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

To find the slope of $l_1$ (the blue line) or $l_2$ (the red line), simply pick any two points that $l_1$ passes through, and then find the vertical change divided by the horizontal change ($m = \frac{\Delta y}{\Delta x}$).

- **$l_1$:**
  - Two points that $l_1$ passes through: $(0, -2), (3, 2)$
  - Slope of $l_1$: $m = \frac{\Delta y}{\Delta x} = \frac{4}{3}$

- **$l_2$:**
  - Two points that $l_2$ passes through: $(-4, 4), (0, 1)$
  - Slope of $l_2$: $m = \frac{\Delta y}{\Delta x} = \frac{-3}{4}$

$l_1$ and $l_2$ have slopes that are the negative reciprocal of each other ($l_1$ $m = \frac{4}{3}$, $l_2$ $m = -\frac{3}{4}$). 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 ($90^\circ$)
- 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 ($y = mx + b$), 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 ($y = mx + b$), if possible.

\[
y - y_1 = m(x - x_1) \\
y - 5 = \frac{2}{3}(x - 4) \\
y - 5 = \frac{2}{3}x - \frac{8}{3} \\
y = \frac{2}{3}x + \frac{7}{3}
\]

On this problem we need to find the equation of a line that is perpendicular to a given line with a slope of $-\frac{3}{2}$. If the line we want to be perpendicular to has a slope of $-\frac{3}{2}$, then the slope of our line needs to $\frac{2}{3}$. So to find the equation that passes through the point $A(4, 5)$ and has a slope of $\frac{2}{3}$, I replace $m$ with $\frac{2}{3}$ and $(x_1, y_1)$ with the point $(4, 5)$ and I plugged this information into point-slope form.
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 ($y = mx + b$), if possible.

Start by converting the equation $2x - 5y = 8$ to slope-intercept form (basically just get $y$ by itself).

$$2x - 5y = 8$$

$$-5y = -2x + 8$$

$$y = \frac{2}{5}x - \frac{8}{5}$$

Then find the equation of the line that parallel to the given line (remember that parallel lines have the same slope).

Then $y - y_1 = m(x - x_1)$

$y - \quad = \quad (x - \quad)$

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 ($y = mx + b$), if possible.

The $y$-axis is a vertical line. A line perpendicular to the $y$-axis would be a horizontal line. That means its slope would be zero.

$m = 0 \; ; \; (0, 2)$

$y = 0x + 2$

$y = 2$
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 \( (y = mx + b) \), 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.

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

\[
8(5x + 9y) = \left(\frac{1}{8}\right) 8
\]

\[
40x + 72y = 1
\]

\[
72y = -40x + 1
\]

\[
y = \frac{-40}{72}x + \frac{1}{72}
\]

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

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 \( \left(\frac{9}{5}\right) \). I now have the slope of the line I’m trying to find \( (m = \frac{9}{5}) \); since the line I’m trying to find has an \( x \)-intercept of 5, I also have a point that I can use, \((5, 0)\):

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

\[
y - 0 = \frac{9}{5}(x - 5)
\]
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 ($y = mx + b$), if possible.
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. \( y = \frac{4}{7}x - \frac{1}{4} \);