Section 3.1

The Rectangular Coordinate System

Each point on a rectangular coordinate plane is represented by a pair of numbers called an ordered pair \((x, y)\).

Completing Ordered Pairs and Making a Table

Complete the table of ordered pairs for \(3x - 4y = 12\).

**Solution:**

<table>
<thead>
<tr>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-2</td>
<td></td>
</tr>
<tr>
<td>-6</td>
<td></td>
</tr>
</tbody>
</table>

**a.** \((0, \_\_\_)\)

Replace \(x\) with 0 in the equation to find \(y\).

\[
3x - 4y = 12 \\
3(0) - 4y = 12 \\
0 - 4y = 12 \\
-4y = 12 \\
y = -3
\]
Complete the table of ordered pairs for \(3x - 4y = 12\).

**Solution:**

<table>
<thead>
<tr>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-3</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>-2</td>
<td>-2</td>
</tr>
<tr>
<td>-6</td>
<td></td>
</tr>
</tbody>
</table>

**b. \((__, 0)\)**

Replace \(y\) with 0 in the equation to find \(x\).

\[
3x - 4y = 12 \\
3x - 4(0) = 12 \\
3x - 0 = 12 \\
3x = 12 \\
x = 4
\]

**c. \((__, -2)\)**

Replace \(y\) with -2 in the equation to find \(x\).

\[
3x - 4y = 12 \\
3x - 4(-2) = 12 \\
3x + 8 = 12 \\
3x = 4 \\
x = \frac{4}{3}
\]
Completing Ordered Pairs and Making a Table (cont’d)

Complete the table of ordered pairs for \(3x - 4y = 12\).

**Solution:**

<table>
<thead>
<tr>
<th>(x)</th>
<th>(y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(-3)</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>(\frac{4}{3})</td>
<td>(-2)</td>
</tr>
<tr>
<td>(-6)</td>
<td>(-\frac{15}{2})</td>
</tr>
</tbody>
</table>

**d. \((-6, \ldots)\)**

Replace \(x\) with \(-6\) in the equation to find \(y\).

\[
3x - 4y = 12 \\
3(-6) - 4y = 12 \\
-18 - 4y = 12 \\
-4y = 30 \\
y = \frac{-15}{2}
\]

Graph lines.

The **graph of an equation** is the set of points corresponding to all ordered pairs that satisfy the equation. It gives a “picture” of the equation.

**Linear Equation in Two Variables**

A **linear equation in two variables** can be written in the form

\[
Ax + By = C,
\]

where \(A, B,\) and \(C\) are real numbers and \(A\) and \(B\) not both 0. This form is called **standard form**.
x and y intercepts

The x-intercept is where the graph crosses the x-axis.
The y-intercept is where the graph crosses the y-axis.

To find the x-intercept, substitute 0 for y and solve for x. This will give you an ordered pair of the form (x,0).

To find the y-intercept, substitute 0 for x and solve for y. This will give you an ordered pair of the form (0,y).

Find the x-intercept and the y-intercept for each of the equations. Using these graph the equation.

5x + 2y = 10
Recognize equations of horizontal and vertical lines and lines passing through the origin.

A line parallel to the x-axis will not have an x-intercept. Similarly, a line parallel to the y-axis will not have a y-intercept.
**Graphing a Horizontal Line**

Graph $y = 3$.

**Solution:**

Writing $y = 3$ as $0x + 1y = 3$ shows that any value of $x$, including $x = 0$, gives $y = 3$.

Since $y$ is always 3, there is no value of $x$ corresponding to $y = 0$, so the graph has no $x$-intercepts.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
</tr>
</tbody>
</table>

The horizontal line $y = 0$ is the $x$-axis.

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**Graphing a Vertical Line**

Graph $x + 2 = 0$.

**Solution:**

$1x + 0y = -2$

shows that any value of $y$, leads to $x = -2$, making the $x$-intercept $(-2, 0)$.

No value of $y$ makes $x = 0$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>0</td>
</tr>
<tr>
<td>-2</td>
<td>2</td>
</tr>
</tbody>
</table>

The vertical line $x = 0$ is the $y$-axis.
Use the midpoint formula.

If the coordinates of the endpoints of a line segment are known, then the coordinates of the \textbf{midpoint (M)} of the segment can be found by averaging the coordinates of the endpoints.

\begin{align*}
\text{Midpoint Formula} \\
\text{If the endpoints of a line segment } PQ \text{ are } (x_1, y_1) \text{ and } (x_2, y_2), \text{ its midpoint } M \text{ is} \\
\left( \frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right).
\end{align*}

In the midpoint formula, the small numbers 1 and 2 in the ordered pairs are called \textit{subscripts}, read as “x-sub-one and y-sub-one.”
Find the midpoint of each segment with the given endpoints.

(5,2) and (-1,8)

(-10,4) and (7,1)

\[
\left(\frac{3}{5}, -\frac{1}{3}\right) \text{ and } \left(\frac{1}{2}, -\frac{7}{2}\right)
\]