1. **Slope**

* **rise**
  
* **run**

\[ \frac{y_2 - y_1}{x_2 - x_1} \]

\[ \text{Slope} = 0 \]

\[ \text{undefined slope} \]

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**Key Concept**

**Forms of Linear Equations**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Symbols</th>
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<tr>
<td>The slope-intercept form of an equation of a nonvertical line is ( y = mx + b ), where ( m ) is the slope and ( b ) is the ( y )-intercept.</td>
<td>( y = mx + b )</td>
</tr>
<tr>
<td>The point-slope form of an equation of a nonvertical line is ( y - y_1 = m(x - x_1) ), where ( m ) is the slope and ( (x_1, y_1) ) is a point on the line.</td>
<td>( y - y_1 = m(x - x_1) )</td>
</tr>
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</table>

* Use when you know the slope and \( y \)-intercept.
* Use when you know the slope and a pt. or 2 pts.
EXAMPLE 1
Graph the following lines.

A. \( y = -\frac{3}{4}x + 2 \)

B. \( y = 2x - 3 \)

EXAMPLE 2
Write the equations for the lines with the given information.

A. slope = 9, y-intercept = -1
   \[ y = mx + b \]
   \[ y = 9x - 1 \]

B. slope = -2, point (-4, 5)
   \[ y - y_1 = m(x - x_1) \]
   \[ y - 5 = -2(x + 4) \]
   \[ y = -2x - 3 \]

C. points (-3, 1) and (5, 2)
   \[ \frac{2-1}{5-(-3)} = \frac{1}{8} \]
   \[ y - y_2 = \frac{1}{8}(x - 5) \]
   \[ y - 2 = \frac{1}{8}x - \frac{5}{8} \]
   \[ y = \frac{1}{8}x + \frac{3}{8} \]
EXAMPLE 3
Write the equations for the horizontal and vertical lines that go through the point \((-5, 7)\).

Horizontal: \(y = 7\)  
Vertical: \(x = -5\)

**Key Concept**  
Slopes of Parallel Lines
- If two nonvertical lines are parallel, then their **slopes are equal**.
- If the slopes of two distinct nonvertical lines are equal, then the lines are parallel.
- Any two vertical lines or horizontal lines are parallel.

EXAMPLE 4
**Got It?** Line \(\ell_3\) contains \(A(-13, 6)\) and \(B(-1, 2)\). Line \(\ell_4\) contains \(C(3, 6)\) and \(D(6, 7)\). Are \(\ell_3\) and \(\ell_4\) parallel? Explain.

\[
\ell_3: \frac{2-6}{-1-(-13)} = \frac{-4}{12} = -\frac{1}{3}
\]
\[
\ell_4: \frac{7-6}{6-3} = \frac{1}{3}
\]
\(\ell_3\) is not \(\parallel\) to \(\ell_4\) because they don't have the same slope.

EXAMPLE 5
**Got It?** What is an equation of the line parallel to \(y = -\frac{1}{x} - 7\) that contains \((-5, 3)\)?

\(m = -1\)

\[
y - 3 = -1(x + 5)
\]

\[
y - 3 = -x - 5
\]

\[
y = -x - 2
\]
**Key Concept  ** Slopes of Perpendicular Lines

- If two nonvertical lines are perpendicular, then the product of their slopes is $-1$.
- If the slopes of two lines have a product of $-1$, then the lines are perpendicular.
- Any horizontal line and vertical line are perpendicular.

**EXAMPLE 6**

**Got It?** Line $\ell_3$ contains $A(2, 7)$ and $B(3, -1)$. Line $\ell_4$ contains $C(-2, 6)$ and $D(8, 7)$. Are $\ell_3$ and $\ell_4$ perpendicular? Explain.

$\ell_3: \frac{-1-7}{3-2} = \frac{-8}{1} \\
\ell_4: \frac{7-6}{8-2} = \frac{1}{6}$

**EXAMPLE 7**

**Got It?** What is an equation of the line perpendicular to $y = -3x - 5$ that contains $(-3, 7)$?

$m = \frac{1}{3} \\
y - 7 = \frac{1}{3}(x + 3) \\
y = \frac{1}{3}x + 8$
EXAMPLE 8
Write equations for the lines using the given information.

A. passes through $(1, 7)$ parallel to the line through $(-3, 1)$ and $(4, 2)$

$m = \frac{2-1}{4-(-3)} = \frac{1}{7}$

$(1, 7)$

$y - 7 = \frac{1}{7}(x - 1)$

$y - 7 = \frac{1}{7}x - \frac{1}{7}$

$y = \frac{1}{7}x + 6 \frac{1}{7}$

B. passes through $(-2, 5)$ perpendicular to the line through $(8, 1)$ and $(-6, 2)$

$m = \frac{2-1}{-6-8} = -\frac{1}{14}$

$m = 14$  

$(-2, 5)$

$y - 5 = 14(x + 2)$

$y - 5 = 14x + 28$

$y = 14x + 33$