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Points and Lines

Set 1: Distance and Midpoint

Instruction

Goal: To provide opportunities for students to develop concepts and skills related to finding the lengths and midpoints of line segments in two-dimensional coordinate systems

Essential Concepts

Specify locations and describe spatial relationships using coordinate geometry and other representational systems.

- Use Cartesian coordinates and other coordinate systems, such as navigational, polar or spherical systems, to analyse geometric situations.

Student Activities Overview and Answer Key

Station 1

Students will be given graph paper and a ruler. Students will work together to construct horizontal, vertical and diagonal line segments. They will find the lengths of horizontal and vertical line segments using graph paper. Then they will construct a triangle and use the Pythagorean theorem to find the length of a diagonal line segment.

Answers

1. horizontal line
2. 6 units
3. Answers will vary.
4. vertical line
5. 11 units
6. Answers will vary.
7. diagonal line
8. No, because it is a diagonal line.
9. triangle
10. Use the Pythagorean theorem.
11. $3^2 + 4^2 = c^2$; $c = 5$

Points and Lines

Set 1: Distance and Midpoint

Instruction

Station 2

Students will be given graph paper, a ruler and the distance formula. Students will construct diagonal line segments and use the distance formula to find the length of the line segment. They will reverse the values of (x_1, y_1) and (x_2, y_2) to show that the start and end points don't matter. They will explain how the distance formula can also be used on horizontal and vertical line segments.

Answers

1. $d = \sqrt{(2 - (-5))^2 + (4 - (-7))^2}$
 $d = \sqrt{170}$

2. Yes, because it is the same line.

3. $d = \sqrt{(-5 - 2)^2 + (-7 - 4)^2}$
 $d = \sqrt{170}$

4. Yes, because the start point and end point don't matter. It is the same line.

5. Answers will vary. Possible answer:

$$d = \sqrt{(2 - 2)^2 + (8 - 5)^2}$$
$$d = \sqrt{9} = 3$$

Station 3

Students will be given graph paper, a ruler and the midpoint formula. Students will find the midpoint of a horizontal line segment by counting the units on the graph paper. Then they will use the midpoint formula to find the midpoint of this horizontal line segment. They will use the midpoint formula to find the midpoint of a diagonal line segment. They will explain why you can't simply count the units on the graph paper for a diagonal line segment.

Answers

1. horizontal line

2. $(1, -4)$

3. Answers will vary. Possible answer: We counted units and found the coordinate halfway between the start point and the end point.

4. $\left(\frac{-2 + 4}{2}, \frac{-4 + -4}{2} \right) = (1, -4)$

5. yes

6. $\left(\frac{-4 + 3}{2}, \frac{5 + -2}{2} \right) = \left(\frac{-1}{2}, \frac{3}{2} \right)$

7. because it is a diagonal line segment and the midpoint values are fractions of units

Points and Lines

Set 1: Distance and Midpoint

Instruction

Station 4

Students will be given graph paper and a ruler. Students will construct a vertical line segment and find the midpoint of the line segment by counting units on the graph paper. Then students will construct a diagonal line segment. They will find the slope of the line and use it to construct two congruent triangles. They will find the midpoint of the line segment by finding the intersection of the two congruent triangles.

Answers

1. vertical line
2. $(-4, 0)$
3. Answers will vary. Possible answer: We found the answer by counting the units halfway between the start point and the end point.
4. diagonal line
5. $m = \frac{4}{8} = \frac{1}{2}$
6. The slope is equal to the rise/run. Using this concept, you can draw a right triangle using the slope of $1/2$ with a rise of 1 and a run of 2. However, to use the entire length of the segment, use a rise of 2 and a run of 4 to draw the right triangle. The intersection of the two congruent triangles is the midpoint of the diagonal line.
7. $(4, 2)$

Materials List/Setup

- Station 1 graph paper; ruler
Station 2 graph paper; ruler
Station 3 graph paper; ruler
Station 4 graph paper; ruler

Points and Lines

Set 1: Distance and Midpoint

Instruction

Discussion Guide

To support students in reflecting on the activities and to gather some formative information about student learning, use the following prompts to facilitate a class discussion to “debrief” the station activities.

Prompts/Questions

1. How can you find the length of a vertical or horizontal line segment using graph paper?
2. How can you find the midpoint of a vertical or horizontal line segment using graph paper?
3. How can you find the length of a diagonal line segment using the Pythagorean theorem?
4. How can you find the length of a diagonal line segment using the distance formula?
5. How can you find the midpoint of a diagonal line segment using the midpoint formula?
6. How can you find the midpoint of a diagonal line segment using congruent triangles?

Think, Pair, Share

Have students jot down their own responses to questions, then discuss with a partner (who was not in their station group), and then discuss as a whole class.

Suggested Appropriate Responses

1. Count the number of units in the line.
2. Count the number of units halfway between the start point and end point.
3. Draw a right triangle. The length of the diagonal line segment is the hypotenuse of the triangle. Use the Pythagorean theorem to find the length of the hypotenuse of the triangle.
4. Use the distance formula, which is $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$.
5. Use the midpoint formula, which is $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$.
6. Find the slope. Create two congruent right triangles using this slope. The intersection of the two congruent triangles is the midpoint of the line segment.

Points and Lines

Set 1: Distance and Midpoint

Instruction

Possible Misunderstandings/Mistakes

- Not realising that you can't simply count the units for diagonal line segments when finding the length or midpoint of the line segment
- Not realising that the start point and end point can be reversed when finding the length or midpoint of the line, which will result in the same answer
- Not finding the slope of the diagonal line segment correctly
- Not creating two congruent right triangles to find the midpoint of the diagonal line segment

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NAME: _____

Points and Lines

Set 1: Distance and Midpoint

Station 1

At this station, you will find graph paper and a ruler. Follow the directions below, and then answer the questions.

- Draw an x - and y -axis on the graph paper.
 - On the graph, plot the points (2, 5) and (8, 5).
 - Use the ruler to draw a straight line between the points.
1. What type of line have you created? _____
 2. If each square on the graph paper represents one unit, what is the distance of the line?

 3. How did you find the distance of the line?
 4. On the graph, plot points (1, 1) and (1, 12). Use the ruler to draw a straight line between the points. What type of line have you created?

 5. If each square on the graph paper represents one unit, what is the distance of the line?

 6. How did you find the distance of the line?

continued

NAME: _____

Points and Lines

Set 1: Distance and Midpoint

7. On a new graph, plot the points $(2, 2)$ and $(5, 6)$. Use a ruler to draw a straight line between the points. What type of line have you created?

8. Can you find the distance of this line using the same methods you used in problems 2 and 5? Why or why not?

9. On the graph used in problem 7, plot the point $(5, 2)$. Draw a straight line to point $(5, 2)$ from each point $(2, 2)$ and $(5, 6)$. What shape have you created?

10. How can you use the shape in problem 9 to find the length of the line from points $(2, 2)$ to $(5, 6)$?

11. What is the length of the line from points $(2, 2)$ to $(5, 6)$? Show your work and answer in the space below.

Length of the line: _____

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