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Understanding the coordinates and the division of a line segment into equal parts is fundamental in coordinate geometry. In this article, we will explore the problem involving points A, B, C, and D, where $A = (-3, 6)$, $B = (6, -3)$, and points C and D lie on the line segment AB such that AB is divided into three equal parts. The goal is to find the coordinates of points C and D, focusing on the calculation of D's position. This problem is a classic example of applying the section formula and understanding the division of line segments in a coordinate plane.

Understanding the Coordinates and the Line Segment

Before diving into the calculations, let's analyze the given points and the problem setup:

- Point A has coordinates $(-3, 6)$.
- Point B has coordinates $(6, -3)$.
- Points C and D are located on the line segment AB.
- The segment AB is divided into three equal parts, implying points C and D serve as division points.

The key to solving this problem lies in understanding how to find the coordinates of points dividing a segment into equal parts.

Division of a Line Segment in Coordinate Geometry

Section Formula Overview

The section formula is a vital tool in coordinate geometry when determining the coordinates of a point dividing a line segment in a given ratio. If a point P divides the segment joining points $A(x_1, y_1)$ and $B(x_2, y_2)$ in the ratio $m:n$, then the coordinates of P are given by:

$$P = \left(\frac{mx_2 + nx_1}{m + n}, \frac{my_2 + ny_1}{m + n} \right)$$

Dividing a Segment into Equal Parts

When a segment is divided into n equal parts, the points dividing the segment are found using the section formula with ratios of $1:n, 2:n, \dots, (n-1):n$. For dividing into three equal parts:

- The points dividing the segment into three parts are located at ratios $1:2$ and $2:1$ along the segment.

Applying this to our problem:

- Point C divides AB such that AC is $\frac{1}{3}$ of AB.
- Point D divides AB such that AD is $\frac{2}{3}$ of AB.

Calculating Coordinates of Points C and D

Let's proceed step-by-step to find the coordinates of C and D.

Step 1: Find the vector from A to B

The vector from A to B is:

$$\vec{AB} = (x_2 - x_1, y_2 - y_1) = (6 - (-3), -3 - 6) = (9, -9)$$

Step 2: Find coordinates of point C ($\frac{1}{3}$ along AB from A)

Point C divides AB in the ratio $1:2$, starting from A. Using the section formula:

$$C = \left(x_1 + \frac{1}{3} (x_2 - x_1), y_1 + \frac{1}{3} (y_2 - y_1) \right)$$

Plugging in the values:

$$\begin{aligned} C_x &= -3 + \frac{1}{3} \times 9 = -3 + 3 = 0 \\ C_y &= 6 + \frac{1}{3} \times (-9) = 6 - 3 = 3 \end{aligned}$$

Therefore, the coordinates of C are $(0, 3)$.

Step 3: Find coordinates of point D (2/3 along AB from A)

Similarly, point D divides AB in the ratio 2:1:

$$D = \left(x_1 + \frac{2}{3} (x_2 - x_1), y_1 + \frac{2}{3} (y_2 - y_1) \right)$$

Calculations:

$$D_x = -3 + \frac{2}{3} \times 9 = -3 + 6 = 3$$

$$D_y = 6 + \frac{2}{3} \times (-9) = 6 - 6 = 0$$

Hence, the coordinates of D are (3, 0).

Summary of Coordinates and Key Findings

- Point C divides segment AB at (0, 3).
- Point D divides segment AB at (3, 0).
- The points C and D are located at 1/3 and 2/3 along the way from A to B, respectively.

Visualizing the Geometry

Understanding the positioning of points A, B, C, and D on the coordinate plane can help clarify the division:

- A (-3, 6): Starting point.
- B (6, -3): Ending point.
- C (0, 3): One-third along the line from A to B.
- D (3, 0): Two-thirds along the line from A to B.

Plotting these points on a graph reveals the linear division of segment AB, illustrating the proportional distances.

Applications of Dividing Line Segments in Coordinate Geometry

Dividing line segments into equal parts has numerous applications:

- Construction of geometric figures: Creating points at specific ratios.
- Coordinate-based design: Precise placement of points in CAD.
- Physics: Finding midpoints or specific ratios in vector analysis.
- Navigation and Mapping: Dividing routes into equal segments.

Practical Example: Dividing a Road into Equal Sections

Suppose a surveyor needs to divide a linear route between two points into equal sections. Using the coordinate geometry principles outlined above, they can accurately determine the coordinates of division points, ensuring precise planning and execution.

Conclusion

The problem of locating points C and D on segment AB, divided into three equal parts, showcases the power of the section formula and vector analysis in coordinate geometry. By understanding the ratios and applying the formulas correctly, we obtain accurate coordinates for any division points along a line segment. This fundamental skill extends beyond theoretical exercises, serving practical purposes in engineering, architecture, navigation, and various fields requiring precise spatial calculations.

Summary of Key Steps:

- Calculate the vector from A to B.
- Use the section formula to find point C at $\frac{1}{3}$ along AB.
- Use the section formula to find point D at $\frac{2}{3}$ along AB.
- Verify the points' positions through plotting and reasoning.

Mastering these techniques enhances spatial reasoning and precision in mathematical problem-solving, making coordinate geometry an essential tool in various scientific and engineering disciplines.

Frequently Asked Questions

What are the coordinates of points A and B in the diagram?

Point A is at (-3, 6) and point B is at (6, -3).

How is point C positioned relative to points A and B?

Point C is located such that the segment AB is divided into three equal parts, with C lying somewhere along this division.

Given that AB is divided into three equal parts, how can we find the coordinates of point C?

The coordinates of C are obtained by dividing the vector from A to B into three equal segments and adding one such segment to A's coordinates.

What is the method to determine point D's coordinates in this diagram?

Point D is to be found using the division of the segment AB into three equal parts, probably as the next division point or based on the problem's specific instructions.

If C is one-third along the way from A to B, what are its coordinates?

C's coordinates are calculated as $((-3 + 1/3(6 - (-3))), (6 + 1/3(-3 - 6))) = (1, 3)$.

How do the division points on segment AB relate to the concept of dividing a line segment into equal parts?

They are points obtained by dividing the vector from A to B into equal segments, which can be found using the section formula or vector addition.

What is the significance of points C and D in the context of dividing segment AB into three parts?

Points C and D represent division points that split segment AB into three equal segments, helping to locate specific points for geometric constructions or proofs.

Additional Resources

Coordinate Geometry Analysis: Understanding the Divided Line Segment in the Given Configuration

Introduction: Unpacking the Geometry Puzzle

Coordinate geometry is a fundamental component of mathematics that provides a powerful toolkit for analyzing and solving spatial problems with precision. The problem at hand involves points A, B, C, and D, with given coordinates and certain conditions about their placement and division of segments. Specifically, the points are given as:

- A = (-3, 6)
- B = (6, -3)

- C and D are points on the plane, with C known and D to be determined.
- The segment AB is divided into three equal parts, and points C and D are positioned accordingly.

The goal is to find the coordinates of point D, given the placement and division conditions, and to understand the geometric relationships involved. This problem is a classic example of how coordinate geometry can be used to analyze segment division and point positioning, offering insights into ratios, midpoints, and segment division.

Understanding the Key Elements of the Problem

Points A and B: The Fixed Endpoints

The points A and B are fixed, with known coordinates:

- $A = (-3, 6)$
- $B = (6, -3)$

Plotting these points on the coordinate plane reveals a segment stretching from the northwest to the southeast, with A situated at the top-left and B at the bottom-right. The segment AB is the primary line of interest, and understanding its division involves analyzing how it can be partitioned into equal parts.

Division of Segment AB into Three Equal Parts

The problem states that "AB is divided into three equal parts," which typically implies that there are two points (say, C and D) located along the segment AB such that:

- C is one-third of the way from A to B.
- D is two-thirds of the way from A to B.

This is a common concept in coordinate geometry, often used in dividing a segment into equal ratios.

Key clarification: Since the problem mentions points C and D in relation to the division of AB, and given the notation, it suggests that:

- C is the first division point (at $1/3$ along AB),
- D is the second division point (at $2/3$ along AB).

Note: The problem's notation suggests that C is at a specific location, and D is to be determined, possibly based on the division ratio.

Calculating the Coordinates of Points C and D

Using the Section Formula for Division of a Segment

The section formula is essential in coordinate geometry for finding a point that divides a segment between two points in a given ratio.

Given two points $P(x_1, y_1)$ and $Q(x_2, y_2)$, and a point R dividing the segment PQ in the ratio $m:n$, the coordinates of R are:

$$R = \left(\frac{mx_2 + nx_1}{m + n}, \frac{my_2 + ny_1}{m + n} \right)$$

Applying this to our segment AB:

- $A = (-3, 6)$
- $B = (6, -3)$

Dividing AB into three equal parts:

- The points C and D correspond to ratios:
- C at $\frac{1}{3}$ along AB: ratio $1:2$ (from A to B)
- D at $\frac{2}{3}$ along AB: ratio $2:1$

Calculating C:

$$C = \left(\frac{1 \times 6 + 2 \times (-3)}{1 + 2}, \frac{1 \times (-3) + 2 \times 6}{1 + 2} \right)$$

$$C_x = \frac{6 + (-6)}{3} = \frac{0}{3} = 0$$

$$C_y = \frac{-3 + 12}{3} = \frac{9}{3} = 3$$

Thus, $C = (0, 3)$.

Calculating D:

$$D = \left(\frac{2 \times 6 + 1 \times (-3)}{2 + 1}, \frac{2 \times (-3) + 1 \times 6}{2 + 1} \right)$$

$$D_x = \frac{12 + (-3)}{3} = \frac{9}{3} = 3$$

$$D_y = \frac{-6 + 6}{3} = \frac{0}{3} = 0$$

Therefore, $D = (3, 0)$.

Summary of Key Points and Geometric Significance

- Point C is located at (0, 3), representing the one-third division point along AB.
- Point D is located at (3, 0), representing the two-thirds division point along AB.

This division demonstrates how coordinate geometry simplifies segment division calculations, offering precise coordinates for points along a line segment.

Exploring Additional Geometric Relationships

While the primary task was to find D, understanding the broader geometric context enriches the analysis. For example:

Midpoint of AB:

$$M = \left(\frac{-3 + 6}{2}, \frac{6 + (-3)}{2} \right) = \left(\frac{3}{2}, \frac{3}{2} \right) = (1.5, 1.5)$$

Distance between A and B:

$$AB = \sqrt{(6 - (-3))^2 + (-3 - 6)^2} = \sqrt{9^2 + (-9)^2} = \sqrt{81 + 81} = \sqrt{162} \approx 12.727$$

Length of segments AC and CD:

- AC length:

$\sqrt{}$

AC = \text{distance between } (-3, 6) \text{ and } (0, 3):

$$AC = \sqrt{(0 - (-3))^2 + (3 - 6)^2} = \sqrt{3^2 + (-3)^2} = \sqrt{9 + 9} = \sqrt{18} \approx 4.243$$

CD length:

$$CD = \sqrt{(3 - 0)^2 + (0 - 3)^2} = \sqrt{3^2 + (-3)^2} = \sqrt{9 + 9} = \sqrt{18} \approx 4.243$$

This confirms that the segment AB is divided equally into three parts, with each of these smaller segments approximately 4.243 units long.

Implications and Applications of the Findings

Understanding how to divide segments into equal parts using coordinate geometry has numerous applications:

- Design and Engineering: Precise division points are critical in structural design, ensuring even load distribution.
- Computer Graphics: Calculating points along lines for rendering or animation.
- Navigation and Mapping: Dividing routes into equal segments for waypoints.
- Educational Tools: Teaching concepts of ratios, proportions, and coordinate calculations.

The methodology illustrated here—using the section formula—can be extended to more complex geometric constructions, such as dividing polygons, constructing similar figures, or analyzing vectors.

Conclusion: Mastery of Segment Division in Coordinate Geometry

This detailed exploration demonstrates the power of coordinate geometry in solving segment division problems with clarity and precision. By leveraging the section formula, we identified the exact coordinates of points C and D that divide segment AB into three equal parts. The process underscores the importance of understanding ratios, the significance of segment division, and the utility of coordinate calculations in broader geometric contexts.

Whether applied in theoretical mathematics, practical engineering, or computer graphics, the principles highlighted here serve as foundational tools for spatial analysis and problem-solving. Mastery of these techniques enhances geometric intuition and equips learners and professionals alike with the skills necessary to approach complex spatial problems efficiently and accurately.

Keywords: Coordinate Geometry, Segment Division, Section Formula, Point D, Geometric Analysis, Line Segment, Ratio, Point Coordinates, Mathematical Precision

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