

Four Is Better Than One

Extending the Coordinate Plane

1

MATERIALS

Patty paper
Masking tape
Index cards
Graph paper

Lesson Overview

Students build from working with rational numbers on a number line to rational numbers on a coordinate plane. They identify the four quadrants, identify points, and make generalizations about points located in given quadrants. Students determine distances between two points that have a common coordinate.

Grade 6 The Number System

Apply and extend previous understandings of numbers to the system of rational numbers.

6. Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates.
 - b. Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.
 - c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.
8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

Essential Ideas

- The coordinate plane is used to plot ordered pairs of rational numbers.
- The coordinate plane has 4 quadrants that are named with Roman numerals.
- The relationship between two ordered pairs differing only by signs is a reflection across one or both axes.
- Absolute value equations are used to determine the distance between two points that share an x-coordinate or a y-coordinate.

Lesson Structure and Pacing: 3 Days

Day 1

Engage

Getting Started: All About Extending

Students use their prior knowledge of the first quadrant of the coordinate plane and of the rational number line to extend from one quadrant to four quadrants. They draw and label an x-axis and y-axis on a coordinate plane dividing the plane into four regions. They identify each region formed by the axes as Quadrants I, II, III, and IV.

Develop

Activity 1.1: Human Coordinate Plane

Students plot and label ordered pairs on a Human Coordinate Plane. Then students identify the coordinates of the ordered pairs plotted by their peers on the Human Coordinate Plane. Students learn to plot points in all four quadrants and on the two axes and identify the coordinates of points plotted on the coordinate plane. Students formalize their understanding of the coordinate plane, and generalize the characteristics of ordered pairs in each quadrant and on the axes.

Day 2

Activity 1.2: Investigating Reflections

Students use patty paper to explore reflections of points across each axis and generalize the relationship between the coordinates of reflections across each axis. Student use the Human Coordinate Plane to investigate the coordinates of reflections of points across both axes. They learn that when two points differ only by sign, the locations of the points are reflections across one or both axes.

Day 3

Activity 1.3: Horizontal and Vertical Distance on the Coordinate Plane

Students calculate the distance between two points that are horizontally aligned and explain how an absolute value equation can be used to calculate this distance. Next, students calculate the distance between two points that are vertically aligned and explain how an absolute value equation can be used to calculate this distance. They will use absolute value equations to calculate the distance between pairs of points with either horizontal or vertical alignment.

Activity 1.4: T-Rex Dig

Students analyze and play a game involving plotting, locating, and determining the length of segments on the coordinate plane. Students must identify integer coordinates of ordered pairs and use their knowledge of the properties of the coordinate plane to play the game.

Demonstrate

Talk the Talk: Determining Coordinates

Students use given information about points, represented with ordered pairs with variable coordinates, to determine distances between the points. They then determine the numerical coordinates of the points.

Facilitation Notes

In this activity, students use their prior knowledge of the first quadrant of the coordinate plane and of the rational number line to extend from one quadrant to four quadrants.

Differentiation strategy

Provide larger versions of each coordinate plane used in this lesson for students who have large handwriting.

Ask students what they remember about the coordinate plane. The discussion should include how to plot ordered pairs, the axes, the origin, units, and grid lines.

Have students work with a partner or in groups to complete Questions 1 through 4. Share responses as a class.

As students work, look for

- Maintaining a constant distance between tick marks.
- Incorrectly labeled negative values.
- Incorrectly labeled quadrants.

Questions to ask

- Did you label your numbers on the gridlines or in the space between the gridlines?
- If you labeled your numbers in the space between two gridlines how will you determine which gridline represents which number?
- Where did you label -1 on the x -axis? on the y -axis?
- Can the positive and negative sides of the x -axis have different scales?
- Can the x -axis and y -axis have different scales?
- What quadrant has negative x -values and negative y -values?
- What quadrant has positive x -values and positive y -values?
- What quadrant has positive x -values and negative y -values?
- What quadrant has negative x -values and positive y -values?
- What quadrant has fractional values?
- What axis separates the positive and negative x -values?
- What axis separates the positive and negative y -values?

Summary

The coordinate plane is comprised of 4 regions called quadrants and allows you to plot ordered pairs of rational numbers.

Activity 1.1

Human Coordinate Plane



Facilitation Notes

In this lesson, a Human Coordinate Plane is used to plot and label ordered pairs. Students learn to (1) plot points in all four quadrants and on the two axes and (2) identify the coordinates of points plotted on the coordinate plane.

Prior to the lesson, create a coordinate grid on the floor using masking tape. Each of the axes should be scaled from -5 to 5 , and only 0 and the even numbers should be labeled. Ensure that the lines are equidistant and far enough apart to allow students to physically plot ordered pairs. Prepare note cards or papers with coordinates of a variety of ordered pairs in all four quadrants and on the axes. Label one side on the card with the letter and the other side with the coordinate pair. Suggestions:

| Student | Location | Student | Location |
|---------|------------|---------|------------|
| A | $(0, 0)$ | H | $(0, -2)$ |
| B | $(2, 3)$ | I | $(-3, -4)$ |
| C | $(4, 0)$ | J | $(0, -4)$ |
| D | $(-1, -3)$ | K | $(-3, 0)$ |
| E | $(3, -1)$ | L | $(5, 5)$ |
| F | $(4, -5)$ | M | $(-4, 1)$ |
| G | $(-5, 3)$ | N | $(1, 5)$ |

To facilitate Question 1, provide the prepared cards to students. Have 4 or 5 students get up at a time, stand at the appropriate locations on the coordinate plane and display the letters on their cards. Students at their seats should plot the points on the graph and complete the table in their textbooks. Then, students standing on the coordinate plane should turn their cards over, and everyone should check their work and make corrections. Repeat the process in groups of 4 or 5 until all the points have been graphed.

Differentiation strategy

If your classroom is too small for the Human Coordinate Plane, use the board to create a large coordinate plane. Use dot stickers and markers to plot the ordered pairs. Assign different colors to each quadrant and require students to select the correct color dot or marker when they plot their ordered pairs.

Questions to ask

- How did you know where to plot your ordered pair?
- If you begin at the origin, what directions would you give someone to plot your ordered pair?

- How many points are located in the first quadrant?
- How many points are located in the second quadrant?
- How many points are located in the third quadrant?
- How many points are located in the fourth quadrant?
- If a point is located on either the x -axis or the y -axis, is it located in a quadrant?

After graphing the points, complete Questions 2 and 3 as a class.

Select students to plot ordered pairs according to the conditions presented in Question 4. As the students complete the activity, discuss other locations where the students could have stood. Consider having multiple students plot ordered pairs that satisfy a given condition and discuss the similarities.

Questions to ask

- If a point has a negative x -coordinate, where could it be located?
- If a point has a negative y -coordinate, where could it be located?
- Where are the axes?
- What is true about one of the coordinates for any ordered pair plotted on an axis?
- How did you determine the x -coordinate of the ordered pair?
- How did you determine the y -coordinate of the ordered pair?
- What other conditions would be interesting to investigate?

Have students complete Questions 5 individually or with a partner. Share responses as a class.

Questions to ask

Looking back through the coordinate planes,

- If a point is located in the first quadrant, what do you know to be true about the coordinates of the point?
- If a point is located in the second quadrant, what do you know to be true about the coordinates of the point?
- If a point is located in the third quadrant, what do you know to be true about the coordinates of the point?
- If a point is located in the fourth quadrant, what do you know to be true about the coordinates of the point?
- If a point is located on the x -axis, what do you know to be true about the coordinates of the point?
- If a point is located on the y -axis, what do you know to be true about the coordinates of the point?
- If you glance at the coordinates of the point, can you tell which quadrant the point is located? How do you know?

Summary

The ordered pairs in a given quadrant or on an axis have the same sign for their x-coordinates and their y-coordinates. It is possible to look at an ordered pair of rational numbers and determine its region or axis location.

Activity 1.2

Investigating Reflections



Facilitation Notes

In this lesson, patty paper is used to explore reflections of points across each axis and generalize the relationship between the coordinates of reflections across each axis. The Human Coordinate Plane is used to investigate the coordinates of reflections of points across both axes.

Have students to complete Questions 1 through 4 with their partner or in groups. Provide each student at least two pieces of patty paper for this activity. Share responses as a class.

Questions to ask

- What do you notice about the signs of the coordinates and their reflections across the x-axis?
- What do you notice about the signs of the coordinates and their reflections across the y-axis?
- How do you know which point was the original and which was its reflection?

Differentiation strategies

- Challenge students to use rational numbers beyond the integers when they are allowed to select their own coordinates.
- For students who struggle, limit initial explorations of reflections to points in Quadrant I. Gradually add other quadrants. Help students see that the patterns are the same, regardless of the initial quadrant location of the points.

Misconceptions

- Students sometimes confuse “using the opposite sign” and “making a number negative”. For example, when generalizing for the response to Question 2: Given a point $A(x, y)$, its reflection across the x-axis is $A'(x, -y)$, students may think that the y-coordinate of A' must be a negative value, when the notation means to take the opposite of the y-value of A . If the y-value of A was negative, then the y-value of A' will be positive.
- Students sometimes do not understand that reflecting across the x-axis is analogous to folding along the x-axis.

Complete Question 5 as a class. Select three students to plot ordered pairs according to the conditions presented in Question 5. Consider repeating this activity multiple times, perhaps starting in different quadrants, to help students see the pattern.

Questions to ask

- How did Student A know where to stand?
- Where else could Student A have chosen to stand?
- How could you label B using reflection notation?
- How could you label C using reflection notation?
- Could Students B and C have chosen different locations? Explain.
- If Student A began in Quadrant II, in what quadrant is Student C?
- If Student A began in Quadrant I (III or IV), in what quadrant is Student C?

Have students complete Questions 6 through 8 with a partner or in groups. The instructions do not specify which point is the original and which is the reflection, so students can label either as A or A'. If time permits, students could share answers on the Human Coordinate Plane.

Questions to ask

- How are you using the generalizations from the previous questions to help you decide the locations of the points?
- How could you decide the locations of the points if you forgot the generalizations?
- What is true about all ordered pairs in Quadrant II?
- What is true about all ordered pairs in Quadrant III?
- What is true about all ordered pairs in Quadrant IV?
- What do you know about the signs of coordinates and their reflections across the x-axis?
- What do you know about the signs of coordinates and their reflections across the y-axis?
- What do you know about the signs of coordinates and their reflections across both axes?

Summary

Ordered pairs that differ only by signs are reflections across one or both axes.

Activity 1.3

Horizontal and Vertical Distance on the Coordinate Plane



Facilitation Notes

In this activity, the distance between two points that are horizontally aligned or vertically aligned is determined using an absolute value equation.

Ask students to provide examples of why and when they used absolute value equations in the previous topic. They will revisit absolute value equations throughout the remainder of this lesson and the next.

Have students complete Questions 1 through 3 with a partner or in groups. Share responses as a class.

As students work, look for

- Mixing up the x - and y -coordinates.
- Determining the distance between the points only by counting. Counting is a valid strategy when students begin this activity, but they should move to using absolute value equations.

Questions to ask

- What are the coordinates of the points?
- What do you notice about the values of the coordinates?
- How could you determine the distance by counting?
- What does the absolute value of the x -coordinate of point A tell you about the point and the y -axis?
- What does the absolute value of the x -coordinate of point B tell you about the point and the y -axis?
- What does the absolute value of the y -coordinate of point A tell you about the point and the x -axis?
- What does the absolute value of the y -coordinate of point C tell you about the point and the x -axis?
- What do you notice about point B and $(-9, 2)$?
- What do you notice about point C and $(8, -5)$?
- How do you know to add or subtract in the absolute value equation?

Summary

Absolute value equations are used to calculate the distance between pairs of points with either horizontal or vertical alignment. The absolute values are added when the points are in different quadrants, and the absolute values are subtracted when the points are in the same quadrant.

Activity 1.4

T-Rex Dig



Facilitation Notes

In this activity, a game is played that involves plotting, locating, and determining the length of segments on the coordinate plane. Students must identify integer coordinates of ordered pairs and use their knowledge of the properties of the coordinate plane to play the game.

Have a student read the introduction to T-Rex Dig. Ask students if they have ever played a game similar to this one. Allow students to briefly share their experiences of how to play similar games. In other similar games, students may have used a different form of coordinates, e.g, D3. The idea in T-Rex Dig is the same.

The first question is provided to ensure that students understand how T-Rex Dig is played. Question 1 provides a sample game board. Allow students to work through Question 1 with a partner. Discuss the responses as a class.

Questions to ask

- What are the coordinates for the segment that represents the fossil?
- How can you determine the length of the fossil other than counting?
- How are the coordinates on a fossil related to the length of the fossil?
- How does an absolute value equation justify the length of the fossil?
- How can you determine how many quadrants are crossed by a fossil?
- What does it mean for a fossil to lie on an axis?

Before students begin setting up and playing their own game, discuss the rules under the sample game board. Establish guidelines for what questions can be asked and which questions cannot be asked.

Keep the goals of the activity in mind: to provide opportunities for students to plot and locate rational numbers on the coordinate plane and to use coordinates to determine distance on the coordinate plane.

Allow students to work with a partner for the remainder of this activity.

Summary

Integer coordinates of ordered pairs are used to locate points on a coordinate plane and determine distances.

Talk the Talk: Determining Coordinates

DEMONSTRATE

Facilitation Notes

Information about given points that contain a variable coordinate is used to determine distances between other points. Students determine numerical coordinates of these points.

Allow students to work with a partner or in groups to complete Questions 1 and 2. Encourage students to label the graph as they encounter new information. Share responses as a class.

Questions to ask

- What do you know about the coordinates of point G ?
- How are the coordinates of points F and G similar to each other?
- How do you know where to plot point H ?
- How is point H similar to either point F or point G ?
- What is the distance from point F to point H ?
- How can you use absolute value equations to determine the distance from point F to point H ?
- What is half of 7?
- How far is point F from point G ? What does this mean about the y -coordinate of point F ?
- How did you decide the location of point J ?
- Could point J be located somewhere else? Why?
- Can you give all of the possible locations for point J ?

Summary

Relationships between the ordered pairs of coordinates of points on a graph can be used to determine the exact location of other points.

Four Is Better Than One

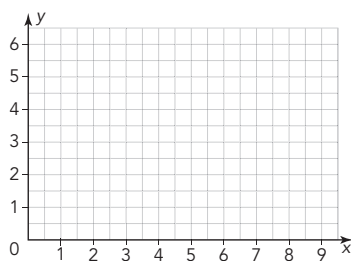
Extending the Coordinate Plane

1

WARM UP

Plot each point.

A (3, 5) B (0, 4) C (6, 1) D (8, 0) E (0, 0)



LEARNING GOALS

- Identify the four quadrants of the coordinate plane and the characteristics of points located in each.
- Locate and plot ordered pairs of positive and negative rational numbers on the coordinate plane.
- Determine the relationship between the signs of coordinates of ordered pairs that are reflections across one or both axes.
- Use absolute value to determine distances on the coordinate plane.
- Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane.

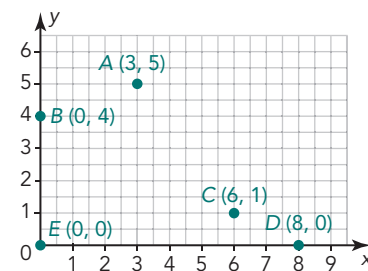
KEY TERM

- quadrants

You can locate and plot ordered pairs of positive numbers on a coordinate plane. How can you extend the plane to include ordered pairs of any rational numbers?

LESSON 1: Four Is Better Than One • M4-57

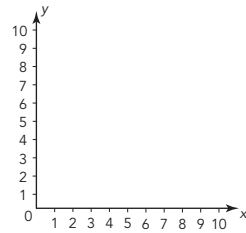
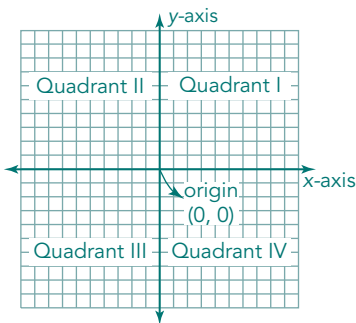
Warm Up Answers



Answers

See graph.

- 1a. The number line extends forever in the left and right directions.
- 1b. The number line extends forever up and down.
2. See graph.
3. There are 4 regions in the coordinate plane.
4. See graph.



Getting Started

All About Extending

Consider the coordinate plane that you have used to graph points where both the x - and y -coordinates were zero or positive numbers.

1. Based on what you have learned about number lines:

- a. What do you know about the number line that makes up the x -axis? Extend that number line and label it appropriately.
- b. What do you know about the number line that makes up the y -axis? Extend that number line and label it appropriately.

2. The point where the x -axis and y -axis intersect is known as the **origin**. Label the point of intersection with its coordinates.

By extending the number lines that form the axes, you have created the entire coordinate plane.

3. How many regions are created when the coordinate plane is extended to all rational numbers?

The regions on the coordinate plane are called **quadrants**. They are numbered with Roman numerals from one to four (I, II, III, IV) starting in the upper right-hand quadrant and moving counterclockwise.

4. Label each of the quadrants on your coordinate plane.

The coordinate plane is often called the Cartesian coordinate plane, named for René Descartes.

M4-58 • TOPIC 2: The Four Quadrants

ELL Tip

Beginning speakers may read *intersection* as “inner-section” and think it means “inside a section.” Point out that it is more correct to break the word apart as “intersect-ion.” Explain that an *intersection* is a place where two things meet, or *intersect*, like a busy intersection on a street. Ask students to look for the place where the two axes meet, or intersect, on the coordinate plane. Point out that there’s only one intersection; it is called the *origin*.

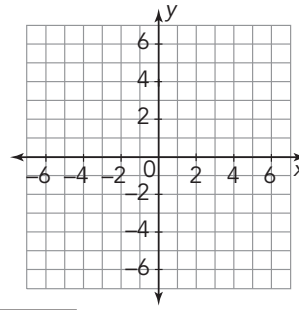
ACTIVITY
1.1

Human Coordinate Plane



Your teacher is going to direct students to stand at certain locations on the human coordinate plane.

- For each student, plot and label the point where the student is standing on the coordinate plane. Then record the coordinates of that point in the table.



| Student | Location | Student | Location |
|---------|----------|---------|----------|
| A | | H | |
| B | | I | |
| C | | J | |
| D | | K | |
| E | | L | |
| F | | M | |
| G | | N | |

- Where did each student always start? How did each student know which direction to go first?
- What do you notice about the coordinates of the points that are in the same quadrant of the coordinate plane?

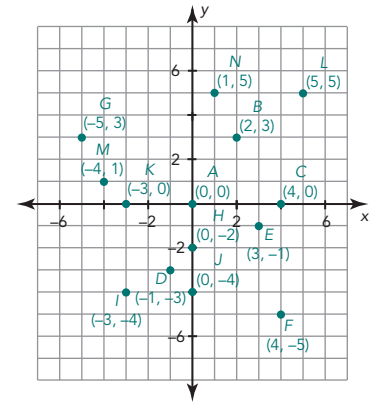
Help each other decide how to plot the ordered pairs.



LESSON 1: Four Is Better Than One • M4-59

Answers

- Sample answer.



See table below.

- The starting place is the origin.
The first coordinate is the x-coordinate. So students walked the appropriate distance left or right first.
- Points in the same quadrant have the same signs (positive or negative) on their x- and y-coordinates.

- | Student | Location | Student | Location |
|---------|----------|---------|----------|
| A | (0, 0) | H | (0, -2) |
| B | (2, 3) | I | (-3, -4) |
| C | (4, 0) | J | (0, -4) |
| D | (-1, -3) | K | (-3, 0) |

| Student | Location | Student | Location |
|---------|----------|---------|----------|
| E | (3, -1) | L | (5, 5) |
| F | (4, -5) | M | (-4, 1) |
| G | (-5, 3) | N | (1, 5) |

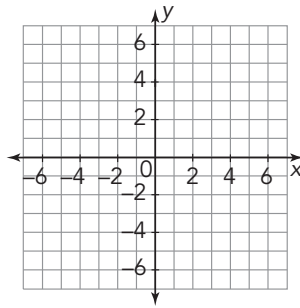
Answers

4. Sample answers.

| Location |
|------------|
| $(-2, -3)$ |
| $(-4, 8)$ |
| $(3, -1)$ |
| $(4, 0)$ |
| $(-1, 7)$ |
| $(-1, -7)$ |

5. Sample answers.

- $(+, +)$
- $(-, +)$
- $(-, -)$
- $(+, -)$
- $(x, 0)$
- $(0, y)$



Your teacher is going to select students to plot ordered pairs that meet specific conditions. The students will select locations that satisfy those conditions.

4. For each student, plot and label the point where the student is standing on the coordinate plane. Then record the coordinates of that point in the table.

| Student | Condition | Location |
|---------|-----------------------|----------|
| A | Anywhere | |
| B | Negative x-coordinate | |
| C | Negative y-coordinate | |
| D | On an axis | |
| E | In QII | |
| F | In QIII | |

5. Compare the ordered pairs you have plotted and identified in this activity. What is similar about the points you graphed in each region or axis of the graph?

- | | |
|------------|------------|
| a. QI: | b. QII: |
| c. QIII: | d. QIV: |
| e. x-axis: | f. y-axis: |

ACTIVITY
1.2

Investigating Reflections



In this activity, you will use patty paper to search for specific patterns on the coordinate plane.

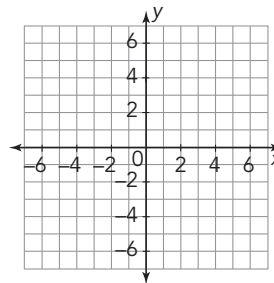
Reflecting across the x -axis: Place a sheet of patty paper over the coordinate plane and trace the axes.

1. For each ordered pair,

- Plot and label the point on patty paper.
- Fold the patty paper on the x -axis.
- Trace the point through the patty paper.
- Label the coordinates of the new point.

- | | |
|---------------|--------------------------------------------|
| a. $A(4, 1)$ | $A'(\underline{\quad}, \underline{\quad})$ |
| b. $B(-3, 4)$ | $B'(\underline{\quad}, \underline{\quad})$ |
| c. $C(5, -2)$ | $C'(\underline{\quad}, \underline{\quad})$ |
| d. $D(0, -7)$ | $D'(\underline{\quad}, \underline{\quad})$ |

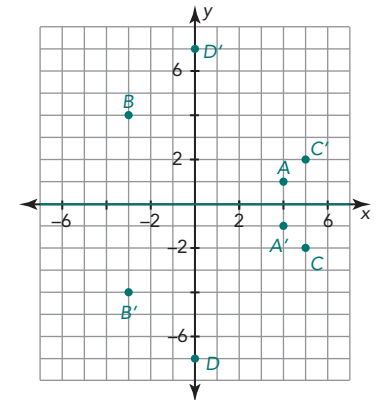
- 2. What did you notice about the coordinates of the original points and their reflections? Write a generalization for how the coordinates of a point and its reflection across the x -axis are related.**



A' is read "A prime."

Answers

- 1a. $A'(4, -1)$
- 1b. $B'(-3, -4)$
- 1c. $C'(5, 2)$
- 1d. $D'(0, 7)$



- 2. Each x -coordinate remained the same but the y -coordinates changed sign, from positive to negative or from negative to positive. Given a point $A(x, y)$, its reflection across the x -axis is $A'(x, -y)$.**

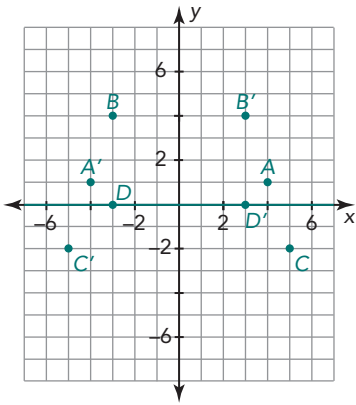
Answers

3a. $A'(-4, 1)$

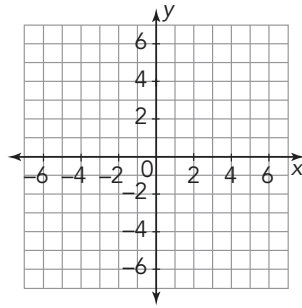
3b. $B'(3, 4)$

3c. $C'(-5, -2)$

3d. $D'(3, 0)$



4. Each y -coordinate remained the same but the x -coordinates changed sign, from positive to negative or from negative to positive. Given a point $A(x, y)$, its reflection across the y -axis is $A'(-x, y)$.



Now let's investigate reflecting across the y -axis. Place a new sheet of patty paper over the coordinate plane and trace the axes.

3. For each ordered pair,

- Plot and label the point on patty paper.
- Fold the patty paper on the y -axis.
- Trace the point through the patty paper.
- Label the coordinates of the new point.

a. $A(4, 1)$ $A'(\underline{\quad}, \underline{\quad})$

b. $B(-3, 4)$ $B'(\underline{\quad}, \underline{\quad})$

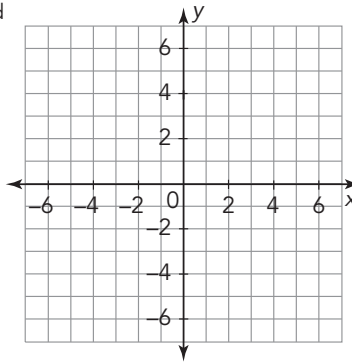
c. $C(5, -2)$ $C'(\underline{\quad}, \underline{\quad})$

d. $D(-3, 0)$ $D'(\underline{\quad}, \underline{\quad})$

4. What did you notice about the coordinates of the original points and their reflections? Write a generalization for how the coordinates of a point and its reflection across the y -axis are related.

Your teacher is going to select students to plot ordered pairs that meet specific conditions. The students will select locations that satisfy those conditions.

5. For each student, plot and label the point where the student is standing on the coordinate plane. Then record the coordinates of that point in the table.

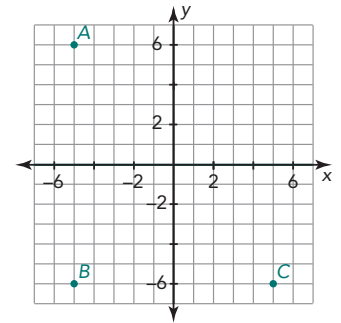


| Student | Condition | Location |
|---------|-----------------------------------|----------|
| A | Quadrant II | |
| B | Reflection of A across the x-axis | |
| C | Reflection of B across the y-axis | |

6. Compare the ordered pairs for A and C. What do you notice about their coordinates? Write a generalization for how the coordinates of a point and its reflection across both axes are related.

Answers

5. Sample answers.



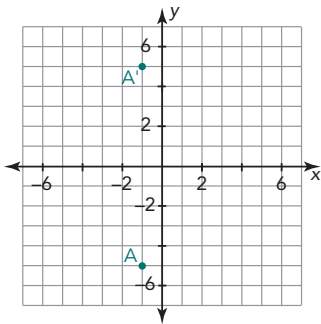
| Location |
|------------|
| $(-5, 6)$ |
| $(-5, -6)$ |
| $(5, -6)$ |

6. The coordinates of point C are the opposites of the coordinates of point A, $(-5, 6) \rightarrow (5, -6)$. Given a point $A(x, y)$, its reflection across both axes is $A'(-x, -y)$.

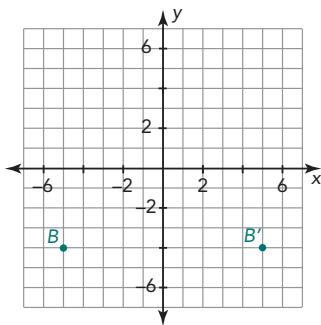
Answers

Sample answers.

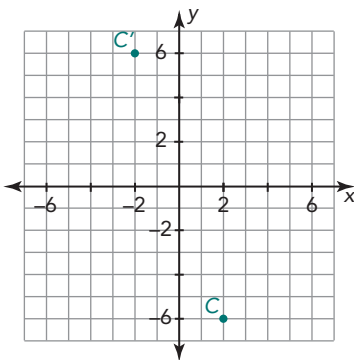
7a. $A(-1, -5)$ $A'(-1, 5)$



7b. $B(-5, -4)$ $B'(5, -4)$

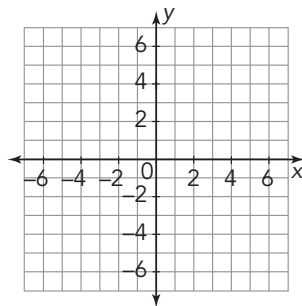


7c. $C(2, -6)$ $C'(-2, 6)$



8. Points that are reflections across one or both axes differ only by the signs of the coordinates.

7. For each pair of conditions, plot and label two points. Record the coordinates of the points.



- a. One point is in Quadrant II. The two points are reflections of each other across the x -axis.

- b. One point is in Quadrant III. The points are reflections of each other across the y -axis.

- c. One point is in Quadrant IV. The points are reflections of each other across both axes.

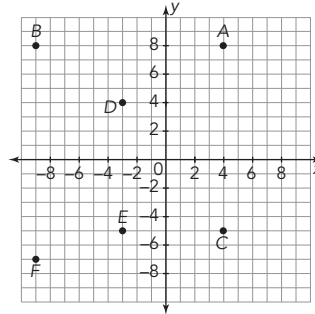
8. In general, how are points that are reflections across one or both axes similar to and different from each other?

ACTIVITY
1.3

Horizontal and Vertical Distance on the Coordinate Plane



1. Consider points *A* and *B*.
 - a. Use the coordinate plane to determine the distance from point *A* to point *B*.
 - b. Describe how the coordinates of points *A* and *B* are similar.
 - c. Write an absolute value equation using the *x*-coordinates of the points to calculate the distance.



2. Consider points *B* and *F*.
 - a. Use the coordinate plane to determine the distance from point *B* to point *F*.
 - b. Describe how the coordinates of points *B* and *F* are similar.
 - c. Write an absolute value equation using the *y*-coordinates of the points to calculate the distance.
3. Write an absolute value equation and calculate the distance from:
 - a. point *D* to $(-3, -5)$. b. $(-7, -4)$ to $(3, -4)$.
 - c. $(6, 2)$ to $(6, -5)$. d. point *B* to $(-9, 2)$.
 - e. $(8, -7)$ to point *F*.

Answers

- 1a. The distance is 15 units.
- 1b. They both have a *y*-coordinate of 8.
- 1c. $|4| + |-9| = 13$
- 2a. The distance is 15 units.
- 2b. They both have an *x*-coordinate of -9.
- 2c. $|8| + |7| = 15$
- 3a. $|4| + |-5| = 9$
- 3b. $|-7| + |3| = 10$
- 3c. $|2| + |-5| = 7$
- 3d. $|8| - |2| = 6$
- 3e. $|8| + |-9| = 17$

Answers

- 1a. The T-Rex's skull is 5 ft long. $|3| + |-2| = 5$

ACTIVITY

1.4

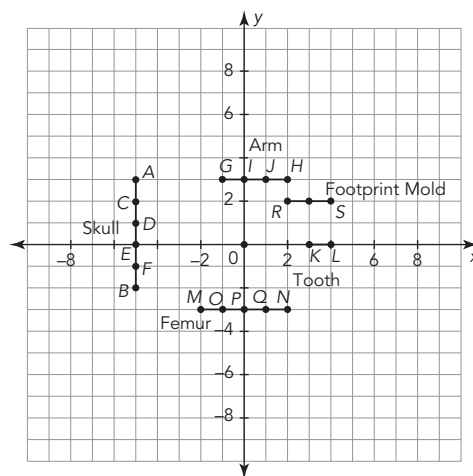
T-Rex Dig



In the T-Rex Dig game, players place the “bones” of their dinosaur horizontally or vertically on a coordinate grid. Players then take turns guessing the location of each other's dino bones using coordinates. Once a player has located all of the other player's dino bones, the game is over.

Let's look at a sample game board and questions that might be asked to uncover all the dino bones.

1. Use the game board to answer questions about the T-Rex fossils. (Each grid line is 1 foot long.)



- a. How long is the T-Rex's skull? Write an absolute value equation to justify your answer.

- b. How many coordinates must be guessed to completely “uncover” the skull?
- c. How long is the T-Rex’s femur? Write an absolute value equation to justify your answer.
- d. What is the greatest number of quadrants crossed by any one fossil?
- e. Are any fossils on an axis? If so, identify the axis, the fossil, and the coordinates of the fossil(s).

2. **Your turn!** Use the graph paper provided at the end of the lesson. Use the bottom grid to plot and label your 5 fossils. You may want to label some of the coordinates to help you as you play the game. Use the top grid to record the coordinates you ask of your partner.

As you play the game ask your opponent mathematical questions. For example, you can ask:

- Is the femur symmetric over an axis?
- How many of your fossils are vertical?
- Are any of the fossils on an axis? (But you can’t ask which axis!)
- Do any of the fossils share an ending x-coordinate with another fossil?

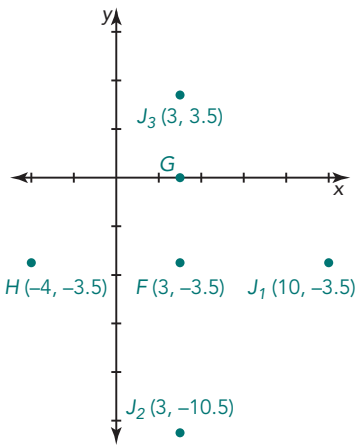
LESSON 1: Four Is Better Than One • M4-67

Answers

- 1b. Six coordinates are required to uncover the skull.
- 1c. The T-Rex’s femur is 4 ft long. $|-2| + |2| = 4$
- 1d. At most two quadrants are crossed by a fossil.
- 1e. The tooth is on the x-axis. Its coordinates are (3, 0) and (4, 0).
2. Answers will vary.

Answers

- 1 $a = -3.5$. The distance from point F to point H is $|3| + |-4| = 7$. Because the distance from point F to point G is half that distance, the distance is 3.5 units. Point G is on the x -axis and has a y -coordinate of 0, and point F is 3.5 units below point G , so the y -coordinate of point F is -3.5 .
2. Point J must be 7 units in any direction from point F . Assuming point J is not the same as point H and that point J lies vertically or horizontally from point F , point J could be located at $(3, -10.5)$, $(10, -3.5)$, or $(3, 3.5)$.



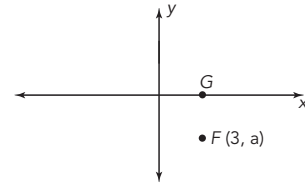
NOTES

TALK the TALK

Determining Coordinates

Use the graph and information provided to answer each question.

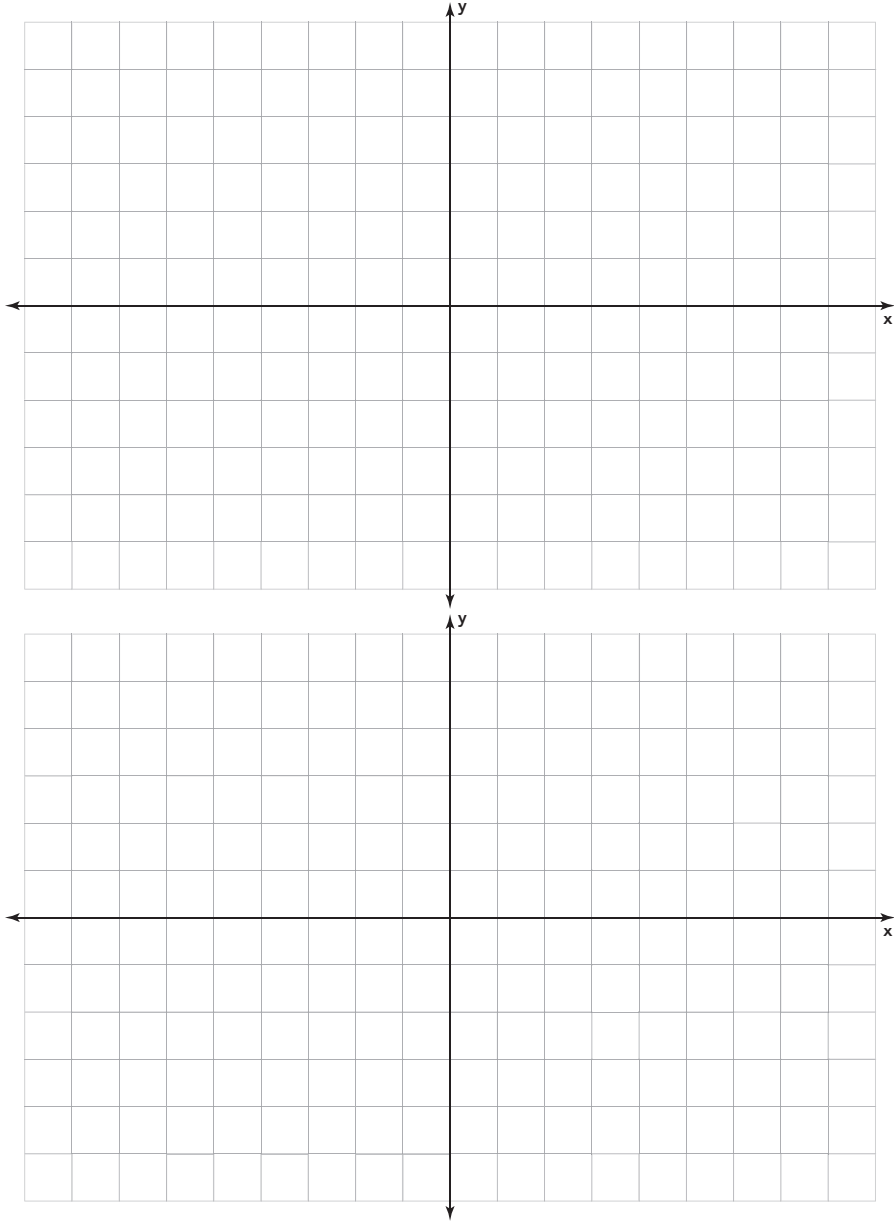
- The graph shows the locations of point F and point G .
- Point G is on the x -axis and has the same x -coordinate as point F .
- Point H is located at $(-4, a)$.
- The distance from point F to point G is half the distance from point F to point H .



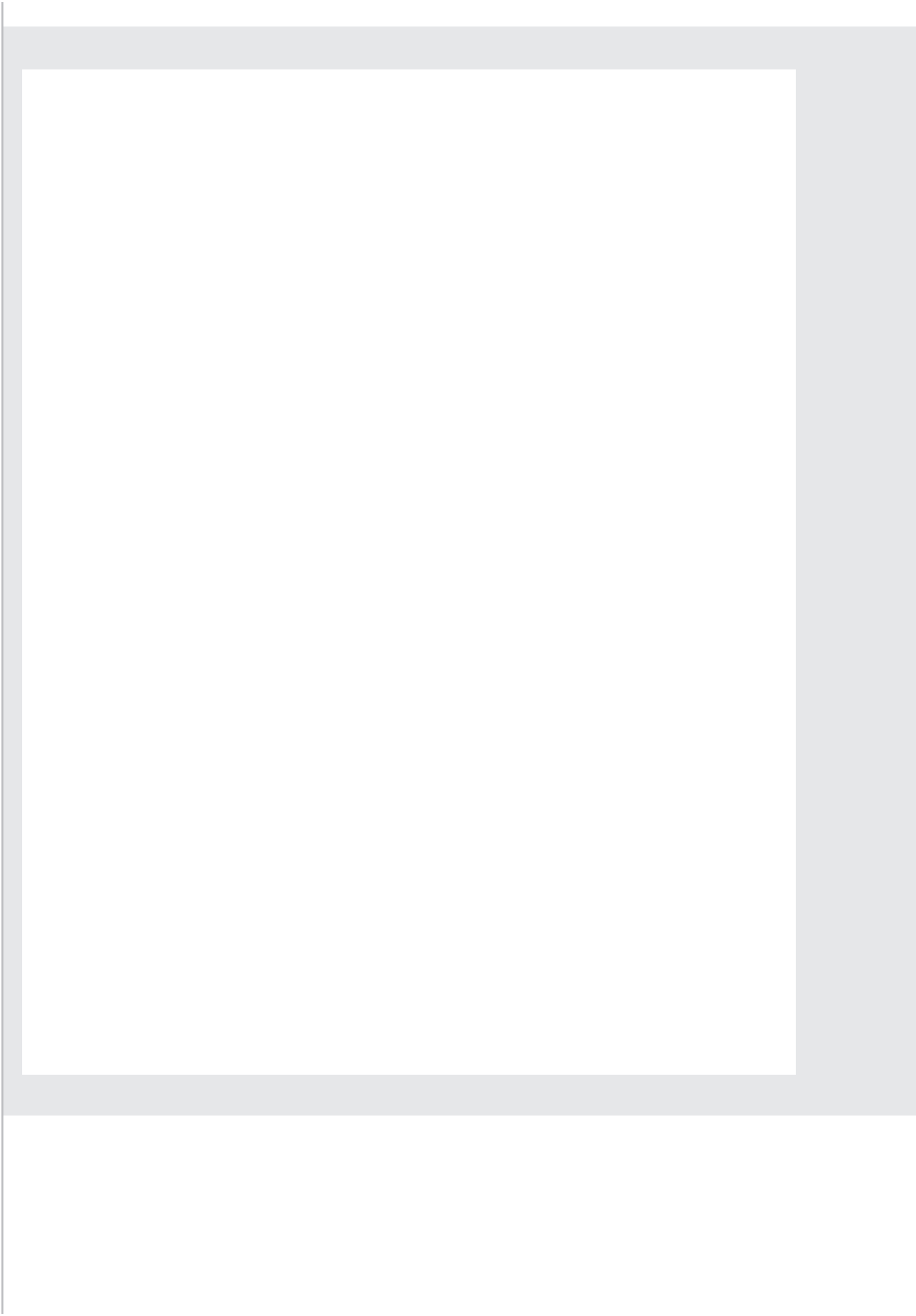
1. What is the value of a ? Explain how you determined this coordinate.

2. Plot point J so that the distance from point F to point J is the same as the distance from point F to point H . Explain how you decided where to plot point J .

T-Rex Dig Game Board



LESSON 1: Four Is Better Than One • M4-69



Assignment

Write

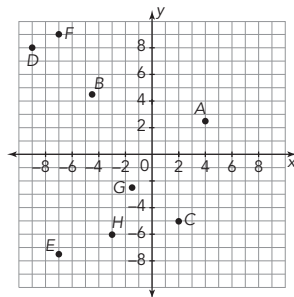
Use the terms **axis**, **quadrant**, and **coordinates** to explain how ordered pairs that differ only by sign are related to each other.

Remember

The Cartesian coordinate plane is formed by two perpendicular number lines that intersect at the zeros, or the origin. The intersecting number lines divide the plane into four regions, called quadrants.

Practice

1. Identify the ordered pair associated with each point graphed on the coordinate plane.



2. Plot and label the locations of points P through Z on a coordinate plane. Draw line segments from point to point, beginning and ending at point P. Describe the resulting figure.

P (0, 5) Q (1, 3) R (4, 3)
 S (2, 1) T (4, -3) V (0, -1)
 W (-4, -3) X (-2, 1) Y (-4, 3)
 Z (-1, 3)

3. Plot the ordered pair (a, b) in Quadrant I of a coordinate plane and the ordered pair (c, d) in Quadrant III. Plot and label each additional ordered pair. Explain how you knew where to plot each point.

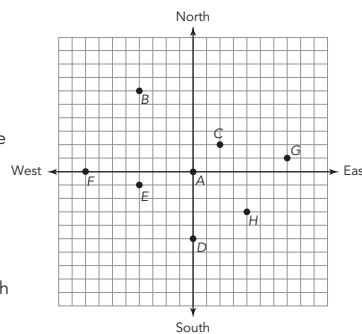
a. $(-a, b)$ b. $(a, -b)$ c. $(-a, -b)$ d. $(-c, d)$ e. $(c, -d)$ f. $(-c, -d)$

4. The coordinate plane shown represents a map of Paul's neighborhood. Each square represents one city block. Paul's house is located at point A, which is the origin. The other points represent the following locations.

B – USA Bank C – Paul's friend Franco's house
 D – Gray's Grocery Store E – Post Office
 F – Edward Middle School G – Playground
 H – Smiles Orthodontics

5. Explain how Paul can get to the given destination from his house if he were to first walk east or west and then walk north or south. Then, determine the coordinates of the destination point and the quadrant in which the point is located.

a. USA Bank b. Smiles Orthodontics
 c. Franco's house d. Playground
 e. Post Office



LESSON 1: Four Is Better Than One • M4-71

- 5d. Paul should go 7 blocks east, then 1 block north. The point is $(7, 1)$. It is located in Quadrant I.
- 5e. Paul should go 4 blocks west, then 1 block south. The point is $(-4, -1)$. It is located in Quadrant III.

Assignment Answers

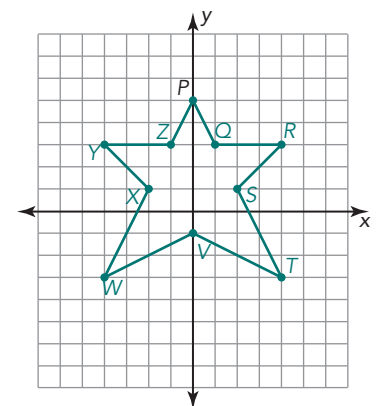
Write

Answers will vary.

Practice

1. A $(4, 2.5)$ B $(-4.5, 4.5)$
 C $(2, -5)$ D $(-9, 8)$
 E $(-7, -7.5)$
 F $(-7, 9)$
 G $(-1.5, -2.5)$
 H $(-3, -6)$

2.



- 3a. Quadrant II
 3b. Quadrant IV
 3c. Quadrant III
 3d. Quadrant IV
 3e. Quadrant II
 3f. Quadrant I

4. Read only.

- 5a. Paul should go 4 blocks west, then 6 blocks north. The point is $(-4, 6)$. It is located in Quadrant II.
- 5b. Paul should go 4 blocks east, then 3 blocks south. The point is $(4, -3)$. It is located in Quadrant IV.
- 5c. Paul should go 2 blocks east, then 2 blocks north. The point is $(2, 2)$. It is located in Quadrant I.

Assignment Answers

6. The ordered pair associated with point B is $(-4, 6)$. The ordered pair associated with point E is $(-4, -1)$. Both points have an x -coordinate of -4 .
7. $|6| + |-1| = 7$
8. If the points are on the same vertical line, add the absolute value of the y -coordinates. If the points are on the same horizontal line, add the absolute value of the x -coordinates.

Stretch

Answers will vary based on how students create their rectangles.

Review

Sample answers.

1. 3.41, 3.42
2. 2.45, 2.5

Check students' number lines.

3. $-2\frac{1}{8}$
4. 5.97
5. 172 ft^2
6. 272 in.^2

6. Identify the ordered pairs associated with B and E . Describe how the ordered pairs are similar.
7. Write an absolute value equation using the y -coordinates of the points to calculate the distance between B and E .
8. How can an absolute value equation help you calculate the distance from one point to another on the coordinate plane when the points are on the same vertical or horizontal line?

Stretch

Create a rectangle $ABCD$ on a coordinate plane that meets the following conditions:

- all four points are in different quadrants
- point A is in Quadrant II with coordinates $(-a, b)$
- the distance from point A to point B is $3a$
- the distance from point A to point D is $4b$
- neither axis is a line of symmetry in the rectangle

Review

Determine two rational numbers that are between the two given rational numbers.

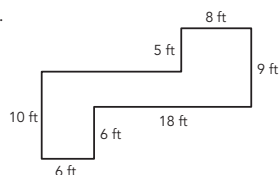
1. 3.4 and 3.5 2. $\frac{12}{5}$ and $\frac{13}{5}$

State the opposite of each number and plot both numbers on a number line.

3. $2\frac{1}{8}$ 4. -5.97

Calculate the area of each composite figure.

5.



6.

