**Example 1:** The two lines given below are perpendicular. What do you notice about the slopes of those two lines?

\[ l_1 \text{ and } l_2 \text{ have slopes that are the negative reciprocal of each other } \left( l_1 \text{ } m = \frac{4}{3}, \text{ } l_2 \text{ } m = -\frac{3}{4} \right). \text{ This is true not just for these two lines which are perpendicular, but for all perpendicular lines.} \]

**Perpendicular lines:**
- two lines that intersect at a right angle (90°)
- the slopes of the lines are the negative reciprocal of each other (opposite signs, flipped over)
  - if two lines are perpendicular, and the slope of the first line is \( m \), the slope of the second line is \( -\frac{1}{m} \)
**Example 2:** Find the slope of a line that is perpendicular to the line \( y = \frac{2}{3}x - 4 \). Enter exact answers only (no approximations).

When a linear equation is expressed in slope-intercept form, like \( y = \frac{2}{3}x - 4 \), the slope is simply the coefficient of \( x \). So in this case the slope is \( \frac{2}{3} \).

In order to be perpendicular to the line \( y = \frac{2}{3}x - 4 \), any other line must have a slope that is the negative reciprocal of that. So perpendicular lines must have a slope of \( -\frac{3}{2} \).

**Example 3:** Find the slope of a line that is perpendicular to the line \( 9x - 4y = 5 \). Enter exact answers only (no approximations).
**Example 4:** Find the equation of the line passing through the point $A(2, -3)$ and is perpendicular to a line with a slope of $m = -\frac{8}{7}$. Enter exact answers only (no approximations), and write the equation in slope-intercept form (if possible).

\[
y - y_1 = m(x - x_1)
\]

\[
y - (-3) = \frac{7}{8}(x - 2)
\]

\[
y + 3 = \frac{7}{8}x - \frac{7}{4}
\]

\[
y = \frac{7}{8}x - \frac{19}{4}
\]

On this problem we need to find the equation of a line that is perpendicular to some other line with a slope of $-\frac{8}{7}$. If the line we want to be perpendicular to has a slope of $-\frac{8}{7}$, then the slope of our line needs to $\frac{7}{8}$. So to find the equation that passes through the point $A(2, -3)$ and has a slope of $\frac{7}{8}$, I replace $m$ with $\frac{7}{8}$ and $(x_1, y_1)$ with the point $(2, -3)$ and I plugged this information into point-slope form.

**Example 5:** Find the equation of the line that passes through the point $A(4, 5)$ and is perpendicular to the line $y = -\frac{3}{2}x + \frac{7}{2}$. Enter exact answers only (no approximations), and write the equation in slope-intercept form (if possible).
Example 6: Find the equation of the line that passes through the point \( A(7, -3) \) and is perpendicular to the line \( 2x - 5y = 8 \). Enter exact answers only (no approximations), and write the equation in slope-intercept form (if possible).

Example 7: Find the equation of the line with a \( y \)-intercept of 2, that is perpendicular to the \( y \)-axis. Enter exact answers only (no approximations), and write the equation in slope-intercept form (if possible).

Keep in mind that horizontal lines have a slope of zero and are of the form \( y = \# \), while vertical lines have an undefined slope and are of the form \( x = \# \).
**Example 8:** Find the equation of the line with an $x$-intercept of 5, that is perpendicular to the line $5x + 9y = \frac{1}{8}$. Enter exact answers only (no approximations), and write the equation in slope-intercept form (if possible).

On this problem I’ll start by converting the linear equation $5x + 9y = \frac{1}{8}$ from general form to slope-intercept form so I can identify its slope.

\[
5x + 9y = \frac{1}{8}
\]

\[
9y = -5x + \frac{1}{8}
\]

\[
y = -\frac{5}{9}x + \frac{1}{72}
\]

Now that I know the slope of the given line is $-\frac{5}{9}$, I know that in order for another line to be perpendicular to the given line, its slope must be the negative reciprocal of that $\left(\frac{9}{5}\right)$. So I now have the slope of the line I’m trying to find $\left(m = \frac{9}{5}\right)$. And since the line I’m trying to find has an $x$-intercept of 5, I also have a point that I can use $(5, 0)$. So now I’ll plug this information into point-slope form:

\[
y - y_1 = m(x - x_1)
\]

\[
y - 0 = \frac{9}{5}(x - 5)
\]

\[
y = \frac{9}{5}x - 9
\]
Example 9: Find the equation of the line that crosses the $y$-axis at $-\frac{1}{4}$ and is perpendicular to the line $y = -\frac{7}{4}x + 5$. Enter exact answers only (no approximations), and write the equation in slope-intercept form (if possible).

Answers to Exercises:

1. negative reciprocal; 2. $m = -\frac{3}{2}$; 3. $m = -\frac{4}{9}$; 4. $y = \frac{7}{8}x - \frac{19}{4}$; 5. $y = \frac{2}{3}x + \frac{7}{3}$; 6. $y = -\frac{5}{2}x + \frac{29}{2}$; 7. $y = 2$; 8. $y = \frac{9}{5}x - 9$; 9. $y = \frac{4}{7}x - \frac{1}{4}$;