

Four Is Better Than One

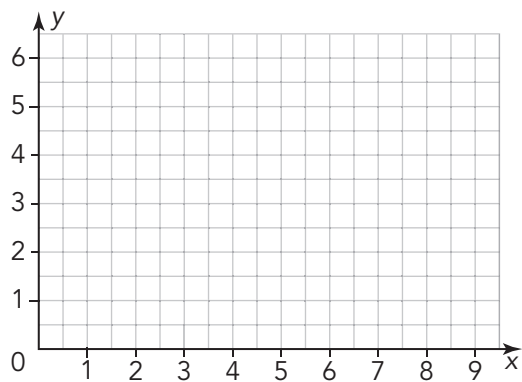
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Extending the Coordinate Plane

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.

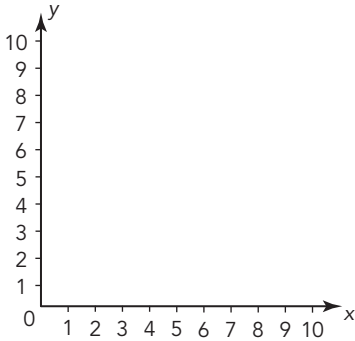
KEY TERM

- 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?

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

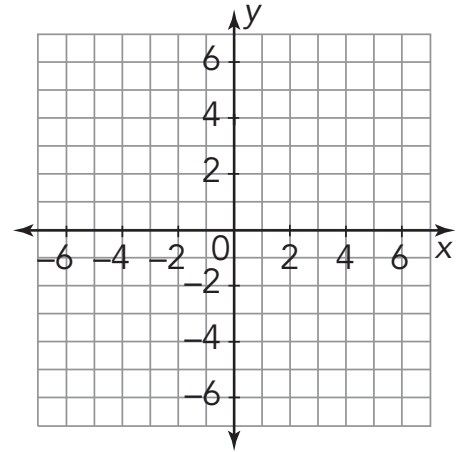
The regions on the coordinate plane are called **quadrants**. They are numbered with Roman numerals from one to four (I, II, III, IV) starting in the upper right-hand quadrant and moving counterclockwise.

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



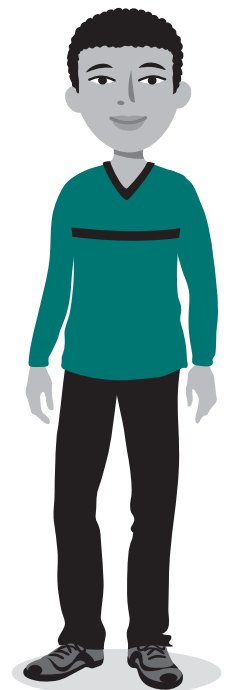
Your teacher is going to direct students to stand at certain locations on the human coordinate plane.

1. 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.

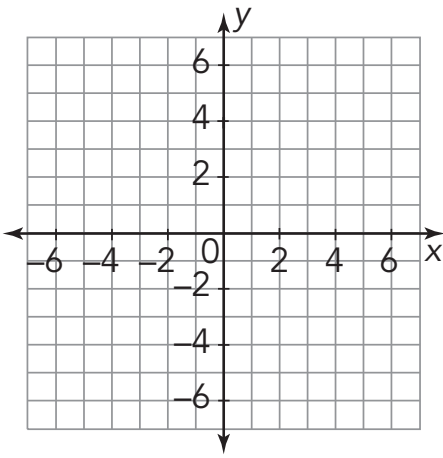


Student	Location	Student	Location
A		H	
B		I	
C		J	
D		K	
E		L	
F		M	
G		N	

Help each other decide how to plot the ordered pairs.



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



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:



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,

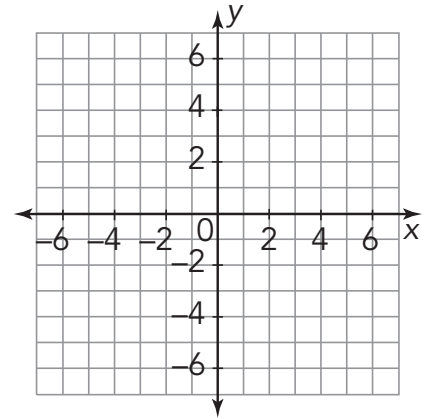
- Plot and label the point on patty paper.
- Fold the patty paper on the x -axis.
- Trace the point through the patty paper.
- Label the coordinates of the new point.

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

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

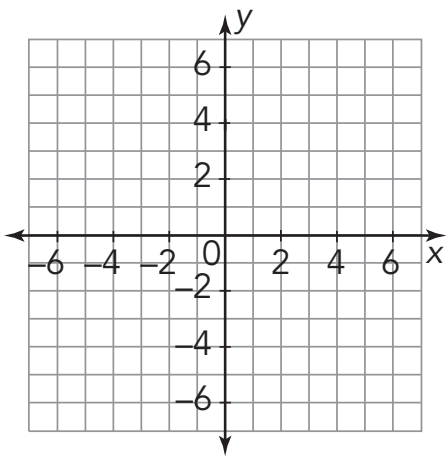
c. $C(5, -2)$ $C'(\underline{\quad}, \underline{\quad})$

d. $D(0, -7)$ $D'(\underline{\quad}, \underline{\quad})$



A' is read "A prime."

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.



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

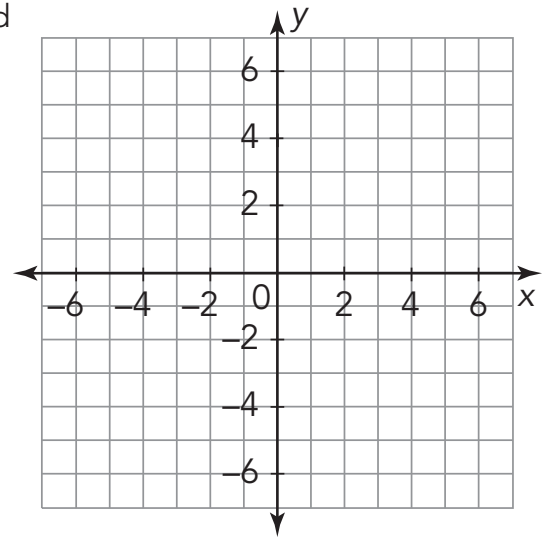
c. $C(5, -2)$ $C' (\underline{\quad} , \underline{\quad})$

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.

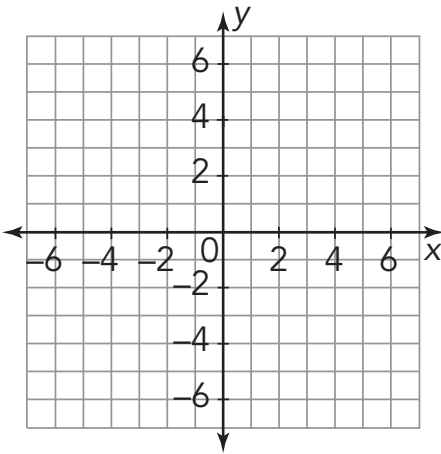
5. For each student, plot and label the point where the student is standing on the coordinate plane. Then record the coordinates of that point in the table.



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.

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.

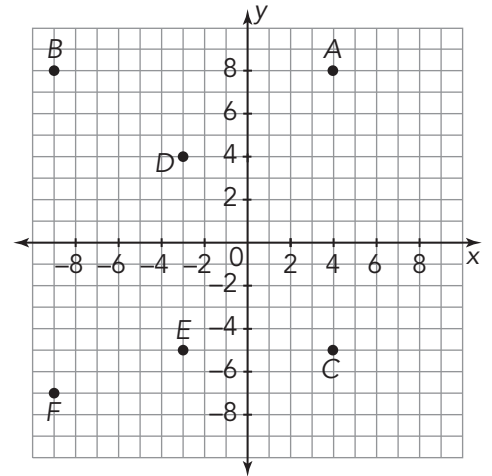
8. In general, how are points that are reflections across one or both axes similar to and different from each other?

Horizontal and Vertical Distance on the Coordinate Plane



1. Consider points A and B .

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



2. Consider points B and F .

- Use the coordinate plane to determine the distance from point B to point F .
- Describe how the coordinates of points B and F are similar.
- 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:

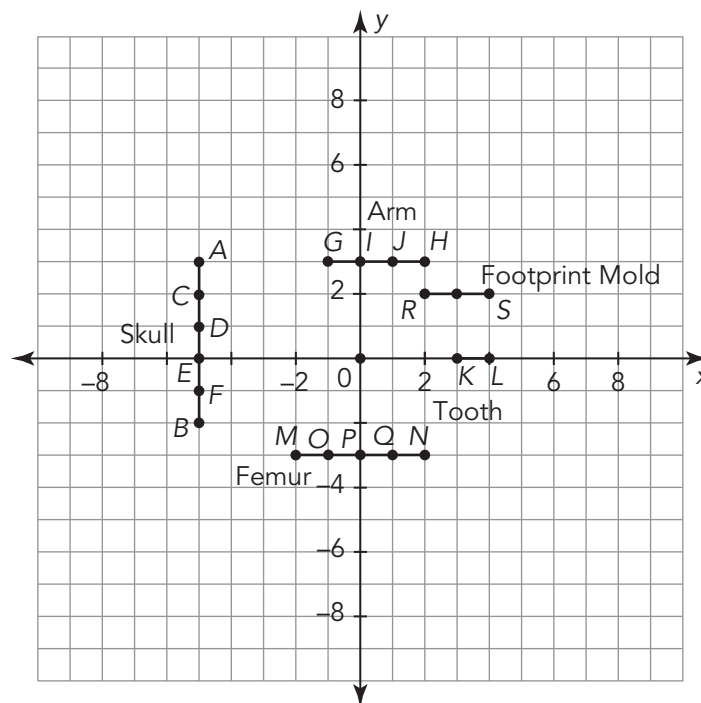
- point D to $(-3, -5)$.
- $(-7, -4)$ to $(3, -4)$.
- $(6, 2)$ to $(6, -5)$.
- point B to $(-9, 2)$.
- $(8, -7)$ to point F .



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.

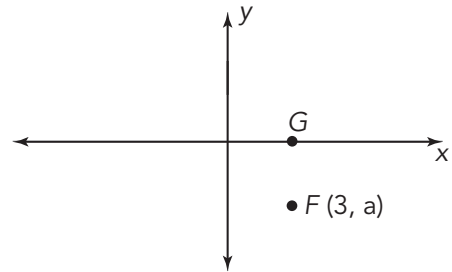
As you play the game ask your opponent mathematical questions. For example, you can ask:

- 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?
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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 .

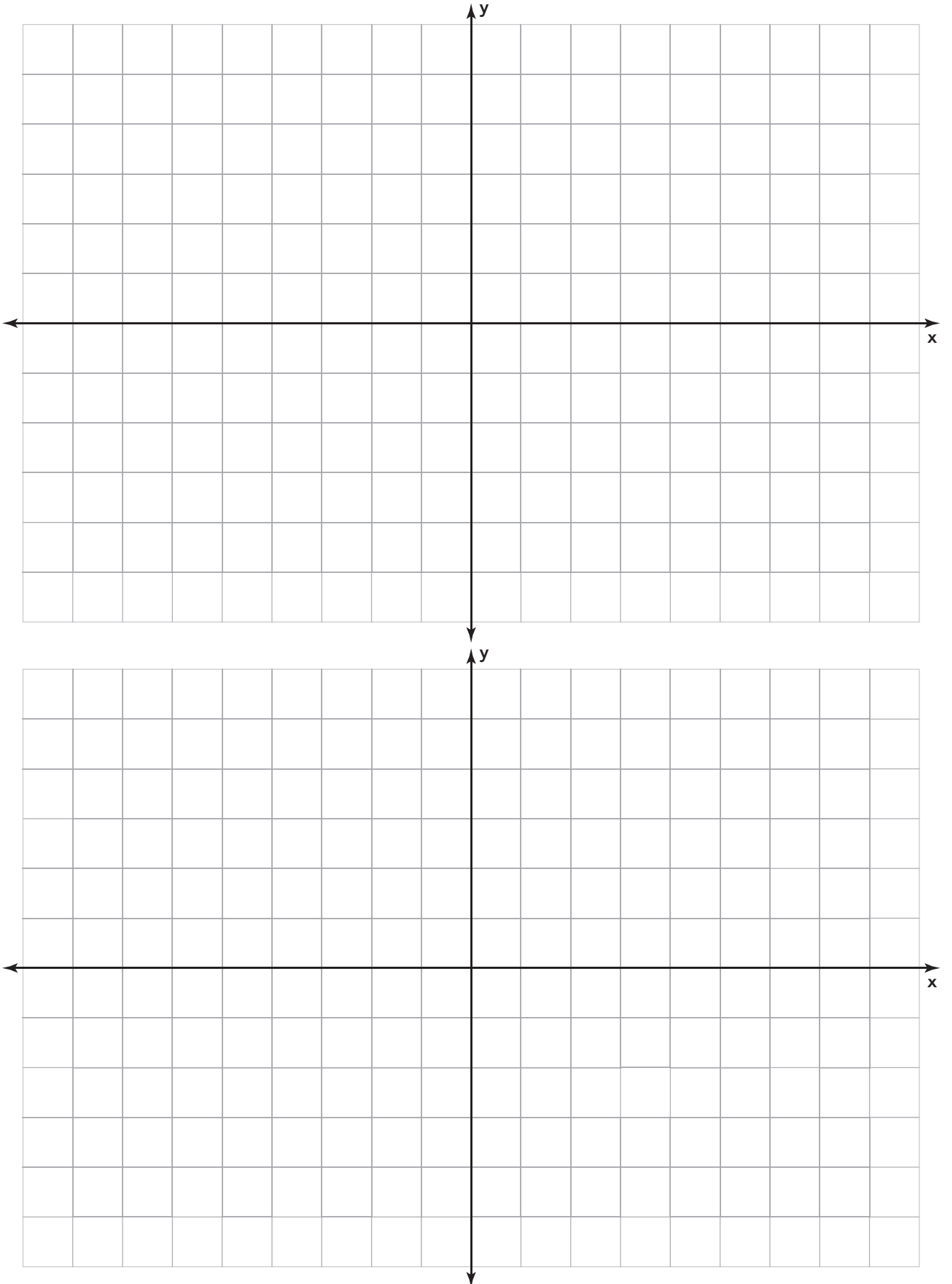


- Point G is on the x -axis and has the same x -coordinate as point F .
- Point H is located at $(-4, a)$.
- The distance from point F to point G is half the distance from point F to point H .

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



Assignment

Write

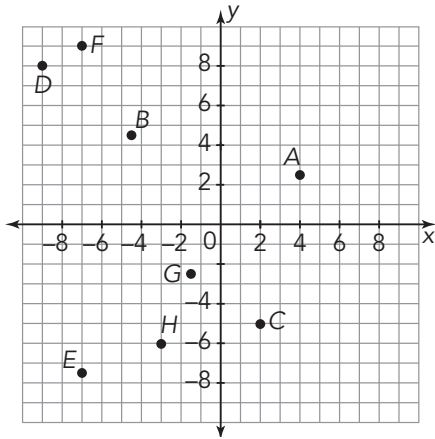
Use the terms **axis**, **quadrant**, and **coordinates** to explain how ordered pairs that differ only by sign are related to each other.

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.



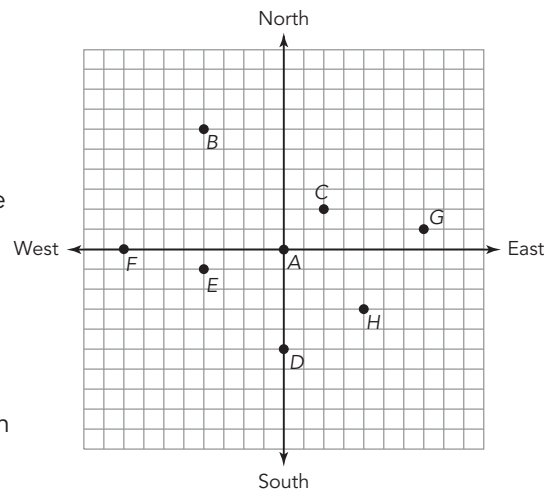
2. Plot and label the locations of points P through Z on a coordinate plane. Draw line segments from point to point, beginning and ending at point P . Describe the resulting figure.

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

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

- Identify the ordered pairs associated with B and E . Describe how the ordered pairs are similar.
- Write an absolute value equation using the y -coordinates of the points to calculate the distance between B and E .
- 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.

- 3.4 and 3.5
- $\frac{12}{5}$ and $\frac{13}{5}$

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

- $2\frac{1}{8}$
- -5.97

Calculate the area of each composite figure.

