the x-coordinate and the y-coordinate represent the number of minutes spent playing the piano and the number of minutes spent studying, respectively.

b. **Graph** Graph the ordered pairs.

c. **Words** Describe the general pattern of points of your graph.

d. **Graph** Choose a point on the graph that is *not* one of the points you plotted. Use the coordinates to predict a pair of values for the piano time and study time.

35 Six students in Mr. Maloney's class made a table of ordered pairs for their height in inches x and their shoe size y.

Height (in.)	58	56	62	60	59	61
Shoe Size	6	$5\frac{1}{2}$	$8\frac{1}{2}$	8	7	$7\frac{1}{2}$

a. Graph the ordered pairs.

b. Compare this graph to the graph in Example 4. **Sample answer: 3 times the x-value plus 1 equals the y-value**

36. **Multiple Representations** The numbers 4, 7, 10, 13, … form an *arithmetic sequence* because each term can be found by adding the same number to the previous term.

Term Number	1	2	3	4
Term	4	7	10	13

a. **Numbers** Write the set of ordered pairs (term number, term). **{(1, 4), (2, 7), (3, 10), (4, 13)}**

b. **Graph** Graph the ordered pairs. **See Answer Appendix.**

c. **Words** Describe the shape of the graph. **The graph shows a positive, linear relationship.**

d. **Words** If possible, write a rule to find the twentieth term. Explain how you found the rule or why you cannot write a rule. **Sample answer: 3 times the x-value plus 1 equals the y-value**

H.O.T. Problems Higher Order Thinking

C 37. **Reason Abstractly** Write a vocabulary term that completes the following.

A point is to a number line as a(n) __?__ is to a coordinate grid. **ordered pair**

38. **Persevere with Problems** Describe all of the possible locations for the graph of (x, y) if $x = 2$. **the vertical line where $x = 2$**

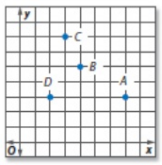
39. **Justify Conclusions** Refer to Exercises 32 and 33. For which graph would it make more sense to connect the points with line segments? Explain. **See Answer Appendix.**

40. **Building on the Essential Question** Explain why the point $M(4, 3)$ is different from the point $N(3, 4)$. **See Answer Appendix.**

PG 36

Standardized Test Practice

41. On the map of a campsite shown below, the tent is located at (3, 7). Which point represents the location of the tent? **C**



A point *A*
B point *B*
C point *C*
D point *D*

42. Rectangle *ABCD* has vertices *A*(1, 3), B(1, 6), and C(5, 6). What are the coordinates of point *D*? **H**

F (6, 5)
G (5, 1)
H (5, 3)
J (6, 1)

43. What is the domain of the relation below? **A**

x	y
1	3
2	4
4	8
6	1
7	4

A {1, 2, 4, 6, 7}
B {1, 3}
C {1, 3, 4, 8}
D {(1, 3), (2, 4), (4, 8), (6, 1), (7, 4)}

44. **Short Response** Point *Z* is located at (4, 7) on a coordinate plane. Point *T* is located 3 units to the right and 4 units down from point *Z*. What is the *x*-coordinate of point *T*? **7**

Common Core Review

Name the property shown by each statement. 7.EE.1

45. $5 \cdot 3 = 3 \cdot 5$ **Commutative (×)**

46. $6 \cdot 2 \cdot 0 = 0$ **Multiplicative Property of 0**

47. $0 + 13 = 13$ **Identity (+)**

48. $(5 + x) + 6 = 5 + (x + 6)$ **Associative (+)**

State whether each conjecture is true. If not, give a counterexample. 7.EE.1

49. Division of whole numbers is associative. **no; $(100 \div 10) \div 2 \neq 100 \div (10 \div 2)$**

50. Subtraction of whole numbers is commutative. **no; $9 - 3 \neq 3 - 9$**

51. Melinda purchased the items shown in the table. 7.EE.3

a. Write an expression to show the total cost of the items. **$3s + 16$**

b. Suppose the cost of the sweater is $25. How much did she spend in all? **$91**

Item	Price ($)
sweater	s
purse	$s + 12$
belt	$s + 4$

Find the value of each expression. 6.EE.2c

52. $x + 7$ if $x = 8$ **15**

53. $d - 5$ if $d = 12$ **7**

54. $18 + m$ if $m = 4$ **22**

55. $f - 12$ if $f = 28$ **16**

56. $s + 14$ if $s = 32$ **46**

57. $19 - b$ if $b = 5$ **14**

Find the value of each expression. 5.OA.1

58. $8 + 12 \times 4 \div 8$ **14**

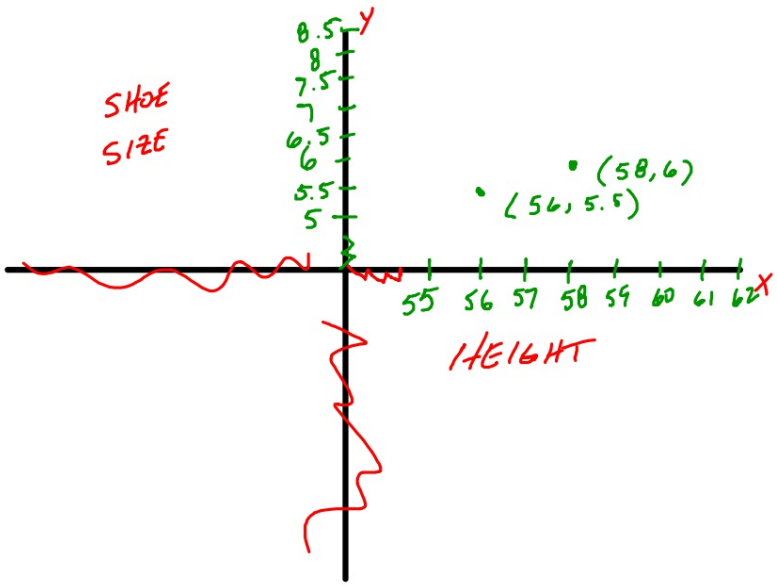
59. $13 - 6 \times 2 + 1$ **2**

60. $14 - 2 \times 7 + 0$ **0**

61. $30 - 14 \times 2 + 8$ **10**

62. $11 + 4 \times (12 - 7)$ **31**

63. $(11 - 7) \times 3 - 5$ **7**


SHOE SIZE
8.5
8
7.5
7
6.5
6
5.5
5
Y
(58,6)
(56, 5.5)
55 56 57 58 59 60 61 62
X
HEIGHT