TASK: GRAPHING ON THE COORDINATE PLANE

ESSENTIAL QUESTIONS
- Why is it useful for me to know the absolute value of a number?
- What are opposites and what characteristic do they have on the number line?
- How are opposites and absolute value related?
- How can I use absolute value to help me determine the distance between two points on a coordinate plane?
- What generalizations can I make about reflecting points across the x-axis or the y-axis?

STANDARDS ADDRESSED
MCC6.NS.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, debits/credits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

MCC6.NS.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.

MCC6.NS.6a Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., \(-(-3) = 3\), and that 0 is its own opposite.

MCC6.NS.6b Understand signs of number 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.

MCC6.NS.6c 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.

MCC6.NS.7 Understand ordering and absolute value or rational numbers.

MCC6.NS.7c Understand the absolute value of a rational number as its distance from 0 on the number line; interpret absolute value as magnitude for a positive or negative quantity in a real-world situation.

MCC6.NS.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.

MCC6.G.3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply those techniques in the context of solving real-world mathematical problems.
STANDARDS FOR MATHEMATICAL PRACTICES ADDRESSED

1. **Make sense of problems and persevere in solving them** – Students make sense of problems involving points and polygons in the coordinate plane.

2. **Reason Abstractly and quantitatively** – Students demonstrate abstract reasoning about rational numbers with their visual representations. Students consider the value of these numbers in relation to distance (coordinate plane).

3. **Construct viable arguments and critique the reasoning of others.** - Students construct arguments regarding number line representations.

4. **Model Mathematics** - Students use the coordinate plane to reflect points across the axes.

5. **Use appropriate tools strategically** – Students use number lines to represent situations involving positive and negative numbers.

6. **Attend to precision** – Students attend to the language of real-world situations to determine if positive or negative quantities/distances are being represented.

7. **Look for and make use of structure** - Students recognize that the axes on the coordinate plane are number lines.

8. **Look for and express regularity in repeated reasoning** – Students relate new experiences to experiences with similar context when studying positive and negative representations of distance and quantity.

**TASK COMMENTS**

In this task, students move their thinking about distance from the horizontal number line and a vertical number line to the coordinate plane. They plot points, reflect over the \(x\)-axis or the \(y\)-axis, use opposites and absolute value to determine distances, identify and draw polygons, find the length of the sides of the polygons, and apply these techniques to the context of solving real-world mathematical problems.
LEARNING TASK: GRAPHING ON THE COORDINATE PLANE.

Number lines can be used to show numbers and their opposites. Both 3 and $-3$ are 3 units from zero on the number line. Graphing points and reflecting across zero on the number line extends to graphing and reflecting points across the $x$-axes (horizontal number line) or the $y$-axis (vertical number line) on a coordinate plane.

1. On the horizontal number line, plot 7 and $-7$. What is the distance of each point from zero? What is the distance between 7 and $-7$? How does absolute value help you write a number sentence to help you find the distance between 7 and $-7$?

Solution

Each point is 7 units from 0. The distance between 7 and $-7$ is 14 units. Absolute value helps us write a number sentence to help find the distance between 7 and $-7$ by using the distance from 0 on the number line. $|7| + |-7| = 14$.

2. On the horizontal number line, plot 5 and $-5$. What is the distance of each point from zero? What is the distance between 5 and $-5$? How does absolute value help you write a number sentence to help you find the distance between 5 and $-5$?

Solution

Each point is 5 units from 0. The distance between 5 and $-5$ is 10 units. Absolute value helps us write a number sentence to help find the distance between 5 and $-5$ by using the distance from 0 on the number line. $|5| + |-5| = 10$. 
3. On the horizontal number line, plot 2 and −2. What is the distance of each point from zero? What is the distance between 2 and −2? How does absolute value help you write a number sentence to help you find the distance between 2 and −2?

Solution
Each point is 2 units from 0. The distance between 2 and −2 is 4 units. Absolute value helps us write a number sentence to help find the distance between 2 and −2 by using the distance from 0 on the number line. |2| + |−2| = 4.

4. On the vertical number line, plot 1 and −1. What is the distance of each point from zero? What is the distance between 1 and −1? How does absolute value help you write a number sentence to help you find the distance between 1 and −1?

Solution
Each point is 1 unit from 0. The distance between 1 and −1 is 2 units. Absolute value helps us write a number sentence to help find the distance between 1 and −1 by using the distance from 0 on the number line. |1| + |−1| = 2.
5. On the vertical number line, plot 10 and −10. What is the distance of each point from zero? What is the distance between 10 and −10? How does absolute value help you write a number sentence to help you find the distance between 10 and −10?

Solution
Each point is 10 units from 0. The distance between 10 and −10 is 20 units. Absolute value helps us write a number sentence to help find the distance between 10 and −10 by using the distance from 0 on the number line. \[ |10| + |-10| = 20. \]

6. On the vertical number line, plot 8 and −8. What is the distance of each point from zero? What is the distance between 8 and −8? How does absolute value help you write a number sentence to help you find the distance between 8 and −8?
Solution
Each point is 8 units from 0. The distance between 8 and −8 is 16 units. Absolute value helps us write a number sentence to help find the distance between 8 and −8 by using the distance from 0 on the number line. |8| + |−8| = 16.

7. The points (1, 3), (-1, 5), (-3, 3), and (4, -4) have been graphed on the coordinate plane. Reflect each point across the x-axis. What are the coordinates of the reflected points?

When the star (1, 3) is reflected across the x-axis, the new point is located at _____.

Solution
(1, -3)

When the triangle (-1, 5) is reflected across the x-axis, the new point is located at _____.

Solution
(-1, -5)

When the smiley face (-3, 3) is reflected across the x-axis, the new point is located at _____.

Solution
(-3, -3)

When the lightning bolt (4, -4) is reflected across the x-axis, the new point is located at _____.

Solution
(4, 4)

What similarities do you notice between the coordinates of the original point and the reflected point?

Solution
The x coordinate stays the same. The y coordinate becomes the opposite.
8. The points (1, 3), (-1, 5), (-3, 3), and (4, -4) have been graphed on the coordinate plane. Reflect each point across the y-axis. What are the coordinates of the reflected points?

When the star (1, 3) is reflected across the y-axis, the new point is located at _____.

**Solution**
(-1, 3)

When the triangle (-1, 5) is reflected across the y-axis, the new point is located at _____.

**Solution**
(1, 5)

When the smiley face (-3, 3) is reflected across the y-axis, the new point is located at _____.

**Solution**
(3, 3)

When the lightning bolt (4, -4) is reflected across the y-axis, the new point is located at _____.

**Solution**
(-4, -4)

What similarities do you notice between the coordinates of the original point and the reflected point?

**Solution**
The x coordinate becomes the opposite. The y coordinate stays the same.
9. The smiley face, located at point (-4, 5), has been reflected across the y-axis. The new location of the smiley face is (4, 5). What is the distance between (-4, 5) and (4, 5)? Write a number sentence using the distance from the y-axis to help justify your answer.

Solution
The distance between the two points is 8 units.

\[ |-4| + |4| = 8 \]

10. A point, located at (-3, -4), has been reflected across the x-axis. The new point has the coordinates (-3, 4). What is the distance between (-3, -4) and (-3, 4)? Write a number sentence using the distance from the x-axis to help justify your answer.

Solution

\[ |-4| + |4| = 8 \]
Use the drawing of the city to help you answer questions 11-17.

11. What is the location of city hall? What is the location of the police station? How many blocks apart are these two buildings?

**Solution**
City hall is located at (0, 0), and the police station is located at (0, -4). The two buildings are 4 blocks apart.

12. What is the location of the art museum? What is the location of the animal shelter? How many blocks apart are these two buildings?

**Solution**
The art museum is located at (6, 1), and the animal shelter is located at (6, -2). The two buildings are 3 blocks apart.

13. What is the location of the hospital? What is the location of the cemetery? How many blocks apart are these two buildings?

**Solution**
The hospital is located at (-6, -4), and the cemetery is located at (3, -4). The two buildings are 9 blocks apart.

14. What is the location of the hospital? What is the location of the police station? How many blocks apart are these two buildings?

**Solution**
The hospital is located at (6, -4), and the police station is located at (0, -4). The two buildings are 6 blocks away.
15. The police station is being moved to its new location located at (-6, -1). Is the police station closer to, farther away from, or the same distance from the Hospital?

**Solution**
The police station is now three blocks away from the hospital. It was six blocks away. It is now closer to the hospital.

16. The art museum and the animal shelter are moving as well. Their movement can be described as a reflection across the y-axis. What are the coordinates of the new location for the art museum and the animal shelter? How many blocks are they from each other? Is this the same distance as in question 12? Why or why not?

**Solution**
The art museum is now located at (-6, 1), and the animal shelter is now located at (-6, -2). These two buildings are three blocks apart. This is the same distance as they were in question 12 when they were located at (6, 1) and (6, -2). The reason they are the same distance apart is because when they are reflected across the y-axis the y coordinate stays the same and the x coordinate becomes the opposite. This keeps the two buildings the same distance apart.

17. The stadium is also being moved. Its new location can be described as a reflection across the x-axis. What is the new location of the stadium? How many blocks is the new stadium from the old stadium?

**Solution**
The stadium is now located at (-2, -3). The stadium is now 6 blocks from the old stadium.

18. On a map, the library is located at (-2, 2), the city hall is located at (0, 2), and the middle school is located at (0, 0).

A. Represent the locations as points on a coordinate grid with a unit of 1 mile.

**Solution**
See Grid on left.

B. What shape is formed by connecting the three locations?

**Solution**
A triangle is formed by connecting the three locations.
C. The city council is planning to place a city park in this area. How large is the area of the planned park?

**Solution**

The area of the planned park is 2 square miles. The formula $A = \frac{1}{2}bh$ or $A = \frac{bh}{2}$ can be used to solve this. The base is 2 miles and the height is 2 miles.

19. On the map, the elementary school is located at (-4, 2), the middle school is located at (2, 2), and, the high school is located at (-4, -3).

A. Each interval on the number lines represents two miles (0 to 1 represents 2 miles). Each school forms the vertex of a rectangle. If the district office for the school system is the fourth vertex of the rectangle, what are the coordinates? How do you know?

**Solution**

The district office would be located at (2, -3). I know this because the point where the high school is located would be reflected across the y-axis or the point where the middle school is would be reflected across the x-axis.

B. What are the length and width of the rectangle?

**Solution**

The length of the rectangle is 12 miles. The width of the rectangle is 10 miles.

C. What is the perimeter of the rectangle?

**Solution**

The perimeter of the rectangle, found by using the formula $P = 2l + 2w$ or $P = l + l + w + w$, is 44 miles.

D. What is the area of the rectangle?

**Solution**

The area of the rectangle, found by using the formula $A = lw$ is 120 square miles.
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2. On the horizontal number line, plot 5 and −5. What is the distance of each point from zero? What is the distance between 5 and −5? How does absolute value help you write a number sentence to help you find the distance between 5 and −5?

3. On the horizontal number line, plot 2 and −2. What is the distance of each point from zero? What is the distance between 2 and −2? How does absolute value help you write a number sentence to help you find the distance between 2 and −2?
4. On the vertical number line, plot 1 and −1. What is the distance of each point from zero? What is the distance between 1 and −1? How does absolute value help you write a number sentence to help you find the distance between 1 and −1?

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9. The smiley face, located at point (-4, 5), has been reflected across the y-axis. The new location of the smiley face is (4, 5). What is the distance between (-4, 5) and (4, 5)? Write a number sentence using the distance from the y-axis to help justify your answer.
10. A point, located at (-3, -4), has been reflected across the x-axis. The new point has the coordinates (-3, 4). What is the distance between (-3, -4) and (-3, 4)? Write a number sentence using the distance from the x-axis to help justify your answer.

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   A. Represent the locations as points on a coordinate grid with a unit of 1 mile.
   
   B. What shape is formed by connecting the three locations?
   
   C. The city council is planning to place a city park in this area. How large is the area of the planned park?

19. On the map, represent the locations as points on the coordinate plane. The elementary school is located at (-4, 2), the middle school is located at (2, 2), and, the high school is located at (-4, -3).
   
   A. Each interval on the number lines represents 2 miles (0 to 1 represents 2 miles). Each school forms the vertex of a rectangle. If the district office for the school system is the fourth vertex of the rectangle, what are the coordinates? How do you know?
B. What are the length and width of the rectangle?

C. What is the perimeter of the rectangle?

D. What is the area of the rectangle?