8.1 The Cartesian Coordinate System

French mathematician René Descartes is credited for uniting geometry and algebra his development of the Cartesian Coordinate System. As a result of his work, we are now able to find a visual representation of an equation.

Let’s begin by describing the basics behind the Cartesian Coordinate System which is formed by intersecting two number lines at a $90\degree$ angle at the zero location of each. This point of intersection is called the origin.

The horizontal number line is called the $x$-axis and the vertical number line is called the $y$-axis.

Each point in the Cartesian Coordinate System is identified with an ordered pair of numbers.

To locate a point, we need to know the $x$-coordinate and $y$-coordinate. The $x$-coordinate is the horizontal distance from the origin and the $y$-coordinate is the vertical distance from the origin.

The sign of the coordinate indicates which direction to move.

A positive $x$-coordinate means move right $x$ units. A positive $y$-coordinate means move up $y$ units.
A negative $x$-coordinate means move left $x$ units. A negative $y$-coordinate means move down $y$ units.
If the $x$-coordinate is zero, there is no movement. If the $y$-coordinate is zero, there is no movement.

The graph (or plot) of an ordered pair is a closed circle drawn at the location of the point $P(x, y)$.  

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**Example 1:** Plot the point \( P(6, 8) \).

**Solution:**

Start at the origin.

Move **right** along the horizontal \( x \)-axis to 6.

Move **up** 8 units until aligned with the 8 on the vertical \( y \)-axis.

Draw a **closed circle** at the location \( (6, 8) \).

Label the point with the letter \( P \).

**Note:** We always label each point we plot with the letter given in the directions. If there is no letter given, then write the coordinates \((x, y)\) near the point.

**You Try It 1:**

a) Plot the point \( Q(9, 4) \).

b) Plot the point \( R(2, 6) \).
**Example 2:** Plot the point $A(-3, 4)$.

Solution:

Start at the origin.

Move **left** along the horizontal $x$-axis to $-3$.

Move **up** 4 units until aligned with the 4 on the vertical $y$-axis.

Draw a **closed circle** at the location $(−3, 4)$.

Label the point with the letter $A$.

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**You Try It 2:**

a) Plot the point $B(-5, 8)$.

b) Plot the point $C(-9, 1)$. 

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**Example 3:** Plot the point $D(-5, -7)$.

**Solution:**

Start at the origin.

Move **left** along the horizontal $x$-axis to $-5$.

Move **down** 7 units until aligned with the $-7$ on the vertical $y$-axis.

Draw a **closed circle** at the location $(-5, -7)$.

Label the point with the letter $D$.

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**You Try It 3:**

a) Plot the point $E(-2, -4)$.

b) Plot the point $F(-7, -3)$.  

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**Example 4:** Plot the point \( U (0, 4) \).

Solution: Start at the origin.

The 0 indicates that we do not move along the horizontal \( x \)-axis.

Move up along the vertical \( y \)-axis until aligned with the 4.

Draw a closed circle at the location \((0, 4)\).

Label the point with the letter \( U \).

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**You Try It 4: a)** Plot the point \( V (0, -4) \).

**b)** Plot the point \( W (0, 9) \).
Example 5: Plot the point $G(-9, 0)$.

Solution: Start at the origin.

Move left along the horizontal $x$-axis to $-9$.

The 0 indicates that we do not move along the vertical $y$-axis.

Draw a closed circle at the location $(-9, 0)$.

Label the point with the letter $G$.

You Try It 5: a) Plot the point $H(9, 0)$.

b) Plot the point $I(1, 0)$.
Example 6: Plot the following points on the same set of axes.

a) \(O(0, 0)\)  
b) \(P(5, -6)\)  
c) \(Q\left(-\frac{4}{2}, 1\right)\)  
d) \(R\left(0, \frac{7}{2}\right)\)

Solution:

a) \((0, 0)\) are the coordinates of the origin. There is no horizontal nor vertical movement.

b) Start at the origin. Move 5 units to the right, then move 6 units down.

c) Start at the origin. Move \(\frac{4}{2}\) units to the left, then move 1 unit up.

d) \(\left(0, \frac{7}{2}\right)\) is the same as \(\left(0, \frac{3}{2}\right)\). Start at the origin. There is no horizontal movement. Move \(\frac{3}{2}\) units up.

You Try It 6: Plot the following points on the same set of axes.

a) \(S(-8, 0)\)  
b) \(T(1, 7)\)  
c) \(U\left(\frac{11}{2}, -3\right)\)  
d) \(V\left(-8, -\frac{4}{2}\right)\)
Example 7: Use the graph below to identify the coordinates of the points $J$ and $K$.

![Graph](image)

Solution: This example emphasizes the importance of reading a graph carefully.

To find the coordinates of each point, draw a vertical and horizontal line from the point to each axis to accurately identify each coordinate.

Point $J$ has $x$-coordinate $-5$ and $y$-coordinate $5$. So, the coordinates of $J$ are $(-5, 5)$.

Point $K$ has $x$-coordinate $2$ and $y$-coordinate $-6$. So, the coordinates of $K$ are $(2, -6)$. 
You Try It 7: Use the graph below to identify the coordinates of the points $L$, $M$, $N$, and $P$.

Example 8: Plot the following points on the same set of axes. Connect the points in the order given to form a closed geometric figure. Then find the area of the figure formed.

$A(-2, -2) \quad B(-2, 7) \quad C(1, 7) \quad D(1, -2)$

Solution:

The four points form a rectangle. **Rectangle $ABCD$ has length 9 units and width 3 units.**

**Area of Rectangle $ABCD$:** $A = lw$

$= (9 \text{ units})(3 \text{ units})$

$= 27 \text{ square units}$
You Try It 8: Plot the following points on the same set of axes. Connect the points in the order given to form a closed geometric figure. Then find the area of the figure formed.

\[ A \left( -8, -4 \right) \quad B \left( -8, 2 \right) \quad C \left( 3, 2 \right) \quad D \left( 3, -4 \right) \]

Example 9: Plot the following points on the same set of axes. Connect the points in the order given to form a closed geometric figure. Then find the area of the figure formed.

\[ E \left( 3, -4 \right) \quad F \left( 0, 7 \right) \quad G \left( 6, 7 \right) \]

Solution:

The three points form a triangle. Triangle EFG has base 6 units and height 11 units.
Area of Triangle $EFG$: $A = \frac{1}{2}bh$

$= \frac{1}{2}(6 \text{ units})(11 \text{ units})$

$= 33 \text{ square units}$

You Try It 9: Plot the following points on the same set of axes. Connect the points in the order given to form a closed geometric figure. Then find the area of the figure formed.

$E(-6, 0)$  $F(2, 0)$  $G(2, -7)$